EERA
European Energy Research Alliance
JP WIND

R&I strategy

EERA JP Wind R&I strategy

I. Introduction to the EERA JP Wind R&I Strategy

II. Research Agenda topics:

1. Next generation wind turbine technologies and disruptive concepts
2. Grid integration and energy systems
3. Sustainability, Social Acceptance, Economics and Human Resources
4. Offshore wind (bottom-fixed and floating)
5. Operation and maintenance
6. Fundamental Wind Energy Science

The European Energy Research Alliance is the largest energy research community in Europe. It is a membership-based, non-profit association and brings together 250 universities and public research centres in 30 countries. To organise work within the association and realise its strategy, EERA operates 17 joint research programmes. They cover the whole range of low-carbon technologies as well as systemic and cross-cutting topics.

The Joint Programme on Wind Energy (JP Wind) is part of the EERA.

EERA JP Wind is a collaboration among the 53 major public research organisations in 16 European countries, with substantial research and innovation efforts in wind energy.

EERA JP WIND MISSION

The mission of 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.

EERA JP Wind aims to provide the following **benefits** to its partners:

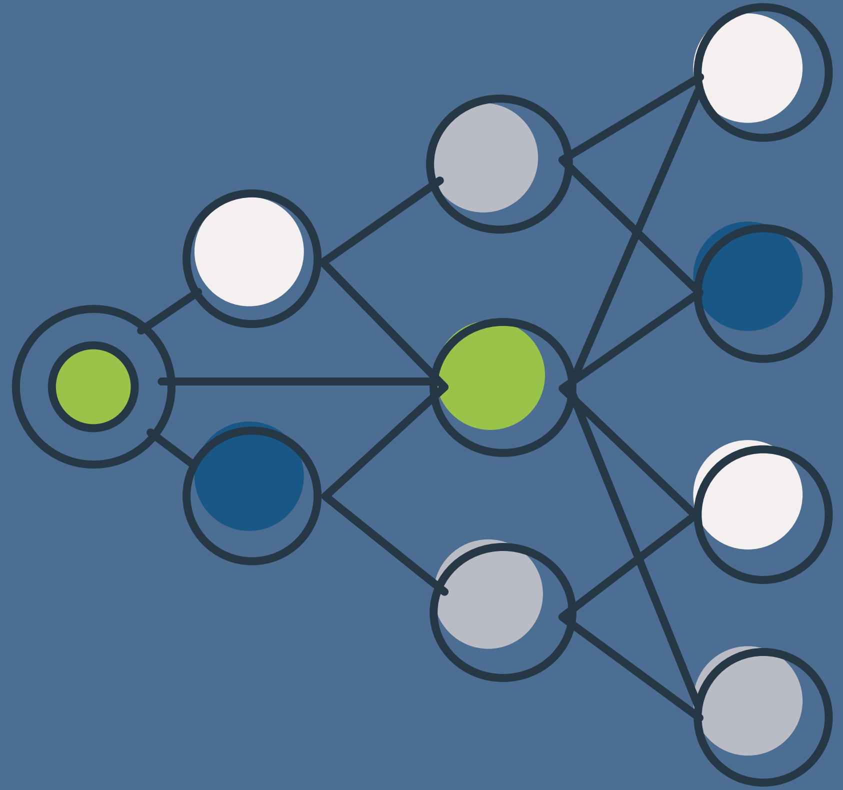
Support R&D managers in institutions with significant wind energy R&D in shaping their research strategies according to European and national priorities and build the network to execute it. In EERA JP Wind we work together, to develop and understand the key research priorities for the European wind energy sector and implement it through joint projects or in national research programmes.

Influence EU strategic research priorities. EERA JP Wind aims to be the most important platform to engage in EU strategic research priority setting. This will happen directly via EERA JP Wind as well as in collaboration with national partners and the European Technology and Innovation Platform for Wind Energy (ETIPWIND).

Access a unique pool of knowledge, data and research facilities. The members of EERA JP Wind are the main organisations for public wind energy R&D in Europe. That creates a unique knowledge pool and a platform for sharing and accessing data and research facilities.

