IRPWind Success Stories

April 2018

This project has received funding from the European Union's Seventh Programme for research, technological development and demonstration under grant agreement No. 609795.

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AGREEMENT NO.: 609795
DURATION: December 2013 – April 2018
COORDINATOR: Danmarks Tekniske Universitet (DTU)

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FOREWORD

It is with great pleasure that I am writing this foreword for this IRPWind Success Stories report. It really highlights the excellent work done by the IRPWind consortium coordinated by DTU. I would like to mention especially and thank the coordinator Peter Hauge Madsen, who has supported the project continuously with his energy and enthusiasm. In fact, under his leadership IRPWind has become a success of the European Energy Research Alliance Joint Programme on Wind Energy (EERA JP Wind).

As European Commission we support (international) cooperation between different stakeholders sharing the same goals. It is important to bring together skills and knowledge from different research organisations and universities and this is what undoubtedly happened in the IRPWind consortium.

The aim was threefold: to develop a joint strategy and to prioritise research tasks, to align European and national research efforts, and to share knowledge and research infrastructure. It was valuable that the partners in the consortium achieved as well cooperation with partners outside the consortium, with the industry and with international partners in the USA and Japan in line with the H2020 mission: “Open Innovation, Open Science and Open to the World”.

This report shows some important examples of cooperation. Not everything was successful, but that is a result as well. Not everything is successful in Research and Innovation (R&I) and there are some lessons learned from mistakes. It is good to share this experience also in the report in order to help in the future a more effective use of limited resources.

I hope this report will be a source of inspiration for every reader and that it will create new ideas for cooperation. The IRPWind project may now be finished, but the EERA JP on Wind Energy is not! I therefore trust and encourage the partners to continue with their cooperation in Europe. I look forward to a continued cooperation on an EERA JP Wind 2.0!

Matthijs Soede, Research Programme Officer
European Commission – DG Research and Innovation
Brussel, April 2018

INTRODUCTION

The Integrated Research Programme for Wind Energy (IRPWind) has been one of the most exciting experiments in wind energy research and collaboration coming from of the EU's 7th Framework Programme for Research and Technological Development (FP7). Within the framework of the EU's Strategic Energy Technology Plan (SET-Plan), the project has tested novel ways of creating sustained long-term collaboration in the European research environment to help drive down costs of wind energy, and so supporting the EUs global leadership in wind energy.

With the launch of the European SET-Plan in 2008, the European Commission wrote that

"Member States, the Community, industry and research organisations all have different roles to play within a coherent overall effort. Achieving our ambitious goals will require a fundamental departure from current practice throughout the innovation system, striking the right balance between cooperation and competition at national, European and global levels." [1]

IRPWind has been a unique opportunity to test and validate how to strike this "right balance" in long-term collaboration between organisations that cooperate and compete at the same time.

In the following pages, we have collected successful results and the most important lessons learned from 4 years of intense collaboration within the IRPWind project.

IRPWind has created a new mission for the Joint Programme for Wind Energy under the European Energy Research Alliance (EERA JP Wind). We believe that the EERA JP Wind will further accelerate the collaboration inspired by IRPWind.

A real success of IRPWind was the ability of the scientific work packages to really bring in contributions from national projects to increase the impact of research and to foster novel multidisciplinary research collaboration between previously separate disciplines. This was possible due to the pre-competitive nature of the low Technology Readiness Level (TRL) research conducted within the project, which enabled organisations to share data and facilities.

IRPWind also gave rise to better data management based on a unified classification system of data for wind energy, new mobility programs adapted to the needs of senior researchers, and tested ways to support breakthrough innovations by sharing research facilities.

Last, but certainly not least, IRPWind supported closer integration of the research organisations and the European wind energy sector through collaboration with the European Technology and Innovation Platform for Wind Energy (ETIPWind). This has already resulted in better coordinated research and innovation agendas which will produce better collaboration on innovation between public and private partners.

We are convinced that IRPWind has been a success in accelerating the work started in EERA JP Wind and, as an integral part of the SET-Plan, our success stories are also the success stories of the SET-Plan.

Peter Hauge Madsen
IRPWind project coordinator
EERA JP Wind coordinator

1. ref: http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52007DC0723&from=EN, p.6

EUROPEAN COLLABORATION TO MEET EU SET-PLAN OBJECTIVES

THE IDEA: EUROPEAN RESEARCH PROGRAMME FOR LONG-TERM COLLABORATIVE RESEARCH

The objective of the IRPWind project was to implement an integrated research programme fostering long-term collaborative research and open innovation among key research performers, led by the EERA JP Wind. The project is an instrumental part of the EU SET-Plan, which aims to foster this long-term collaboration through national alignment. That is, by aligning national research priorities and translating them into jointly funded projects. This would accelerate the EU's transition to a low carbon economy whilst maintaining European leadership in renewable energy.

The SET-Plan has had a big impact on European energy research collaboration and from that perspective it has been a success. Still, its ultimate objective of national alignment has not materialized to the extent envisioned, in spite of the IRPWind project's best efforts. What happened?

THE SCOPE: IMPLEMENTING LONG-TERM R&I TROUGH NATIONAL ALIGNMENT

To implement long-term collaboration in R&I, driven by the alignment of national programmes, the IRPWind project carried out a number of dedicated activities:

- Each IRPWind partner worked with national funding agencies and stakeholders to increase national-EU coordination and used IRPWind activities to leverage national funding for projects and alignment activities
- In its first year IRPWind carried out a survey of the wind energy R&I ecosystem in the various countries. The report showed a great diversity in how wind energy R&I is funded and what the various national priorities are.
- In coordination with EERA JP Wind, IRPWind participated in SET-Plan fora such as the Technology Platform for Wind Energy (TPWind), its successor the European Technology & Innovation Platform (ETIPWind) and the joint member states-industry-academia task force European Wind Initiative.

LESSONS LEARNED: FROM NATIONAL ALIGNMENT TO INSTITUTIONAL ALIGNMENT

By autumn 2016, two and a half years into the IRPWind project, it was clear that national alignment was not happening, despite the project's best efforts. Only a few projects, such as the NSON project, have successfully coordinated cross-border activities that receive funding from various Member States.

As a consequence, when the project partners started to work on the business plan for what EERA JP Wind would look like after IRPWind, the discussion about national alignment became a key element of the exercise. The result is a shift from national alignment to institutional alignment. Here, we define institutional alignment as coordination and collaboration between two or more research organisations.

This shift in focus makes sense. Firstly, aligning institutions is within our control and EERA JP Wind and IRPWind have created the necessary level of trust between organisations that are both collaborators and competitors to make it happen. Secondly, the vision of EERA JP Wind and IRPWind has always been to coordinate pre-competitive (i.e. low TRL) wind energy research and most of this research is done by EERA JP Wind members. Thirdly, by strengthening cooperation between organisations, national R&I schemes would automatically move closer together to facilitate this collaboration. Over time this bottom-up approach could lead us to the holy grail of the SET-Plan: national research alignment.

