ETIP Wind

EUROPEAN TECHNOLOGY & INNOVATION PLATFORM ON WIND ENERGY

Report with conclusions from the workshop on Horizon 2020 Energy work programme 2018 -2020

WindEurope

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Introduction

The European Technology and Innovation Platform on Wind Energy (ETIPWind) connects Europe's wind energy technology community coming from policy, academia and the industry. It contribute to positioning wind energy as a strategic industrial sector for Europe by:

- Influencing the direction and priorities of EU research and innovation (R&I) policy to drive down Levelised Cost of Electricity (LCoE), sustain the European wind energy industry's technological leadership and train/educate the needed personal (academical and technical);
- Promoting an ambitious visionary strategy placing wind energy at the centre of the European technology and innovation policy to 2020 and beyond;
- Responding to political consultations and developing reports that communicate the strategical focus on R&I;
- Coordinating the alignment of priorities at EU and national levels, taking into account the Strategic Research Agenda and the updated Strategic Energy Technology Plan (SET-Plan) objectives as well as other strategic roadmaps;
- Organising workshops and networking events in order to bring key decision makers from the research community, industry and political environment together.

The ETIPWind has two constituted bodies:

- **Advisory Group:** CTOs from leading developers, manufactures and utilities who convene twice a year to advice on strategic R&I objectives.
- **Steering Committee:** Technical representatives from leading wind energy industry and research institutions who meet every three months to confirm the suggested objectives and execute follow-up activities.

The **R&I workshop** taking place on June, 3rd gathered the wind energy community in order to agree on the R&I challenges and priorities that should form the basis of the 2016 Strategic Research Agenda (SRA), with the main focus on fulfilling the following objectives:

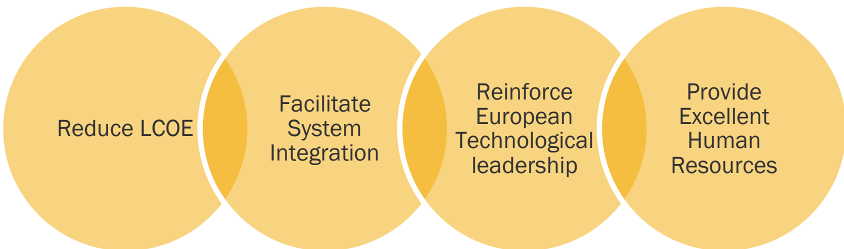


Figure 1. Main objectives of SRA 2016

The gap analysis carried out in Q1 2016 - "The status of implementation of SRA 2014 and future priorities" highlighted four main priorities, narrowing the R&I scope and emphasizing the research and innovation areas that could allow academia and industry stakeholders to increase collaboration in R&I projects suitable for European funding schemes.

The identified R&I priorities formed the basis of the discussion of the workshop, the audience also raised important additional points that is taken into account in the conclusions in this report. Additionally they will be taken into consideration when writing the SRA 2016. Finally, R&I stakeholder were enabled to raise other topics after the workshop, mentioning them in the ETIPWind website

Contents

1 A word of welcome by the ETIPWind Chairman

Aidan Cronin, Chairman, ETIPWind Steering Committee

Overview of the main challenges for policy, industry and academia, and the role of ETIPWind to support them. An emphasis was put on the role of ETIPs as industry-led stakeholder forums recognised by the European Comission as key actors in driving innovation. The timeline for the ETIPWind Work Programme 2016 was reminded, highlighting the release of the Strategic Research Agenda 2016 in September 2016 as the main result.

ETIPWind is, by EC contract PP03041-2014, required to: "*Provide […]an analysis on the status of the implementation of the SRA and the SET-plan integrated roadmap based on information coming from industry. In the analysis an overview should be provided of industrial developments, research investments in Research, Development and Innovation linked to the priorites as set out in the SRA and the Integrated Roadmap*…"

2 Industrial policy supporting Europe's leadership in wind energy

Gwennaël Joliff-Botrel, Head of Unit, Strategy (Energy), DG R&I, European Commission

ETIPWind is welcomed as one of the main solutions to implement the Strategic Energy Technology Plan (SET Plan[1]) which accounts for the 5th pillar of the Energy Union (Research, Innovation and competitiveness). It is seen as a fundamental tool to think, develop and implement R&I agendas in accordance with current market opportunities and needs. ETIPWind should be able to mobilise stakeholders to implement the needed R&I activities in order to maintain the European leadership over Renewable Energy and more specificly Wind Energy.