Being part of a globally leading network of wind energy researchers. EERA JP Wind provides its members with a potential global outreach to collaborative partners around the world.

Development of EERA JP Wind R&I strategy and connection to other strategies



EERA JP Wind has developed its own R&I strategy. The 53 partners of EERA JP Wind have collaborated through workshops and discussions at the EERA JP Wind and SETWind annual event to define the R&I priorities for wind energy research. These R&I priorities will support the goals of the SET-Plan and contribute to an accelerated implementation of wind energy. The partners in EERA JP Wind are working on wind energy research and innovations that will keep Europe at the forefront of the world's pre-competitive wind energy research and maintain Europe's innovative wind industry. For that reason, EERA JP Wind works closely with ETIPWind and EAWE. The European Technology & Innovation Platform on Wind Energy (ETIPWind) is the industry platform that provides a public forum to wind energy stakeholders to identify common Research & Innovation (R&I) priorities and to foster breakthrough innovations in the sector. The European Academy of Wind Energy (EAWE) is a community of universities and research institutes in Europe.

Both **ETIPWind** and **EAWE** have recently published their research strategies. The R&I strategy of EERA JP Wind is strongly connected to these. The three research strategies are complementary and have their own purpose and application: where the ETIPWind strategy primarily aims at higher Technology Readiness Level (TRL) that supports industry on relatively short term needs, the EAWE strategy primarily focuses on more fundamental research topics at low Technology Readiness Level (TRL).

EERA JP Wind's research agenda may be seen as bridging these agenda's and spans over a broad range of technology readiness levels. It deals both with TRL 3-5 topics that support industry developments that are foreseen on longer timescales as well with TRL 6-8 activities, which primarily focuses on incremental innovations. All research is performed in close collaboration with industry and EERA JP Wind R&I priorities support the ETIPWind SRIA priorities. In addition, EERA JP Wind proposes strategic underpinning basic research as well as key radical high-risk innovations.

The EERA JP Wind strategy aims at research that is required to bring the results of more fundamental research into applications. The result is a research scope with a range of TRL 3 to TRL 8 and a strong focus on applicability to industry and product development. The innovations that result strongly support industry needs. A successful and leading European wind industry requires the support from expert groups in short, medium and long-term research activities and requires a research strategy from all three perspectives.

ETIP Wind
EUROPEAN TECHNOLOGY & INNOVATION PLATFORM ON WIND ENERGY

eawe
european academy of wind energy

Structure of the EERA JP Wind R&I strategy

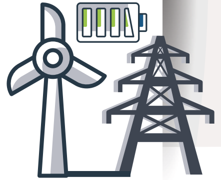
The partners in EERA JP Wind have defined the R&I strategy. It is intended to highlight the priority topics for wind energy research, each with associated challenges and key action areas. The resulting R&I strategy is the result of discussions with the 53 major European research groups organised in EERA JP Wind. Six urgent and important topics have been identified:

1

NEXT GENERATION WIND TURBINE TECHNOLOGY & DISRUPTIVE CONCEPTS

Large technology developments are being realised and foreseen while wind energy is being implemented in large numbers. The wind sector requires a strong scientific knowledge base to develop wind energy generators beyond its capabilities of today and tomorrow. New concepts contribute to the massive deployment but require major support at higher TRLs to overcome the inertia of existing concepts.

2



GRID INTEGRATION AND ENERGY SYSTEMS

R&I must contribute to the transition towards 100% RES power systems, understanding the challenges and developing the required technical capabilities. This includes aspects such as dynamic stability of systems with very large penetration of converters, market designs and interactions with other energy systems, energy sector coupling, energy conversion and storage.

3

SUSTAINABILITY, SOCIAL ACCEPTANCE AND HUMAN RESOURCES

Massive implementation of wind power must be done in a sustainable manner, creating maximum value for stakeholders, including investors, users and citizens with respect to the Sustainable Development Goals. This is achieved by taking away barriers to massive deployment, implementing more integrative development, and ensuring sufficient qualified human resource.