SUCCESS: STRONGER EUROPEAN COLLABORATION IN RESEARCH AND WITH INDUSTRY

The shift from national to institutional alignment has become one of the cornerstones of EERA JP Wind 2.0, i.e. the improved EERA JP Wind organisation. In 2018, we expect a series of bilateral memoranda of understanding (MoUs) between EERA JP WIND partners that will translate into real collaboration. This would not have been possible without the SET-Plan determining the right framework conditions and creating a vision of stronger European collaboration in energy research.

Another area where IRPWind and EERA JP Wind have had a clear impact is in the collaboration with industry, and again the SET-Plan provided the right framework conditions. In 2016 the European Technology and Innovation Platform (ETIPWind) was established and created productive collaboration with our colleagues from the European wind energy industry. The ETIPWind Strategic Research and Innovation Agenda was the first visible product of this collaboration, but the real effects go much wider. We see increased industrial participation in our IRPWind and EERA JP Wind conferences and the Industrial Advisory Board actively helps to promote data sharing. Together the European industry, academia and research organisations are creating a common vision and understanding of where the wind energy sector needs to go to remain competitive.

Increasing collaboration between organisations which are at the same time competitors and collaborators has been at the heart of the EU SET-Plan. With IRPWind, we have had the chance to take this collaboration one step further and set the direction for more and stronger collaborations in the future of EERA JP Wind.

THE IRPWIND CONFERENCE: NOW A MUST ATTEND EVENT

THE IDEA: REGULAR DISSEMINATION TO ALIGN R&D STRATEGIES OF ACADEMIA AND INDUSTRY

Aligning the European Research and Development (R&D) goals and strategies of the wind energy research community with those of the industry is important to ensure optimal use of human and financial resources invested in R&D. However, alignment can be challenging, because R&D projects enjoying EU support often span multiple years. So, the European research community on wind energy is looking for new ways to transfer knowledge and share the results of national and European R&D efforts more effectively.

Project consortia do often include industry, but dissemination at dedicated events and through scientific publications is still the best way to create synergies. In addition, the European Energy Research Alliance Joint Programme Wind (EERA JP Wind) is growing in size, although cross pollination and building on each other's research results can pose challenges. To overcome these challenges the IRPWind/EERA JP Wind holds an annual event: the IRPWind conference.

FIGURE 1
Participants at the IRPWind conference

© Peter van Aalst

FIGURE 2
Matthijs Soede (EC) at the IRPWind conference

© Peter van Aalst

THE SCOPE: ORGANISATION OF AN ANNUAL CONFERENCE WITH THE PARTICIPATION OF ACADEMIA, INDUSTRY AND POLICY MAKERS

The IRPWind conference is a large annual dissemination event targeting EERA JP Wind partners. It presents the outcomes of both EERA JP Wind and national projects. The event aims to share knowledge (also within EERA JP Wind) and provide an opportunity for all members to network and discuss wind energy related research topics.

More crucially, the conference disseminates the knowledge generated towards industry representatives, thus spreading the expertise on wind energy across Europe. Besides participants from the research community and industry, national programming agencies and European institutions such as the European Commission join the conference.

The annual conference lasts 2 days, includes some 50 presentations and is attended by over 100 persons. It includes both plenary sessions and parallel break-outs. All 4 editions of the conference also included a poster area and a networking event on the evening of the first day.

FIGURE 3
Bernard van Hemert (Ampyx) at EERA JP Wind conference 2017

© Peter van Aalst

LESSONS LEARNED: INVOLVE INDUSTRY THROUGH PLENARY PRESENTATIONS AND RESTRICT THE AMOUNT OF PARALLEL SESSIONS

Industry representatives facilitate the conference's plenary sessions. This ensures strong commitment and high quality of industry representatives and exposes the research community to practical examples of the challenges faced by the industry. Typically 8 plenary sessions are covered by industrial representatives. The opening and closing of conferences are facilitated by officials from the European Commission.

The third and fourth edition of the conference saw a reduction in parallel sessions. This allowed more people to attend the session of their choice. This meant that presentations had a larger audience, further increasing the value of participation in the event. The attendees confirmed the value of these lessons learned, by completing the questionnaire that was sent after each conference. Many also highlighted the informal atmosphere as one of the key factors that makes this event a success.

SUCCESS: THE EERA JP WIND/IRPWIND CONFERENCE HAS BECOME A GO-TO EVENT FOR MANY STAKEHOLDERS IN WIND ENERGY R&D

The EERA JP Wind/IRPWind conference has seen recurring participation both from EERA JP Wind management and scientists, as well as industry and EU representatives. They all see the event as an annual chance to catch up with the European wind R&D community. The informal character of the conference encourages open discussion, making it an ideal networking event as well. But the end of the IRPWind project will not be the end of the EERA JP Wind/IRPWind conference. In September 2018 EERA JP Wind will organise the first new edition of the annual conference.

ESTABLISHING A NORTH SEA OFFSHORE NETWORK – THE NSON PROJECT

THE IDEA: TO ESTABLISH EERA JOINT PROGRAMMES WIND ENERGY AND SMART GRIDS AS THE REPRESENTATIVES OF THE RESEARCH COMMUNITY ON GRID INTEGRATION ISSUES

From our experience of working in various wind energy and grid integration networks such as TP Wind and TP Smart Grids, we knew that the EERA Joint Programmes on wind energy and smart grids (EERA JPs) would need to co-operate intensively to establish a strong position for themselves towards key stakeholders such as European Network of Transmission System Operators (ENTSO-E). So, with the support from IRPWind and the ELECTRA project, we wanted to establish the EERA JPs as the representatives of the R&I community on network issues. In particular, IRPWind focused on improving wind power plant capabilities and tools to support grid planning and operation. The objective was to develop solutions to the challenge of a comprehensive energy supply transformation in terms of energy networks.

THE SCOPE: CLOSE CO-OPERATION OF JP WIND ENERGY AND JP SMART GRIDS

From the beginning, the two joint programmes worked together on issues of grid integration and grid expansion. They drafted and submitted joint proposals for EU calls, organised joint workshops and ensured joint presence of the EERA JPs at ENTSO-E. In doing so, we created a single academic contact point for external stakeholders such as the grid companies and ENTSO-E.

As part of this collaboration, the two EERA JPs developed a project idea for a North Sea Offshore Network (NSON). They implemented the project via a number of national projects following the “Berlin Model” funding framework. As a result, three national NSON projects: NSON-NO[2], NSON-DE[3], and NSON-DK[4], were started to implement the overall NSON project.

2. NSON-NO: https://www.sintef.no/en/publications/publication/?pubid=CRIStin+1288291
3. NSON-DE: https://www.iee.fraunhofer.de/de/projekte/suche/laufende/nson.html
4. NSON-DK: http://www.sys.man.dtu.dk/research/eer/research-projects/nson-dk

LESSONS LEARNED: COORDINATING AND COMBINING RESEARCH PROPOSALS AT A NATIONAL LEVEL INCREASES THE IMPACT OF PUBLIC FUNDING FOR R&I

The members of the NSON project board, Fraunhofer IEE (formerly IWES), SINTEF, University of Strathclyde, DTU and ECN, developed a vision of a future offshore grid infrastructure that would link up both existing and planned offshore wind farms in the North Sea region. Researchers in the national NSON projects then worked together on various technical, market and system integration aspects of potential hybrid transmission assets in the North Sea. IRPWind made bilateral and multilateral exchange possible of the knowledge gathered. For instance, the IRPWind Mobility scheme facilitated a researcher exchange programme between Fraunhofer IEE and SINTEF[5] and between ECN and Fraunhofer IEE, leading to a number of joint publications and projects.