The European Comission reminded that ETIPs are industry led and innovation driven covering the whole innovation chain[2].

[1] Towards an Integrated Strategic Energy Technology (SET) Plan: Accelerating the European Energy System Transformation C(2015) 6317 final

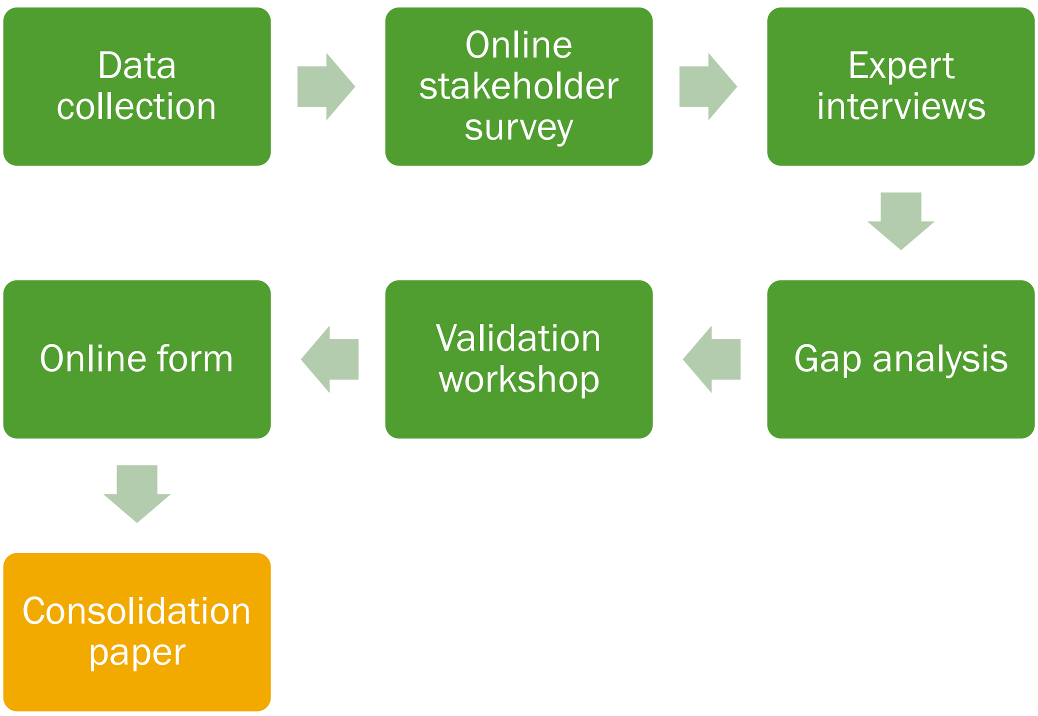
[2] EC, research and innovation union: https://ec.europa.eu/research/innovation-union/index_en.cfm?pg=etp

3 Outcomes of the 2014 Strategic Research Agenda and implications for future priorities

Daniel Fraile, Senior Analyst Grids, WindEurope

Figure 2 Strategic Research Agenda 2014

Figure 3 Strategic Research Agenda 2016



The study led by the ETIPWind secretariat aimed at understanding the future priorities of Wind Energy R&I as a result of several initiatives encouraging the wind energy stakeholders to input:

- Data collection (methodology approved by ETIPWind Steering Committee)
- Quantiative activity: Online stakeholder survey (230 valid responses from R&I specialists within industry and academia)
- Qualitative activity: More than 20 Expert interviews (from industry and academic organisations)

These activities formed the data basis for the development of an extensive *Gap Analysis* (presented to the ETIPWind Steering Committee) whereafter it was validated during a public consultation (*validation workshop*, 3 June). Parrallel to the public consultation an *online form* was available to give input via virtual means.