4

OFFSHORE WIND (BOTTOM FIXED + FLOATING)

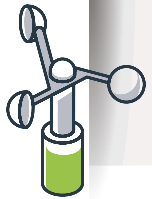
Massive offshore implementation of wind power requires R&I to further reduce risks and costs, thus accelerate deployment. Developments will occur further offshore and in deeper water requiring floating wind power. Integrated design methods need to be developed, including wind and waves, electrical infrastructure, environment, substructures, control, logistics and risks.

5

OPERATION AND MAINTENANCE

In order to reduce the cost of wind power, operation and maintenance must be optimised. Robotics solutions should reduce the required human intervention and sensor system provide the information for improved monitoring and control to increase life. The abundance of data and information should be used in big-data analytics technologies to improve O&M.

6



FUNDAMENTAL WIND ENERGY SCIENCE

Research in the fundamental wind energy sciences is required to develop the research competences and the underpinning scientific knowledge. This leads to improved standards, methods and design solutions. Models and experimental data are needed for complex sites and extreme climate, larger and lighter turbines, more efficient wind farms and large-scale penetration in the energy system.

EERA JP Wind R&I strategy – Contribution to SET Plan and SDGs

The outcome of the research described in the EERA JP Wind R&I strategy will contribute to the European Strategic Energy Technology Plan (SET Plan) as well as to the Sustainable Development Goals (SDGs).

SET Plan

The EU is committed to becoming the global leader in renewable energy technology and realise an CO2-free energy system. The EU Energy Roadmap 2050 aims to ensure a clean, competitive and reliable energy supply. The SET Plan aims to accelerate the development and deployment of low-carbon technologies. It promotes research and innovation efforts across Europe by supporting the most impactful technologies in the EU's transformation to a low-carbon energy system.

SDGs

The 2030 Agenda for Sustainable Development was adopted by all United Nations Member States in 2015, providing a shared blueprint for peace and prosperity for people and the planet, now and into the future. The 17 SDGs are an urgent call for action by all countries - developed and developing - in a global partnership. They recognize that ending poverty and other deprivations must go hand-in-hand with strategies that improve health and education, reduce inequality, and spur economic growth – all while tackling climate change and working to preserve our oceans and forests.

1.

Next generation wind turbine technologies and disruptive concepts

Large technology developments are being realised and foreseen while wind energy is being implemented in large numbers (6000GW wind power worldwide implementation). EERA partners work on next generation wind turbines, the outcome is used by industry for product development. New concepts require major support at higher TRLs (demonstration at full scale in a R&D context) to overcome the inertia of existing concepts.

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

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.

2.

Grid integration and energy systems

R&I must contribute to the transition towards 100% RES power systems, understanding the challenges and developing the required technical capabilities. This includes aspects such as offshore grid development and operation at North Sea scale, dynamic stability of electricity systems with very large penetration of converter-based generation and maintaining a secure and affordable energy provision through advanced ancillary services capabilities, hybrid renewable energy systems, sector coupling and energy conversion and storage.

2. Grid integration and energy systems

Research gaps

Validated energy systems models for assessing the value of wind power with 100 % variable renewable energy supply. Various scenarios / hourly timestep models exist, but with more or less crude assumptions, e.g. on wind variations, balancing capabilities, regional transportation bottlenecks, etc. New methods, metrics and tools to assess the adequacy of supply.