The NSON vision was presented to the members of ENTSO-E's North Sea's Countries' Offshore Grid initiative (NSCOGI) and the national stakeholders. However, the frequent changes in NSCOGI governance strained the cooperation with the EERA JPs and NSON projects. In general, cooperation with ENTSO-E on EU projects was limited as EU tenders often focused on high-TRL demonstration projects. These projects only require partial input from the academic community.

SUCCESS: EERA JPS CONTRIBUTE TO THE ENTSO-E ROADMAP ON R&D

In IRPWind we created clear channels to impact different stakeholders, including key industry players. For example, we assembled a joint consultancy team of experts and researchers from IRPWind and the European Energy Research Alliance (EERA JPs Wind Energy and Smart Grid) to provide a voluntary review of the ENTSO-E Innovation and Development Roadmap 2017-2026. The team included members from Fraunhofer IEE, RSE SPA, the University of Strathclyde, and SINTEF.

This review process of the ENTSO-E roadmap was very comprehensive. We carried out a critical, constructive and multi-step review and produced several reports, all in line with the deadlines put forward by ENTSO-E. The review reports covered technical aspects and editorial improvements and also suggested new topics to be included in the ENTSO-E Innovation and Development Roadmap 2017-2026. The whole process underlined the efficiency of the internal communication structures between the IRPWind partners involved in collaboration with the EERA Joint Programmes.

The entire review process took several months and concluded with a 1-day face-to-face meeting with ENTSO-E representatives in Munich in April 2016. The review was extremely well received by ENTSO-E and they will invite IRPWind and the EERA JP teams for more collaborative activities in the future.

5. E.g. https://blog.sintef.com/sintefenergy/wind-power/impact-of-alternative-flexibility-options-on-offshore-grids-in-the-north-sea/

JOINT EXPERIMENTS ENHANCE EUROPEAN RESEARCH COORDINATION AND IMPACT NATIONAL RESEARCH PROGRAMMES

THE IDEA: PROMOTING ALIGNMENT OF NATIONAL RESEARCH ACTIVITIES THROUGH JOINT EXPERIMENTS

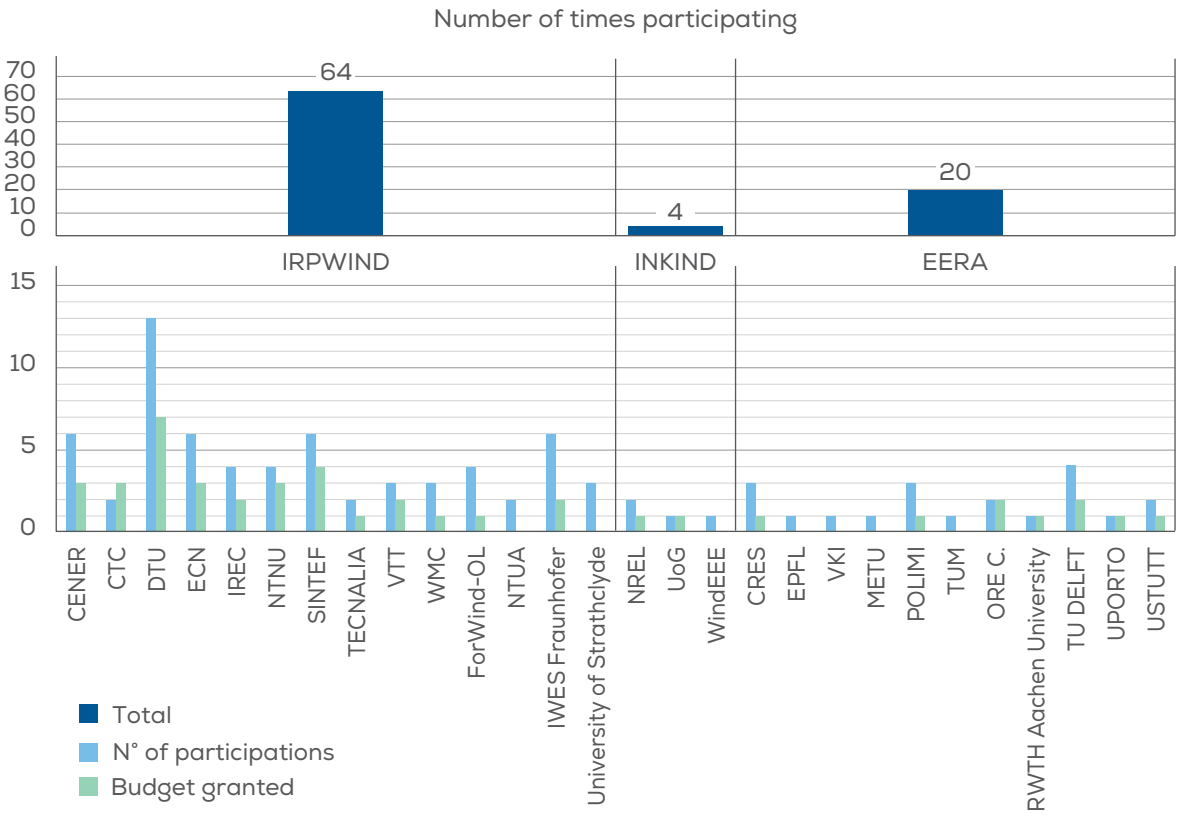
There is a scattered picture of available research facilities across Europe which results in a sub-optimal use of their capabilities. European investments in research facilities could and should bring more value for money by joining forces. Most large research facilities are promoted by single member states and are operated by single national institutes or universities. Although the facilities are sometimes used in collaborative projects, they are mostly devoted to research activities on a national level. These national priorities do not always match with the wider European research needs. So IRPWind had the idea to promote and facilitate the alignment of national research activities through joint experiments carried out in research facilities across Europe.

THE SCOPE: 28 INSTITUTIONS PARTICIPATED IN 2 CALLS FOR JOINT EXPERIMENTS

Other scientific sectors have well established procedures on sharing research facilities. The Marinet programme for marine energies is a prime example. The IRPWind partners took the Marinet programme as a starting point. Based on this, we created all essential documents to establish the rules and conditions for collaborative research activities. In addition, the IRPWind team identified other critical procedures to raise the necessary awareness of future participants and to facilitate participation in the "Calls for Joint Experiments". These procedures include a catalogue of research facilities, rules & conditions, an application form and frequently asked questions, and an evaluation criteria table and scoring system. In addition the IRPWind Description of Work (DoW) was revised to allow funding for the Joint Experiments.

FIGURE 4

A break down of participations in proposed Joint Experiments per research centre



Source: Antonio Ugarte, CENER

The IRPWind project held two calls for Joint Experiments. Participation in the second call was three times that in the first call. A large variety of topics were proposed for Joint Experiments and Open Data Sets. A total of 28 institutions participated, which is almost 55% of EERA JP Wind members. A detailed overview of participation by individual research institutes can be found in Figure 4. We would like to highlight the in-kind participation of 4 entities. This demonstrates the scientific interest of third parties in the proposed Joint Experiments.