This line of activities have formed the data presented in this consolidation paper.

Daniel shared the key findings of the study about the status of the implementation of the SRA 2014, during the past three years. Assessing the intensity of research of each of the 5 SRA 2014 pillars (See figure 2, and more details in Annex), confronting the expert interviews and the data collection.

It appeared that an important and increasing amount of research was led in the “Offshore” pillar, which also accounts for the growth in the “External Conditions” pillar. By contrast, wind specific Grid Integration research was deemed low compared to current industry needs. Within the “Wind Turbine Systems”, the growing importance of Operation and Maintenance has shed light on the change in the R&I trends in that specific pillar. In the country assessment, the most active countries identified were Germany, Denmark and the UK with an important activity on Offshore Wind for all of them.

A more targeted approach was adopted with 4 pillars that would favour the deployment of EC funded projects:

- Grid Systems, infrastructure and integration,
- Operation & Maintenance,
- Industrialisation and
- Offshore balance of plant.

During dialogues following after the validation workshop a 5th pillar has been identified to provide more covering on long term R&I. this pillar is called “Next Generation Wind Technologies”.

The importance of non technology aspects included in Market Deployment was also highlighted, as necessary for the development of further Wind Technology.

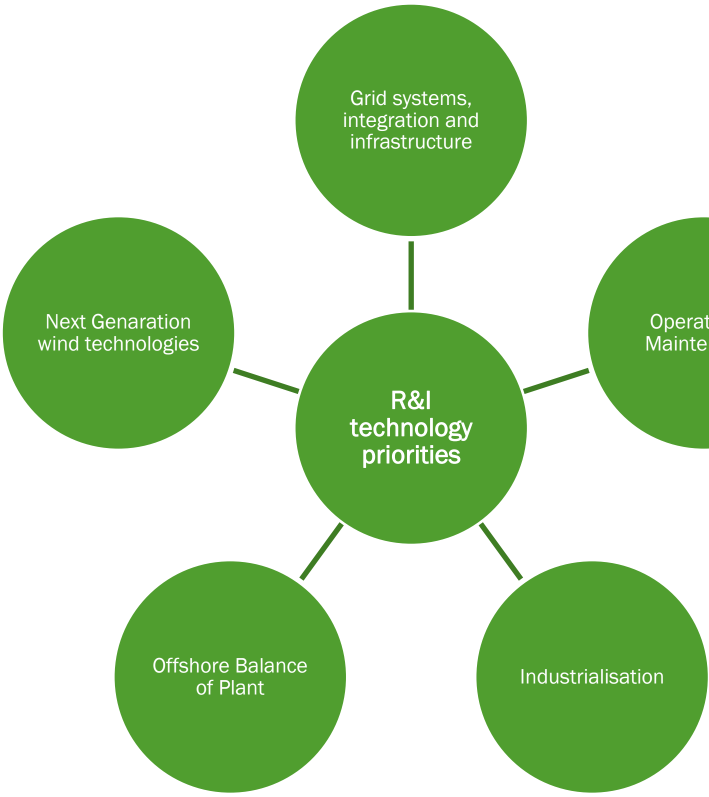


Figure 5. Currently identified priority pillars for technological R&I

4 Break-out discussions

Based on the findings in the gap analysis ETIPWind secretariat established a validation workshop programme creating room to discuss the priorities in break out sessions. Prior to the validation workshop **4 distinct discussion papers** were developed by members of the ETIPWind Steering Committee. The relevance of these elements was then discussed in each break-out session and on top, some new elements were added by the participants.