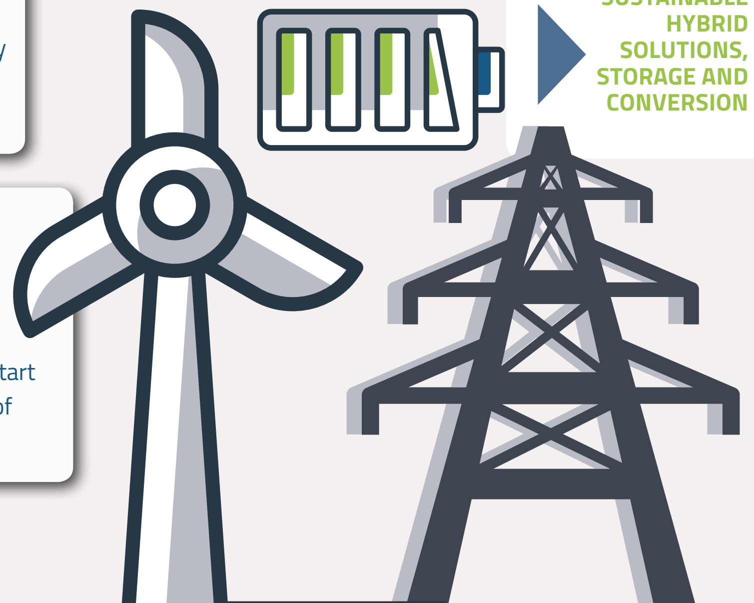
System friendly wind power. Wind power plants need to move towards being the backbone of the electricity system, being able to provide services like grid forming and black-start.

Behaviour and control of large HVDC connected clusters is vital for enabling future development of large interconnected offshore grids, serving to connect wind farms to different national markets and offshore loads, as well as power/energy exchange between regions. Essential aspects are strategic grid planning, optimal power flow, reliable operation and protection schemes and supporting the interconnected terrestrial grids.

Dynamic performance of very large wind power clusters needs to maintain power quality and stability in offshore wind farm grids that are fully based on power-electronic converters in order to guarantee reliable and efficient wind farm operation.

Degradation and failure mechanisms of cables, transformers and power electronic converters call for extensive research and testing to be fully understood and enable reliable grid solutions, including mitigating measures.

Advanced system services from wind power, providing reserve power for frequency support, reactive power for (dynamic) voltage support, mitigate or actively compensate harmonics for maintaining power quality and providing black start (grid forming operation) for increasing security of supply and helping system restoration, etc.



Key action areas

DESIGN AND CONTROL OF WIND POWER PLANTS FOR 100% RES POWER SYSTEM
Technical solutions for wind power plants to enable safe and efficient power system operation with 100% renewable generation.

POWER MARKET DESIGN, ENERGY MANAGEMENT AND BALANCING
The energy system transition requires development of tools for energy management, taking into account wind forecast uncertainty, and supporting the interaction between wind power, other generation, conversion and storage, demand-response and grid capacity limitations.

SUSTAINABLE HYBRID SOLUTIONS, STORAGE AND CONVERSION
Combining wind with other renewables, utilizing complementary generation patterns, contributes to improving the security of supply and lowering grid integration costs. Conversion and storage is essential to realize the required generation flexibility and security of supply, both in the short term as well as seasonal. Furthermore, integrating of these solutions in offshore wind farms is needed to facilitate their large-scale and economic integration, including off-grid approaches, i.e. using gas or other alternative energy carriers.

INCREASED PERFORMANCE OF WIND POWER VIA DIGITALIZATION
Use of field data, big data analytics and AI combined with system modelling for monitoring, control and performance optimization of wind power in the energy system.

OFFSHORE ENERGY HUBS
Development of energy hubs for offshore wind will lower the cost, augment inter-connection capacity and increase the resilience of the power system.

3.

Sustainability, Social Acceptance, Economics and Human Resources

Massive deployment of wind power must be done in a sustainable manner, creating maximum value for stakeholders, including citizens, users and investors with respect to the Sustainable Development Goals. This is achieved by taking away barriers to massive deployment, implementing more integrative development and ensuring sufficiently qualified human resource.

3. Research gaps

Sustainability, Social Acceptance, Economics and Human Resources

Identifying how wind energy can create even higher value for society, both on the market side (high value energy at low cost), on the societal side (maximising socio-economic benefits, avoiding negative impacts), depending on the interactions between market, technological, environmental issues within the overall policy and regulatory framework.

Assessing and quantifying the contribution of wind energy to the UN Sustainable Development Goals (SDG), and their broad array of indicators.