The first call focused on three technical topics (Wind Turbine, Grid Integration, Wind Tunnels) preselected by the IRPWind Technical Committee. In the first call, three Joint Experiments were granted, those are;

1. **Scanflow:** Scanflow used high-resolution full-scale wind field measurements of a wind turbine to establish a unique turbine power performance and induction zone measurement dataset for benchmark purposes.
2. **Grid Integration 1:** Experimental validation of high definition modular multilevel converter. ORE Catapult developed a High definition Modular Multilevel Converter (HDMMC). The concept helps increase power density and efficiency.
3. **L4WT – LIDARs for Wind Tunnels:** This experiment provides data to wind turbine flow modellers and increases understanding of the possibilities and limitations of LIDAR measurements with high spatial and temporal resolution on scales relevant for wind tunnels.

The second call was open to any technical topic and also included the format of “Open Data Sets” to transform raw data into useful data bases.

The Joint Experiments and Open Data Set granted in the 2nd call are:

Joint Experiments:

4. **Grid Integration 2:** This project built on the results of the first project and focused on the real world application of HDMMC. The project also evaluated the impact of the HDMMC on the performance of a 3 phase converter.

5. **UNAFLOW:** This project gave a deeper insight in the unsteady aerodynamics of wind turbines, especially on floating offshore wind turbines. UNAFLOW took advantage from other EU projects such as LIFES50 and AVATAR.
6. **Multi-axial fatigue model verification:** This project enlarged the current European composite material open access database with the fatigue characterization of a high modulus unidirectional material. This material is broadly used by blade manufacturers, but was not included in the database.
7. **Bearing Test 2:** In this experiment load cases of gearbox bearings were calculated from existing simulations and converted into transient load cases, tailor-made for specific bearing types. All bearings were subjected to a metallurgical damage analysis to verify the presence of the white etching crack failure mode.
8. **Experimental investigation of surface roughness effects and transition on wind turbine:** The project focused on creating a standardised method to simulate and analyse the effect of blade surface roughness on wind turbine performances in wind tunnels. The project tested different cases of surface roughness, all based on measurements from wind turbine blades after years of operation.

Open Data Sets:

9. **Open Data Set for two-dimensional unsteady aerodynamics**: Unsteady aerodynamics of wind turbine blades is becoming more critical considering the complex atmospheric inflow conditions, wake effects in wind farms and dynamic motion and deformation of the wind turbine and its blades. This project created an experimental open database for unsteady aerodynamics of two-dimensional air foils.
10. **LD4U – LIDAR Data for Use:** This experiment built on L4WT and created an open data set of high level data products based on almost three terabytes of high frequency continuous-wave data obtained in an icing wind tunnel L4WT joint experiment
11. **Open data sets of cold climate wind farms:** This data set includes meteorological mast data and operational data of multiple turbines over five years from two sites in Finland. The data helps to better understand pre-construction production assessments in icing conditions and to develop full scale turbine site testing methods.
12. **e-WindLidar:** This experiment developed a functional prototype of a web-based wind LIDAR e-Infrastructure providing end-users with a simple and open access to relevant LIDAR datasets. The prototype also includes tools for converting new LIDAR datasets to a generic format.
13. **Open wind turbine monitoring data set:** This experiment created a long term, raw, open database for wind turbine operation, loading and condition monitoring. It will help testing and standardisation of data analysis techniques.

FIGURE 5
Details on the 1st call for Joint Experiments

1ST CALL			
Leader	**Type**	**Proposal**	**Participants**
ECN	JE	Scanflow	DTU, ECN
SINTEF	JE	Grid Integration 1	SINTEF, ORE Catapult, IREC
DTU	JE	LW4T	DTU, SINTEF, VTT, NTNU

Source: Antonio Ugarte, CENER

FIGURE 6
Details on the 2nd call for Joint Experiments (JE) and Open Data Sets (ODS)

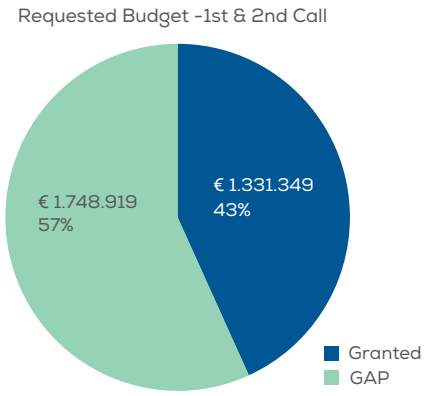
2ND CALL			
Leader	**Type**	**Proposal**	**Participants**
CENER	ODS	Unsteady aerodynamics	CENER, ForWind, UoG, NREL
DTU	ODS	LD4U	DTU
VTT	ODS	Cold climate wind farms	VTT
DTU	ODS	e-WindLidar	DTU, SINETF, Fraunhofer, NTNU, UPorto
CRES	ODS	Wind turbine monitoring	CRES
SINTEF	JE	Grid Integration 2	SINTEF, ORE Catapult, TECNALIA, IREC
ECN	JE	UNAFLOW	ECN, DTU, USTUTT, POLIMI
WMC	JE	Multi-axial fatigue model	WMC, Fraunhofer, CENER
DTU	JE	Bearing Test 2	DTU, RWTH Aachen, TU Delft, NTNU
CENER	JE	Surface roughness effects	CENER, ECN, DTU TU Delft

Source: Antonio Ugarte, CENER

Proposed participation in the Joint Experiments and Open Data Sets exceeded the available budget. Only one third of the proposals could be awarded funding (see Figure 7). These include 11 Joint Experiments and 5 Open Data Sets.

- Submitted: 27 proposals requested funding for a total of € 3,080,268.
- Granted: 16 proposals received funding for a total of € 1,331,349.

FIGURE 7
Requested versus granted budget for Joint Experiments



Source: Antonio Ugarte, CENER

Figure 8 shows the key elements and statistics for both calls. It also shows the difference in percentage between the granted and requested budgets for both calls. This difference coupled with the increased number of proposals received is a clear indicator of the positive response by EERA JP Wind members to the Joint Experiments programme.

LESSONS LEARNED: THERE IS A PRESSING NEED FOR JOINT EXPERIMENTS ON A EUROPEAN LEVEL

Based on the experiences of the first call, the second call was slightly modified to allow more integration among European institutions, for instance by requiring consortiums of at least three members or by combining two or more proposals in the same Joint Experiment. In the evaluation criteria complementary to corresponding national research programmes was added as a criterion.

SUCCESS: THE COORDINATION OF EUROPEAN RESEARCH COORDINATION IMPACTS NATIONAL RESEARCH PROGRAMMES

The Joint Experiments are a success because they establish and promote research synergies among European institutions. They enhance coordination among institutions and the results improve alignment of the various national research programmes. In the experiments human and financial resources were brought together in specific, well-coordinated activities which delivered tangible results. The huge and positive response to the calls shows that there is great value in this type of Joint Experiments on a European level.