4.1 Grid Systems, infrastructure and integration

Adrian Timbus Technology and solutions Manager, Smart Grids and Wind Power, ABB

Topic	Description
Energy management and balancing with other renewable sources	Functionality to control the power of clusters, in combination with other renewables, to minimize schedule deviation for intraday and day ahead horizons
	Continue to improve renewable power forecasting and develop forecasting for fleets, tailored for grid and markets
	Optimization of energy delivery to achieve lower costs of production

Control, architectures for provision of ancillary services	Integrated active and reactive power control, considering different grid architectures (HVDC, AC-DC), cap banks, STATCOM, etc. Address stability issues, dynamic interactions of wind power plant with grid
	Standalone generation, black start capabilities and further integration of RES in Emergency and Restoration plans
	Improve frequency, voltage and inertia support at turbine and farm levels, e.g. by synchronising several machines to adapt production to demand and grid needs
Standardization	Align common information models between IEC 61400-25 and IEC 61850 and create a well-defined interface with the upper energy management systems
Grid Codes	Adjustment of grid codes, fulfilment of grid code obligations – considering structures with near 100% RES generation
Improved transmission systems for on- and offshore wind farms, incl. installation & O&M	Offshore meshed grids to reduce cost and increase reliability of offshore wind power connections (mix ac and dc)
	New collectors grids technologies to collect larger power capacity
	Reliability of cables and substations (e.g. condition monitoring systems)
Energy storage, demand side management and sector coupling	Support wind power integration with energy storage, demand-side management and sector coupling (power to heat/gas) - forecasting error mitigation, ancillary services, black start capabilities, etc…

Table 1. topics of discussion – Grid Systems, infrastructure and integration

The discussion was structured around 4 topics, in line with the gap analysis . The two areas that received most of the attention were**: Wind power grid integration solutions** (including energy management and balancing, control and architectures for provision of ancillary service) and **grid design and development** (mostly focusing on offshore grid infrastructure, energy collection concepts and long-distance transmission). Other discussed topics included energy storage, where research on different **energy storage applications** were identified and classified in the time horizon they should be best implemented. Finally, **large-scale test facilities and standardization of system** components was also discussed and agreed to be a priority.

All participants agreed that technical aspects need to be addressed in parallel to regulatory aspects and power market design. A clear example can be applied to the development of ancillary services from wind farms, where technical capabilities need to be developed in line with the opening of ancillary services markets for wind producers.

Another important take away was the need to increase dialogue with other technology platforms to ensure common solutions can be developed (e.g. Grid architecture design and interaction among technologies, in particular solar PV).

4.2 Operation & Maintenance

Agnar Gudmunsson, Senior Director, Modularization & Standardization, Vestas

Topic	Description
Standardized and validated methods and sensor systems for performance measurement and condition monitoring	Sensors improvement: Reliability, redundancy, sensor protection, maintainability (Low or zero maintenance, self-diagnostic systems), remote sensoring, wireless communications, recording systems.
	New/enhanced sensors for: Grouted connections, joint failures, electrical systems, fatigue, crack initiation, scour development, cyclic degradation, marine growth, SHM in submerged areas,...
	New and enhanced measurement systems for external conditions integrated with WT control system, CMS, RMS,... i.e. inflow sensors, metocean conditions
	Development of standards for power curves assessment based on new measurement technologies (i.e. nacelle lidar) and new analysing methods.
	Standardization and development of new capabilities for CMS/RMS/SHM.
	Use of remote inspection and data analysis systems (ROVS/Drones/CMS vs Divers). Analysis of the use of CMS vs ROVs/Maintenance + underwater remote inspection and condition monitoring (new)
	Acquisition, modelling, sharing tools and documentation of basic material data and standardisation of performance testing / certification methods for materials
	Repair methods
Improvements in energy yield from wind farms through utilization of adaptive, and interactive and big data control	Integration of CMS, RMS, SHM, scada info, metocean info, into a big data analysis tool (expert system).
	Development of maintenance strategies reducing turbine downtime and interaction with turbine control system for yield maximisation.
	Correlation of cumulative fatigue life damage with metocean data and operational data.
	Efficient collection of data as well as improved and new data analysis techniques.
	Acquisition, modelling and sharing of monitoring and O&M data
	Optimise yield and reliability at wind turbine, wind farm and cluster levels (using massive computing for modelling and simulation)
	Use of O&M data for feedback wind turbine design
	Improved yield availability based on optimisation of energy prices
Improvements in reliability and predictability of wind farms and data analysis to improve diagnostics and decision-making	Wakes and inflow modelling, including special conditions like icing
	Modelling for crack initiation and growth prediction. Failure identification through investigation of faults and effects, through i.e. built in sensors.
	Online diagnostics and prediction of structural health and component reliability, based on inflow, power/load measurement, metocean conditions,...
	Development of condition and risk-based maintenance and O&M strategies (including feedback from field service experience).
	Integrated design and design of foundations considering construction, installation, O&M and lifetime.
	Assessment of structural design based on advance modelling and operational actual loads/conditions against design loads.
	CAPEX (design) vs OPEX (maintenance) decision making.
	Concepts with fewer components. Simplification of systems.
	Easy replacement of components for remote/difficult to access or reduced weather windows sites. Access technologies (i.e. vessels/transfer systems).
	Better weather forecasting tools and planning and logistic tools (offshore)
	Industry standards for decision making on O&M interventions
	Forecasting and assessment wind farm impact on radar measurements