Developing technologies and designs to improve recycling and end-of-life solutions.

Identifying skills and training needs required for developing and handling future wind turbine designs and develop best practices for high quality training programs.

Assessing the economic and societal impact of research and innovation projects for wind energy.

Applying life-cycle assessment and estimating requirements of resources for the energy transition, including the availability of resources in power systems with very high shares of wind energy.

Transferring the understanding of mechanisms behind social acceptance into implementable approaches and demonstrating their value for project realisation.

Key action areas

IDENTIFY THE MOST PROMISING AREAS FOR VALUE CREATION BY WIND ENERGY IN THE FUTURE

Assessment of new ideas such as alternative routes to market (e.g. through hydrogen production), regulation and market design (e.g. to reduce barriers, adequate financial mechanisms to support wind investment), new business models (e.g. aggregator services), profit-sharing mechanisms (e.g. local ownership schemes).

STANDARDISED METHODS FOR QUANTITATIVE IMPACT ASSESSMENTS IN RESEARCH PROJECTS

Develop a method for broader socio-economic impact assessments to support prioritising technology innovation activities and project funding decisions (including cost indicators and value creation indicators).

RESEARCH-BASED AND TARGETED CONTINUING EDUCATION AND TRAINING

Identify industry needs and required research-based education and training actions to develop adequate human resources with the right skills and competences that are key to Europe's continued global leadership in wind energy. New skills are required as the technology evolves.

RECYCLING AND CIRCULAR ECONOMY

As wind power increases its share in the energy mix, it needs to address issues related to its environmental and social footprints. An environmental and community friendly design also includes the 'afterlife' of a turbine. We need to develop technologies that are easily recyclable, create designs that are good for recycling and embrace circular economy concepts in our research and development.

SHOW-CASE BEST PRACTICES TO EMPOWERING CITIZENS AND PUBLIC ENGAGEMENT IN WIND POWER PROJECTS

Extensive wind onshore deployment is increasingly impacting citizens, who need be included in the planning and design process. During the past years, we have started to understand mechanisms and solutions for effective participatory processes and create acceptability. We now need demonstration projects on how to build the 'acceptable' onshore wind plant.

4.

Offshore wind (bottom fixed + floating)

Massive offshore implementation of wind power requires R&I to further reduce risks and costs, thus accelerate deployment. Developments will occur further offshore and in deeper water requiring floating wind power. Integrated design methods need to be developed which includes wind and waves, electrical infrastructure, environment, substructures, control, logistics and risks.

Research gaps

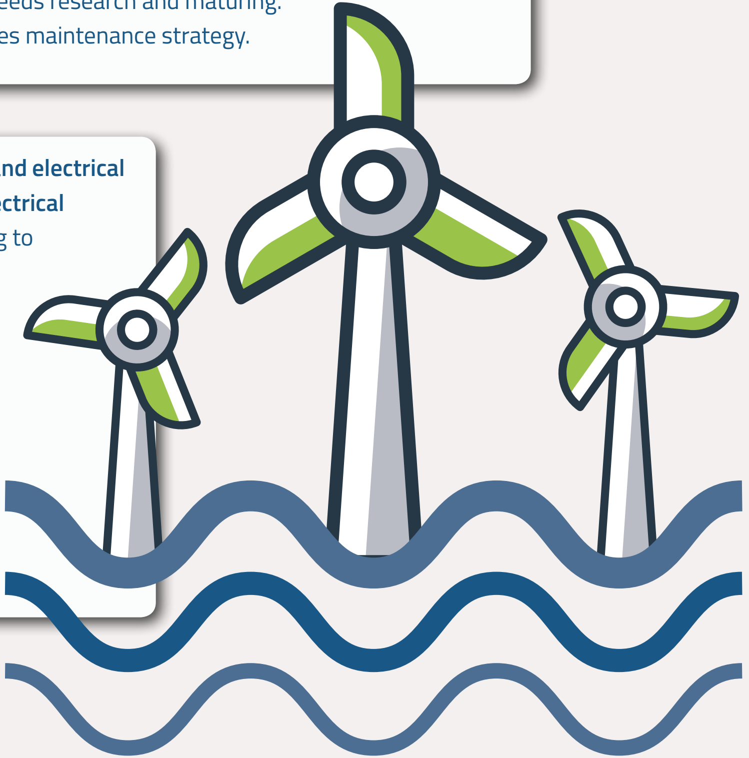
Offshore wind (bottom fixed + floating)

Validation of integrated design models for floating wind plants is needed to ensure cost effective designs and to maximize the opportunities for floating foundations optimization based on wind turbine load control technology.