FIGURE 8
Key elements of the two calls for Joint Experiments

1ST CALL	2ND CALL
Three Topics • Wind Tunnel • Wind Turbines • Grid Integration	Open to all topics Additionally it included “Open Data Sets”
7 proposals received	More than 20 proposals
3 proposals awarded	5 Open Data Sets awarded 8 Joint Experiments awarded
General budget € 450,000	General budget € 900,000
Budget per JE not exceeding € 150,000	Budget per JE not exceeding € 150,000
A requirement of the call was to create a consortium with a minimum of **2 partners** from IRPWind or EERA JP Wind institutions	A requirement of the call was to create a consortium with a minimum of **2 partners** from IRPWind or EERA JP Wind institutions The inclusion of 2 or more research facilities in the same experiment was added to the scoring criteria.

Source: Antonio Ugarte, CENER

THE BRAIN POWER MOBILITY EXPERIENCE

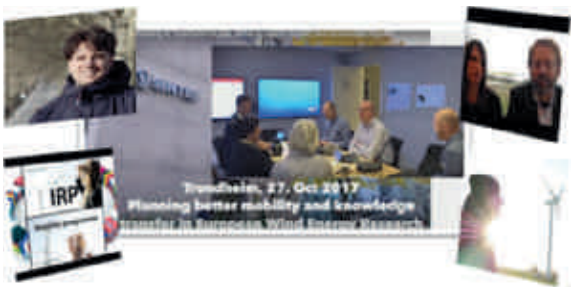
THE IDEA: SHARING AND ALIGNING RESEARCH THROUGH RESEARCHER EXCHANGE PROGRAMMES

The IRPWind Mobility program is a list of activities promoting the exchange of researchers. It greatly facilitates cooperation between IRPWind project members and enables efficient execution of the project's core research activities. The program also connects relevant national projects and initiatives to the EERA JP Wind sub-programmes and monitors emerging technologies and topics suitable for scientific research in the future. The Mobility Programme creates a real circulation of brainpower within IRPWind and EERA JP Wind.

THE SCOPE: RESEARCH EXPERTS AT WORK AND TAKING PART IN THE MOBILITY PROGRAM

Within the IRPWind Mobility program, several schemes were developed aimed at experienced researchers and managers. These include short and medium-term mobility scheme for researchers who are unable to stay abroad for long periods, and a special two week exchange scheme for managers to discuss bilateral research agreements and strategies. The entire programme provided grants for some 50 short and medium-term exchanges. 38 for researchers and 15 for managers. A total of 17 universities and research centres from 14 different countries were involved. Pictures from the exchanges and video interviews from Mobility programme participants can be found online on http://www.IRPWind.eu/mobility and https://youtu.be/eqGx0ByXyiI (see Figure 9).

FIGURE 9
Videos on different mobility experiences (Left: Callies & Frere and Lo Feudo. Right: Irrisarri & Nørkær Sørensen and Vasiljevic. Centre: a managers meeting)



Source: Claudia Calidonna, CNR

LESSONS LEARNED: FLEXIBILITY IN ORGANISING MOBILITY IS NEEDED

Through the project we learned that it is often difficult for experienced researchers to stay abroad for a dedicated period within a strict, rule-governed programme such as the IRPWind Mobility scheme. To stimulate circulation of and exchange between experienced researchers from across the EU in a one-size-fits-all approach does not work. EU-wide mobility programmes for research require flexibility. So the program evolved and introduced more flexibility, especially in terms of calls deadlines (creating an open call), and grant duration (shorter periods).

The changes were highly appreciated and researchers felt more able and comfortable in planning periods abroad. On one occassion the mobility programme was adapted for special circumstances. One researcher could extend his stay due to the imminent birth of his first child. The child was born in the Netherlands during the IRPWind mobility exchange.

Another critical issue was the mobilisation of IRPWind's top level and senior managers such as the Management Board, Work Package Leaders and Steering Committee Members. A special scheme was developed for them. Senior managers came together in thematic working group meetings to design the organisation and strategy of the new EERA JP Wind. Four thematic meetings were organized: Infrastructures and Open Data (hosted by CENER), Research Agenda and Strategy (hosted by DTU), Business Plan and Governance (hosted by ECN) and Mobility and Knowledge Transfer (hosted by SINTEF). A final full immersion meeting was held in at CNR in Rome to summarise and finalise the basis of the new EERA JP Wind 2.0 (see Figure 10).

SUCCESS: THE IRPWIND MOBILITY PROGRAMME AT THE HEART OF THE NEW EERA JP WIND 2.0

The mobility programme successfully mobilised 38 researchers involved in relevant national projects and initiatives related to core projects of IRPWind and EERA JP Wind. Short term results include joint papers, sharing of technical expertise and initial steps taken towards more joint projects. Researchers involved in the mobility programme were enthusiastic about their experience abroad. Many are looking to repeat the experience. 15 managers from 7 different countries came together through the IRPWind mobility programme to define the strategy and organisational structure of the new EERA JP Wind 2.0.

FIGURE 10
Rome 18-20 December 2018. Final meeting on EERA JP Wind 2.0

Source: Mattias Andersson, DTU

SHAREWIND: MAKING WIND ENERGY DATA FINDABLE AND REUSABLE

THE IDEA: EMBRACING THE FAIR PRINCIPLE WILL ENABLE RE-USE OF DATA

There is a major need to organise and structure web distributed data in the wind energy sector. The wind energy research community had already identified this need for "Big Data" organisation, but was challenged by the strong reservations of industry concerning intellectual property (IP) rights. But with the growing economic importance of digitalisation industry's views have changed too. In September 2017, European Distribution Grid Operators and other stakeholders signed the "Tallinn e-energy Declaration". In this declaration, recognising the need for data openness, they proposed a Protocol for a European Open Data (OD) policy in distribution systems with the aim of promoting digitisation of Europe's energy systems. To fully unleash the potential of digitalisation, organised and accessible and open data is needed. One way to do so is by embracing the FAIR (Findable, Accessible, Interoperable and Re-usable) principle. Applying this principle will enable the re-use of existing data for multiple applications and so increasing its value.

THE SCOPE: MAKING DATA FINDABLE AND CREATING AN ACCEPTED DATA TAXONOMY

Five project partners: DTU, CENER, ForWind, Sintef and ECN created a data portal (Figure 11) where a series of standard information (metadata) on web distributed data sources was collected and catalogued and which provides end-users with a search engine to pinpoint data needed for their research.

The first objective was to make data relevant for wind energy findable (the "F" in FAIR). This was achieved by creating a set of standard information to describe datasets (e.g. the associated topic, recorded variables, data format etc.). These metadata were then combined in a single file called a metadata card (Figure 12).

The second objective was to create a standard common vocabulary, i.e. taxonomy, for metadata elements. As an example, for the metadata "topic" the taxonomy shows the classification of the whole wind energy domain and allows data to be organised by topic (e.g. siting, economics, wind turbines, etc. as well as subtopics) As an example, Figure 12 shows the taxonomy of the subtopic "wind power plant". Taxonomies associated with metadata establish a common understanding between data owners and data users. Using terms from a controlled source makes it easier for data owners to find the correct term to use when describing data and to fill in the metadata card correctly, and for potential users to search for the right data.