Lifetime optimization	Fatigue analysis: Improve understanding/measurement of fatigue, remaining life and failure mechanisms, e.g. coupling methods between life time/ageing simulation models and real defects observed on the machines.
	Better understanding of leading edge blade erosion + standardisation, testing
	Lifetime optimisation
	Development of life extension projects. Analysis of service life vs design life.
	Development of end of life strategies: repowering and decommissioning including offshore
	Offshore: Further knowledge on soil-structure-turbine

Table 2. topics of discussion – Operation & Maintenance

The discussion's main focus was on the **condition monitoring** aspect of Operation & Maintenance. Included a better understanding of components and materials. More specifically, it was added that corrosion and crack developments measurements could be standardized in order to facilitate the inspection. New remote solutions were discussed as wel in order to better identify the issues with the possibility to use drones for remote inspection. The implementation of Big Data was then seens as an important concern within this topic, enabling the realisation of more efficient new O&M strategies thanks to a better understanding of health conditions of components and materials.

The development of **better turbine design** was also mentioned as a consequence of a deeper understanding of failure reasons, and maintenance purposes. The overall process of rethinking the turbine's design must primarily come from the return on experience on current operated installations.

Research on how to **enhance a successful cooperation** between the operator, the developer and the manufacturer and the implementation of repair methods were considered important stakes in the aim to reduce the costs of Operations & Maintenance.

Concerning **energy yields,** the audience notably introduced the topic of market driven optimization, in order to increase wind farm revenues. Anoter topic mentioned during the discussion was the development of Electricity production assessment at a wind farm level.

Other topics such as health & safety, cold climates, high altitudes, maintenance vessels, underwater inspection and repowering offshore were also raised, to complement the discussion.

4.3 Industrialisation

Anders Bach Andersen, Senior Product Manager, MHI Vestas

Topic	Description
Standardisation of common sub-assemblies, parts or processes	Uniform solutions across industry for non-competitive items as ladders, sensors, elevators, skylights and other relevant parts
	Foundation concepts and Secondary steel design
	Offshore and onshore substations
	Electrical connections (inter-array & export cables)
	Installation methods, including installation onshore & offshore and services vessels
	Logistics including transporting tools and relevant equipment
	Quality requirements
	Testing and validation, and development of new testing and validating methods

Regulatory Market Requirement & Harmonisation	Heli hoist platform design, Aviation and maritime signal and marking, Fire protection.
	Certification, design codes and standards.
	Quality standards and manufacturing inspection requirements.
Value chain development	Development and common agreement across industry on industry standards
	extended value chain cooperation between OEM and key vendors
	Cooperate on non-competitive **common technical** solutions that are deployed by a wide range of end users, and other stakeholders in the value chain.

Table 3. topics of discussion – Industrialisation

During this breakout discussion, very few elements were added from the list defined by MHI Vestas.

Among them, the optimisation of safety factors for serial production was mentioned, highlighting the important cost reduction that could be triggered by avoiding over engineering.