Efficient multi-disciplinary optimization offers to achieve cost effective and reliable foundations, accounting for a wide range of design parameters and needs research and maturing. Platform and mooring lines maintenance strategy.

Offshore physics (soil damping, breaking waves, soil-structure-fluid interaction, air-sea interaction). The limited understanding of physics phenomena and model uncertainties affecting offshore balance of plant technology prevents accurate design models and optimal cost-effective designs. Proper data sets are lacking.

Site-specific structural and electrical design conditions for electrical infrastructure are lacking to better understand the loading and operational conditions of key electrical components like cables or power converters, enabling improvements in reliability.



Key action areas

ENABLING FLOATING WIND
Develop design model for integrated aero-hydro-elastic optimisation including cost optimisation. Develop technology to enhance mass-production and installation of floating platforms. Develop smart and disruptive solutions for (dynamic) mooring.

EXPERIMENT FOR VALIDATION OF DESIGN AND MULTI-DISCIPLINARY OPTIMIZATION MODELS FOR OFFSHORE WIND FARMS (FLOATING AND FIXED). CREATING OPEN ACCESS DATA SETS
Execute large-scale floating experiment to create open access experimental datasets for effective design model validation and uncertainty calculations, leading to faster improvements of design tools and more accurate designs. Develop an effective coupling of offshore design models (i.e. balance of plant - wind turbine) and metocean models to enable overall system optimization.

UNDERSTANDING AND MODELLING OFFSHORE PHYSICS FOR WIND FARM DESIGN AND OPERATION
The improvement of models focused on key physical phenomena (i.e. soil-structure-fluid interaction) is needed to develop better design tools for industry, able to capture a broader spectrum of failure modes.

UNDERSTANDING THE MECHANICAL AND ELECTRICAL DESIGN CONDITIONS FOR ELECTRICAL INFRASTRUCTURE FOR FLOATING WIND FARMS
Develop more accurate and site-specific load models accounting for metocean conditions (i.e. hydrodynamic forces on dynamic cables) as well as the electrical operational conditions and interactions for improved layout including connections, transformers and inter-array cables.

DEEP SEA FAR OFFSHORE LOCATIONS
Call for new cost-effective solutions for grid connection of floating wind farms, and design of electrically isolated power to X wind farm systems. New knowledge, models and solutions should be developed for inter-array solutions, subsea technologies and solutions for transmission, including alternative wind farm designs for power to X.

IMPACT ON SEA-LIFE AND POSSIBILITIES FOR MULTI-USE
Should be assessed, and models and solutions for environmentally friendly holistic design and operation of offshore wind farms should be developed.

5.

Operation and maintenance

In order to reduce the cost of wind power, operation and maintenance must be optimized. Robotics solutions should reduce the required human intervention and sensor systems provide the information for improved monitoring and control to increase life. The abundance of data and information should be used in big-data analytics technologies to improve O&M.

5. Research gaps

Operation and maintenance

Accurate reliability models of components as functions of operation and loads. Condition based maintenance or replacement of (sub)components relies on accurate reliability models that can predict remaining lifetime or probability of failure for a given load history.

Lifetime extension – is an effective solution for reduction of LCOE reduction as well as impact to environment and resources.

Robotics – Reduction to human presence at offshore platforms at large height to improve health and safety by automated and remote inspections and repair inside the nacelle as outside the turbine.