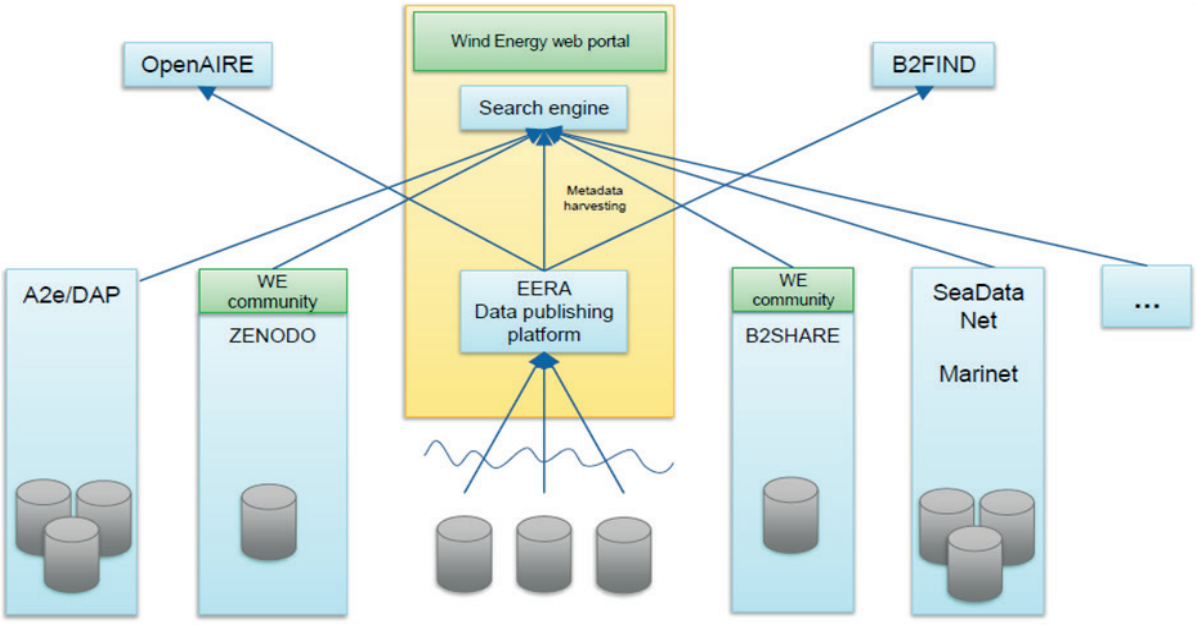
The metadata catalogue solution addresses IP concerns on sensitive data that should not be directly accessible by all users. A data portal containing only a catalogue of metadata, and not the data itself, would make (sensitive) data findable, but not directly accessible. Such a portal guarantees the visibility of both data and owners and controls data access at the same time.

Then the prototype of a data management system for wind energy was created (Figure 11).

It includes the data-publishing portal ShareWind (https://sharewind.eu/) and the temporary wind energy data search engine (http://it.cener.com/demo/ckan/), which will be integrated in the EERA wind energy web portal.

ShareWind is designed to store metadata records, consisting of 15 elements from the Dublin Core standard and 7 optional domain-specific elements (Figure 12).

FIGURE 11
The SHARE WIND Conceptual design



Source: Paweł Gancarski, CENER and Nikola Vasiljevic, DTU

The important aspect of ShareWind is that it supports the taxonomy developed during the IRPWind project, allowing data to be tagged in the right context. ShareWind is based on B2SHARE, an open-source platform developed for European researchers in the EUDAT project.

It is also fully compatible with European initiatives for open science infrastructure such as OpenAIRE, Zenodo or B2FIND allowing it to be easily integrated in the global network of digital research libraries, thus enabling knowledge to be exchanged with research communities from other sectors.

LESSONS LEARNED: WIND ENERGY DATA ORGANISATION REQUIRES COMPETENCE IN INFORMATION SCIENCE

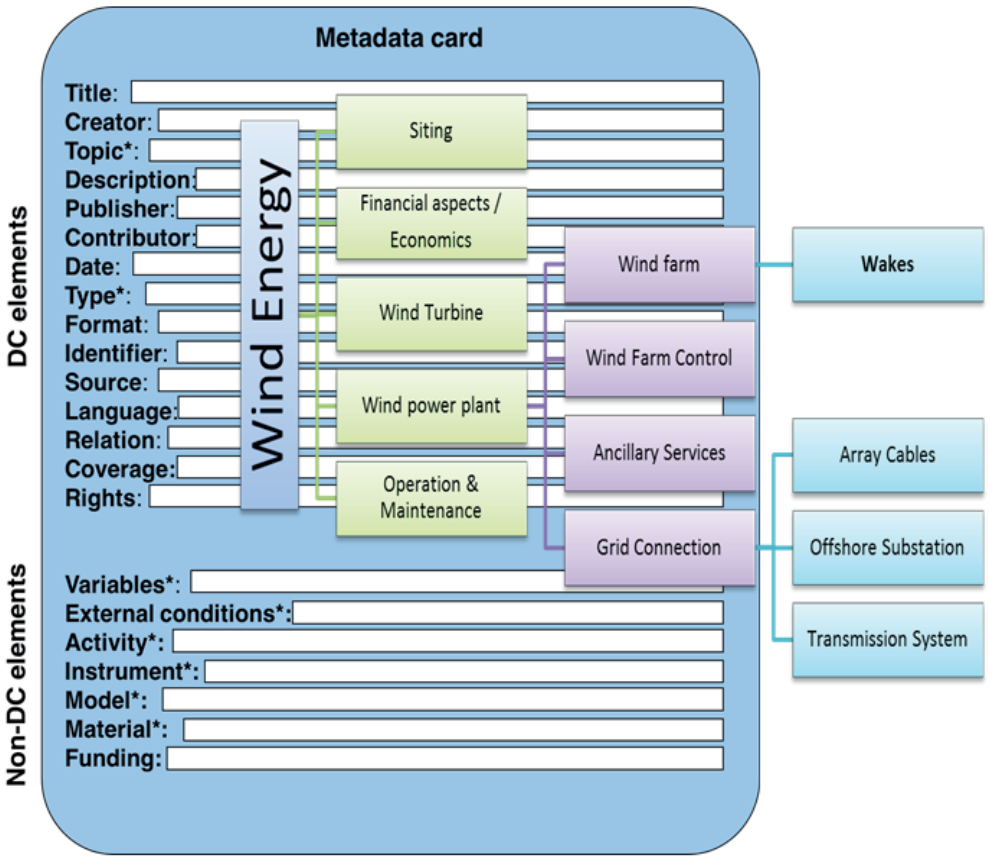
In order to extract the most value from existing web distributed datasets on wind energy, they must be findable and accessible. We realised that the process of data organisation and retrieval needs the integration of specific competences in the field of information science, and in the domain of wind energy.

SUCCESS: THE SHAREWIND WEB PORTAL IS A MILESTONE FOR THE WIND ENERGY SECTOR

ShareWind, the prototype web portal, is a success story for the wind energy community because it is a) the first joint effort to structure wind energy data and b) the first step to implementing an Open Data policy aligning data of the European wind energy community with the FAIR principle. The concept and structure of the taxonomy has been presented and discussed at several relevant events in Europe and the USA. Overall the project results have attracted great interest from the wind energy community including the IEA (Task 11). The ShareWind web portal, including a metadata catalogue of distributed data organised into topics by the taxonomy, is a milestone for data-sharing in the wind energy sector.