New and innovative methods of testing and validation will be needed to reduce the risk related to new technologies and to accelerate the adoption of innovative technologies, contributing to achieve quicker reductions of cost of energy.

From the **value chain development perspective**, the audience highlighted the importance of collaboration between all the different stakeholders (including project developers and key vendors).

Concerning the **regulatory market requirement & harmonisation**, the audience emphasized the importance of having common requirements within the different member states in order to avoid administrative barriers for industrial deployment.

4.4 Offshore Balance of Plant

Jørn Scharling Holm, Technology Partnerships Manager, DONG Energy Wind Power

Topic	Description
Floating offshore wind farms	Methodologies for analysis of turbine substructure interaction on and station keeping of floating wind turbines
	Scaling of substructure designs and weights with larger turbines for the three main concept types: Spar, Semi-sub, TLP, eg. for 6 MW, 10 MW, and 14 MW turbines
	Development of Combined Load Cases (CLC's) in standards to handle floating systems
	Development of controller strategies for floating systems
	Transfer systems for floating substructures/WTG's
	Development of efficient installation methods for each of the three main floating substructure concepts, e.g.:
	Spar: Horizontal tow to site and upending and turbine installation on site in high sea states
	Semi-sub: Installation of anchors, moorings and substructure
	TLP: Stable float out and installation in high sea states
	Strategies for replacement of larger parts (e.g. blades, gearbox, generator) on floating WTG's
	Development of models for design and testing of anchors and mooring systems
	Connection of inter array cables in floating arrays – the lifetime and optimisation of dynamic cables
	Move from a single machine modeling to a farm modeling using multi-scale approach and

	overcome the current limitation of hydrodynamic and aerodynamic behavior modeling using petaflop clusters
	Development of specific test and validation methodologies for floating wind turbines, including key components within the wind turbine and BOP (i.e dynamic cables), system validation and Hardware in the Loop (HIL)
Industrialised transport and installation systems	Installation and access in higher sea states – better vessels and systems
	Optimal installation of 10+ MW systems. Is the traditional assembly method with foundation, tower, nacelle and three blades optimal?
	Requirements for modern installation vessels that can handle increasingly large turbines, foundations, offshore platforms and cables
	Floating installation of bottom fixed foundations and turbines in higher sea states-
	Should include float and sink concepts (jackets)
	Requirements and design for submarine cable installation tools -
	CALCULATION of noise in connection with installation and development of noise mitigation systems, including cumulative effects
	Other environmental effects are also important
	Environmental considerations in installation and decommissioning.
	Development of common HSE requirements in connection with all installation operations
	Development and validation of Logistical models for planning , transportation and installation.
Innovative and industrialised offshore towers and foundations, including better understand-ding of seabed interactions	Development of improved and more efficient measurement and mapping of the soil and seabed properties with various technologies (sonar, CPT, etc.)
	Development of improved theory and methods for probe taking and handling of soil samples
	Development of a Subsea ROV rock coring tool requires development – Shallow bed rock site sampling and piling is difficult at present. This is also relevant for floating too
	Development of improved theory for calculation of soil/foundation interaction
	PISA project and other existing bodies of work exist, more work is required
	Development of improved theory for fatigue properties of steel under influence of corrosion
	Improved theory for calculation and verification of wave loads on offshore structures
	Development of better scour protection, coatings, cathodic methods, etc
	Reduce design margins to reduce costs (e.g probabilistic design, optimisation for specific site conditions)
	Demonstration of immature foundation concepts – including onshore testing for foundation testing (welding, nodes etc)
	Development of common HSE requirements for offshore structures

Table 4. topics of discussion – Offshore Balance of Plant

Within the breakout session on offshore wind balance of plant, an additional fifth sub-category (Wind farm level optimisation and modelling) was added to the four presented at the beginning of the session. A total of 36 items were identified, reflecting the broad nature of the balance of plant category. Points that were discussed had many similarities with content in the other breakout sessions.