Degradation mechanisms of surfaces (wear, erosion and corrosion). Unknowns in degradation mechanisms (f.i. wear in blades and drivetrain, erosion of blades and corrosion of support structures) lead to unexpected behaviour and limited options for cures.

Data analytics for O&M purpose and lifetime health prediction for predictive maintenance. Abundant information and data are available from wind farms, for which processing by big-data analytics technology needs to be developed.

Key action areas

DEVELOPMENT AND VALIDATION OF MODELS OF COMPONENT AND STRUCTURAL DAMAGE AND DEGRADATION AS FUNCTIONS OF LOADS AND ENVIRONMENT
The fundamentals and results of damage and degradation need to be developed from micro-scale to macro-scale level. Validation requires extensive testing programmes.

NEXT GENERATION OF WIND FARM CONTROL
Advanced (including data-driven, model-free, AI, etc) and holistic multi-objective wind farm control optimizing overall performance.

ENABLE DIGITAL TRANSFORMATION IN WIND ENERGY SYSTEM O&M
The abundance of available data requires big data analytics and applying real time testing and "digital twins" to be developed to recognize patterns and improve energy yield and control degradation.

SENSOR SYSTEMS AND DATA ANALYTICS FOR HEALTH MONITORING
Robust, reliable, accurate and durable sensors need to be developed to monitor the condition and degradation of the most critical components and external conditions against lowest costs. Self-diagnostic systems and multi-sensor constructions may include remote sensing of external conditions and damage such as lidars, drones etc.

ROBOTICS
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.

6.

Fundamental Wind Energy Science

Research in the fundamental wind energy sciences is required to develop the research competences and the underpinning scientific knowledge to improve standards, methods and design solutions. Also models and experimental data are needed for complex sites and extreme climates, larger and relatively lighter turbines, more efficient wind farms and large-scale penetration in the energy system. The research leads to updated standardized design criteria and standardized methods for testing and validation.

Photo by A. Vestergaard, UniTTe.dk

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.

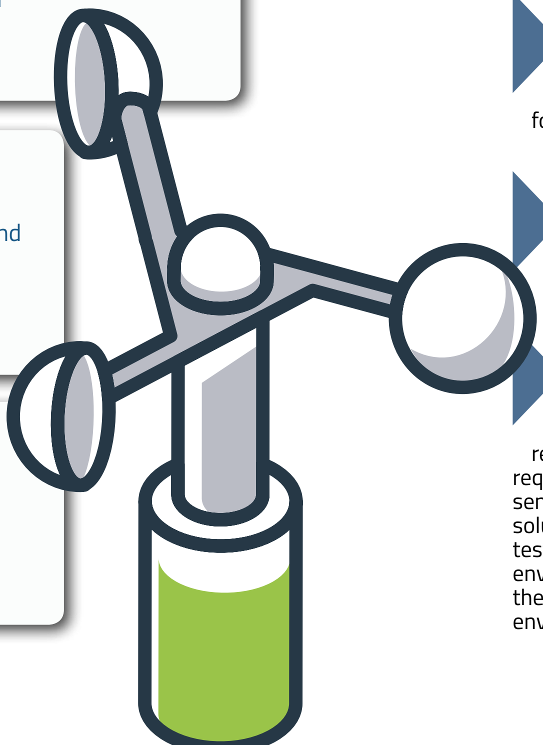
Atmospheric multi-scale flow from mesoscale to wind farm flows i.e. accurate and validated model predicting properties of flow in complex terrain regions down to wind farm flow affected by wakes and turbine control. Improved understanding of important physical phenomena may lead to update of fast engineering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

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.

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.

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.

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

MULTI-SCALE FLOW MODELLING

Multi-scale modelling using high fidelity and high-performance computing to provide accurate estimates of important parameters for siting, control, 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.

European Energy Research Alliance

JP WIND

European Energy Research Alliance (EERA) Aisbl
Joint Programme on Wind Energy
72 rue de Namur | 1000 Brussels | Belgium
+32 2 568 01 04
eerajpwind@eera-set.eu

eerajpwind.eu

EERA
European Energy Research Alliance
JP WIND