Building on this success will depend on acceptance and use of the taxonomy and portal by the wider wind energy community, and particularly by industry. The European Academy of Wind Energy (EAWE) and the European Technology and Innovation Platform on Wind Energy (ETIPWind) will be key in promoting the portal. The good relations between IRPWind / EERA members and EAWE and ETIPWind will facilitate uptake of the portal and data taxonomy.

FIGURE 12
Metadata card and top terms of topic taxonomy and development of the tree branches of two of the terms, Wind Power Plant & Operation and Maintenance



Source: Nikola Vasiljevic and A.M. Sempreviva, DTU.

BLADE SUB-COMPONENT TESTING CONTRIBUTES TO LOWERING THE COST OF WIND ENERGY

THE IDEA: TO DEMONSTRATE THE VALUE OF SUBCOMPONENT TESTING IN BLADE CERTIFICATION PROCESSES

The increasing size of wind turbine blades makes full scale testing a very time-consuming and expensive affair. Sub-component testing can reduce time and costs when designing new blades. It will never replace initial full scale testing, but could avoid unnecessary repetition of these costly tests as sub-component testing allows designers to focus on individual failed structural details. According to the 'DNVGL-ST-0376' standard, sub-component tests can also be included as part of the wind turbine blade structure certification procedure. Within the IRPWind project we wanted to demonstrate the value of blade sub-component testing.

THE SCOPE: EUROPEAN INSTITUTES PARTICIPATED IN A ROUND ROBIN EXERCISE ON BLADE SEGMENT TESTING

The IRPWind project conducted pioneering work on testing segments of commercial wind turbine rotor blades. DTU had four SSP 34m blades available from previous nationally funded projects (see Figure 13). All blades had previously undergone full scale testing, the results of which were made accessible to all project partners. 3m long segments were cut from the undamaged parts of the blades (see Figure 14) and distributed among three research groups from the largest European research institutes for wind energy:

1. Structural testing (WMEC)
2. Non-destructive testing (Fraunhofer IWES)
3. Probabilistic analysis (DTU)

The three groups proceeded with mechanical tests and non-destructive measurements in a round robin exercise. The main objective of the experiment was first to imitate test conditions of a full scale test and second to investigate the trailing edge failure mode. This failure was the main failure mode that occurred during the operational life of this particular blade type (SSP 34m).

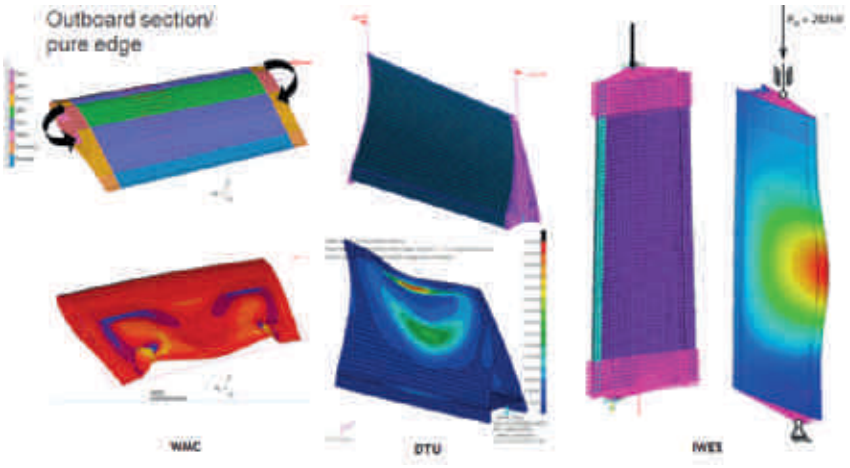
FIGURE 13
One of the SSP 34m blades lying on the DTU premise

Source: DTU

FIGURE 14
The 3m subcomponents cut from the SSP 34m blades

Source: DTU

FIGURE 15
FEM Simulations of the sub parts by WMC, DTU and Fraunhofer IWES



Source: Andreas Makris, CRES

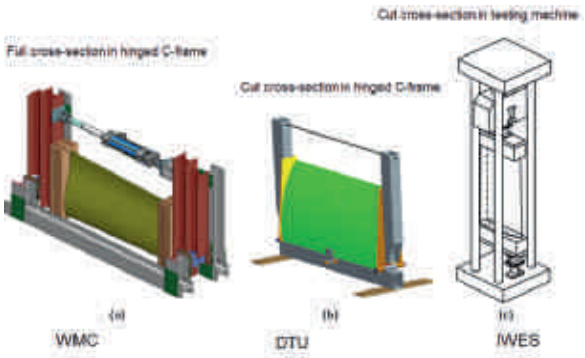
LESSONS LEARNED: PROPER DEFINITION OF TEST CONDITIONS IS CRITICAL

We learned during this research that in order to simulate full scale tests, a proper definition of the boundary and loading conditions is of paramount importance. We developed numerical models to define all the structural details (such as clamping, pistons location and so on) and to determine the testing conditions for the sub-component experiment (see Figure 15). The three research groups each designed and constructed an experimental set up focused on investigating the buckling of the trailing edge (see Figure 16). During the sub-component testing we achieved the same failure mode that was achieved during previous full scale tests.

SUCCESS: REPEATABILITY OF BLADE SUBCOMPONENT TESTING WAS DEMONSTRATED

The IRPWind work on blade sub-component testing was a great success as the round robin exercise demonstrated the validity and repeatability of such testing. This work is a stepping stone for more detailed and cheaper blade testing which will lead to lowering the levelised costs of wind energy. In addition the work strengthened collaboration between researchers from the largest European research institutes for wind energy.

FIGURE 16
Experimental set-up for testing subparts at WMC, DTU and Fraunhofer IWES



Source: Andreas Makris, CRES

DESIGNING OFFSHORE WIND FARMS

THE IDEA: VALIDATION OF DESIGN MODELS REDUCES RISKS AND SAFETY MARGINS

Validation of design models will consider both bottom-fixed and floating wind turbines and use measurement data of the loads and response of tower and support structures and the metocean conditions. Measurement data will be made available from selected offshore wind farms and from scaled experiments in ocean basin labs. Based on the data sets, design models will be validated and actual design conservatism quantified. This will reduce risks and uncertainties and contribute to reducing the cost of energy from offshore wind farms.

THE SCOPE: BENCHMARK OF DESIGN MODELS AGAINST MEASUREMENT DATA

Activities within IRPWind included assimilation of measurement data, benchmarking of design models and further model development, including the investigation of new control systems. This activity was coordinated by SINTEF Energy Research. ForWind Hannover led the activity on data assimilation, while CENER led the benchmark activity and the University of Strathclyde led the activity on model development. The other participants were DTU Wind Energy, CRES, ECN, NTNU, Tecnalia and SINTEF Ocean.

Valuable results were obtained:

- Measurements database including data from the Blyth wind farm and a test of a scaled semi-submersible floating concept;
- A benchmark validation procedure and a web-based platform for benchmark management (windbench.net);
- Improved design tools and guidelines providing reduced uncertainties (TOPFARM, StrathFarm, etc.);
- Investigation of new control systems, enabling optimised wind farm operation.