Within the **Industrialised transport and installation systems** category, research that would accommodate new innovations such as larger turbines and floating concepts was raised, as well as the optimisation of logistical models and advancement of innovations that would allow installation under a wider weather window or sea state. Amongst other environmental factors, the calculation of noise in connection with installations was discussed, where cumulative effects required further work, and the development of an EU noise programme was cited as an ideal solution. In this regard, recent EU funded work was pointed out as being an ideal reference point.

About **Tower and bottom fixed foundations**, participants validated the findings presented, which called for further advancement of sampling techniques and measurements in seabed states and interactions with structures. For the structures themselves, the call for better understanding of fatigue and corrosion as well as an increase in demonstration of novel concepts such as welding techniques was discussed. Projects such as PISA[3] were cited as examples of existing research that would serve as a basis for further work.

In the field of **Substations and cables,** research items here broadly fell into advancement in regulation and standards, and novel innovations. From a regulatory and standards perspective, agreements on procedures for crossing and proximity of cables could be improved and supported with a more sophisticated system of mapping. Within innovations, the development of universal joints, floating substations, and HVDC concepts were also cited as areas of work.

On the topic of **Floating offshore wind**, discussions in this section showed how floating wind had advanced beyond the design phase. Research points focused on how to better install and scale existing designs for larger turbines, with improved station keeping and controller strategies. Models to develop standards for Combined Load Cases (CLCs) and development of mooring systems were also included.

Wind farm level optimisation and modelling was a new point raised by participants. It was pointed out that whilst many models existed at the individual turbine level, that more could be done at the wind farm level to improve decisions taken at the planning phase. Early stage engineering models that are backed by cost models could improve decision making and lower costs of offshore wind projects.

5 Additional input

After the validation workshop (June 3) ETIPWind secretariat have held several dialogue meetings with relevant stakeholders that have complemented the discussion at the workshop with additional input, in order to provide a more complete and accurate SRA. The two main topics that were proposed are:

- A 5th technlology pillar for the long term research: Next generation technologies for wind
- Market deployment

5.1 A 5th technlology pillar for the medium to long term research: Next generation technologies fo wind

This pillar would allow for appropriate focus on medium to long term research priorities and support many of the core elements in the 4 priority pillars already defined.

Wind Energy research for next generation technologies	
Disruptive technologies	New technologies in turbine components (rotor, generator, support structure)
Next generation tests, measurements and standards	Development of novel measurement techniques,
	Aerodynamics and Aeroelasticity test benches

[3]http://www.eng.ox.ac.uk/geotech/research/PISA

	New methodologies validation in standard and new experimental tests
Smart rotor design	Rotor design and aerodynamic modelling
	Aero-structure interaction – the accurate modelling of large, flexible blades
	Aero-acoustics
Matching site conditions	Inflow conditions, including wind, turbulence and complex terrains
	Evaluating uncertainties of design condition models
Materials & structures	New Efficient blade structures
	New Material models and life prediction methods
	New materials for reducing wind farms impact on radar measurement

Table 5. content of the 5th pillar – Next Generation technologies

5.2 Market deployment

Market Deployment as a fundamental element to R&I in order to remove barriers. The main subtopics proposed are in the table below:

Deployment, markets, and society	Market conditions
	Regulatory affairs
	Support schemes and policy designs
	Adapting power markets for wind energy
	Market-uptake measures
	Public engagement and public acceptance
	HR, Education, Training, Skills and Innovation

Table 5. Market deployment – proposed subtopics

6 Next steps

Following the ETIPWind Steering Committee approval of this report the first draft of the 2016 Strategic Research Agenda will begin. The write-up of the 2016 Strategic Research Agenda is ouline in below timeline:

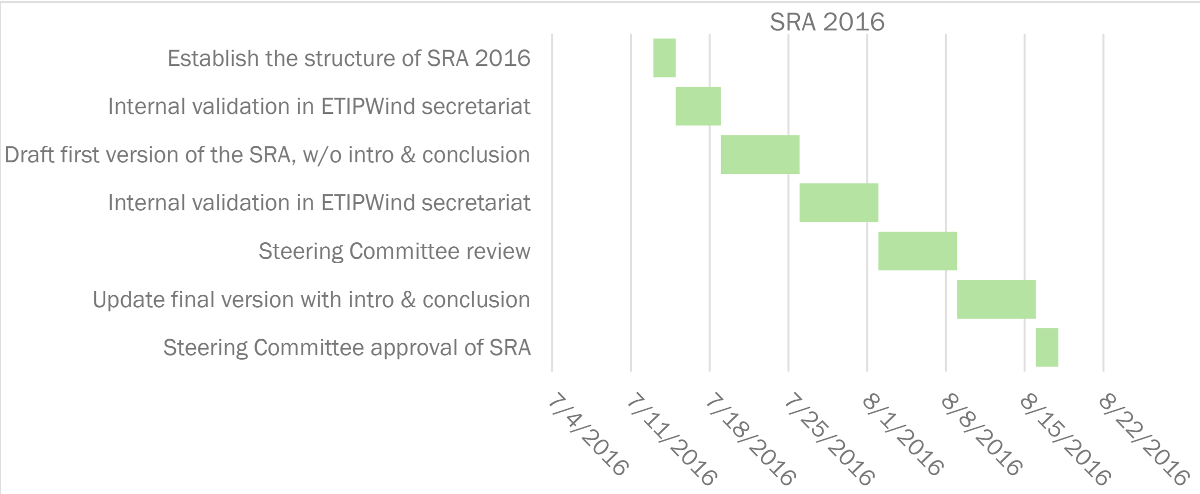


Figure 6. SRA 2016 timeline *(can be subject to changes)*

7 Annex

7.1 Participants List

ETIPWind workshop – "Where should R&I funding go? Have your say!"
3 June 2016, L42, Brussels

Anders Bach Andersen
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CTO, RES, United Kingdom

Carlos Arsuaga
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Brahim Attaf
Independent Expert/Researcher, CMS Ecotechnology, France

Stephan Barth
Managing Director, ForWind - Center for Wind Energy Research, Germany

Aidan Cronin
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Gil Lizcano
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Stéphanie Muller
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Ivan Pineda
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Andreas Rettenmeier
Managing Director, WindForS â€“ Wind Energy Research Cluster, Germany

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Director, Culmer Raphael, United Kingdom

Alice Rosmi
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Klaus Skytte
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7.2 Strategic Research Agenda 2014

In the SRA 2014, 5 pillars for research and innovation were defined:

- External Conditions: climate, wave and soil:

One of the most important drivers for reducing the cost of energy is minimising uncertainty and improving the predictability and availability of wind energy. Key to this is establishing models and data that accurately describe the environmental conditions in which wind turbines operate. By integrating environmental information in all phases of the life cycle of a wind power plant, wind turbine design can be optimised. This reduces risks related to siting, optimises layouts reducing the impacts of loads, maximises production and enables the integration of wind power into the electricity grid based on advanced forecasting.

- Wind Turbine Systems

The wind turbine was considered in the SRA 2014 the most significant element in the cost of energy from wind farms, representing up to 80% of onshore wind power plant project costs and up to 50% for offshore projects.

- Grid Integration

For wind energy to become a mainstream power generating source, new methods of planning and operating the grid with high shares of wind power are needed. This includes capabilities for ancillary services, more appropriate power markets and grid management for wind.

- Offshore Technology

The most critical priority for offshore wind power in the SRA 2014 was to significantly lower its cost of energy in order to become competitive with conventional power generation by 2030. This requires large scale infrastructure for research, development and demonstration, not only for wind turbine structures, but also for the complete life cycle of a wind energy project. This includes design, manufacturing, transportation, logistics, construction, operation, maintenance and decommissioning. An integrated design approach that can minimise the LCOE is targeted by including the site specific boundary conditions in the wind turbine design.

- Market Deployment Strategy

Onshore wind energy has been developed in record time, taking a growing share in the energy mix. Offshore wind has taken its first steps in the energy market, and in view of the success of onshore wind, a bright future seems to lay ahead. However, the current design of electricity markets does not enable optimal integration of large shares of renewables into the power grid. On top, ensuring public acceptance and environmental integration is key to enhance the development of wind energy, with respect to