FIGURE 17
Blyth bottom-fixed offshore wind farm comprising two Vestas V66 2MW wind turbines

Source: AMEC Border Wind

FIGURE 18
Scaled hybrid test of a floating semi-submersible concept at SINTEF Ocean

Source: SINTEF Ocean

LESSONS LEARNED: NEED FOR DEDICATION WHEN PROVIDING OPEN ACCESS OFFSHORE WIND FARM DATA

Access to data for validation of hypotheses is vital to drive research forward. In wind energy research environmental data (e.g. wind, wave, current and soil), operational data of the turbines (e.g. generation and loads) and electric grid interaction are all relevant. International and European projects have collected such data, but this is often incomplete and generally limited. These data are not suited for open collaborative research or transparent benchmarking of numerical tools.

In IRPWind data and resources have been shared between partners from a variety of projects, adding significant value. And yet the collected data from full-scale operational wind farms are still not sufficient for proper benchmarking leaving a great need for a project with sufficient resources dedicated to providing open access data from a full-scale operational offshore wind farm.

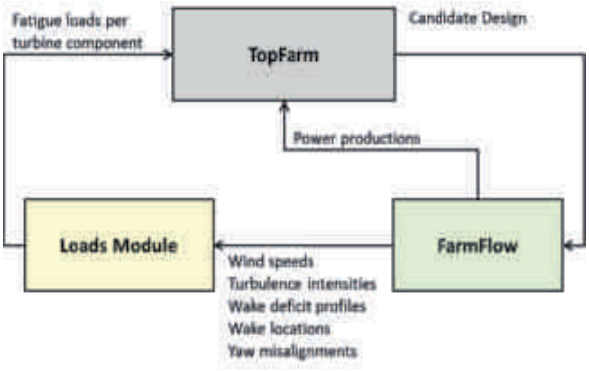
IRPWind should be acknowledged for its significant efforts in creating a dialogue with industry to open up more data. The sector will need new knowledge and increased awareness to accelerate the design optimisation of offshore wind turbines and wind farms. Open access to data is crucial for this.

SUCCESS: SHARING DATA BETWEEN PROJECTS

In IRPWind the partners shared data collected in national projects. One example is the data from the scaled hybrid test of a semi-submersible floating concept. This experiment was carried out at SINTEF Ocean as part of NOWITECH, co-funded by the Research Council of Norway. It included the development of a new hybrid test methodology, the performance of a test in an ocean basin and careful data quality checks and analysis. The project shared this data with the partners of IRPWind for benchmarking design models of such semi-submersible structures. Other lab-scale experiments that shared data include Marinet Tripile, Waveslam, etc. More data can be uploaded to the established database structure. The effort made to share data between projects truly shows the value of international collaboration, but also shows that such cooperation requires active stimuli.

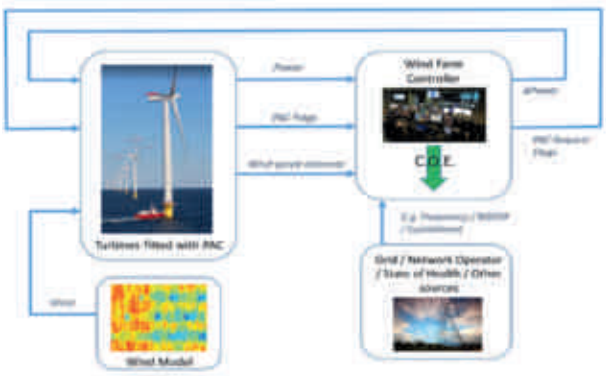
IRPWind has also been successful in establishing a benchmark procedure, improving design tools and investigating new control systems for offshore wind farms. The achieved results give an excellent starting point for more detailed studies on wind farm control, such as the H2020 projects TotalControl and CL-Windcon. The newly established collaboration between the project partners in IRPWind is of high and lasting value.

FIGURE 19
Models (TopFarm combined with FarmFlow and Loads Module) to optimise offshore wind farm design



Source: ECN & DTU

FIGURE 20
Simulation tool (StrathFarm) to assess the performance of a wind farm control system



Source: Alexander Giles, University of Strathclyde

FOCUS, MISSION AND GROWING NUMBER OF PARTNERS REQUIRES AN UPDATE OF THE ORGANISATION

THE IDEA: EERA JP WIND'S EXPANDING ORGANISATION NEEDS RENEWED FOCUS AND STRUCTURE

IRPWind was an EERA JP Wind project fostering coordination and alignment of wind energy research across Europe. The alignment of ongoing national research among the participating organisations started on the initiative of the 13 initial EERA JP Wind members. The coordination of national resources via the members, supported by larger EU-funded projects such as IRPWind, contributed significantly to coordination of wind energy research in Europe. EERA JP Wind was very successful in applying for international, mostly EU-funded, research projects because it was comprised of a relatively small number of institutes that knew each other's strengths.

The success of EERA JP Wind has attracted interest from other research groups to join the Joint Programme. The policy was to select research groups with large structural commitments in wind energy R&I that would strengthen EERA JP Wind. As a result the organisation has grown from 13 to 49 well-established members and now covers all important research and technology organisations (RTOs) and university groups. However, it has become less efficient and needs renewed focus and structure.

THE SCOPE: DEFINING THE NEW EERA JP WIND 2.0 ORGANISATION

Within the IRPWind Mobility scheme a dedicated manager exchange scheme was organized in order to lay the foundation for the new EERA JP Wind 2.0 organisation. You can read about this in the success story about the Mobility programme. Implementing a new organisation for EERA JP Wind will provide value to EERA JP Wind partners and is based on four guiding principles (see Figure 21).

FIGURE 21
The guiding principles of the new EERA JP Wind organisation

Source: Mattias Andersson, DTU

In the new proposed organisation the sub-programmes are completely redefined. On the one hand, there will be sub-programmes for core joint activities, such as planning, outreach, access to facilities and exchange of data and scientific knowledge. On the other hand, the scientific sub-programmes will have a broader description to include more of the required research for wind energy. All participants will be able to join the sub-programmes.

A more dynamic structure with Joint Actions and Joint Projects will ensure efficient execution of research activities. All participants can initiate and participate in Joint Actions and Joint Projects. This will allow joint research activities among partners that have the means to collaborate and lead to collaboration with industry. They must be R&I activities with at least two EERA JP Wind participants and will include dissemination through the sub-programmes.

The core activities of EERA JP Wind will be self-funded, but other activities will require funding. In particular the EERA JP Wind is looking for funding for two very successful activities:

- Mobility programme: exchange of experienced researchers to enhance collaboration among institutes and create significant synergies in research.
- Joint experiments: several EERA JP Wind participants sharing existing research infrastructure leads to strong collaborations and the creation of valuable open datasets.

FIGURE 22
The proposed structure of the EERA JP Wind 2.0

Core sub-programmes • Programme planning and outreach • Infrastructure and data, testing and standards	**Joint Actions** Action (research activities) with a specific programmatic goal that is being executed by a consortium of participants who have the resources and projects to deliver SMART deliverables that contribute to this programmatic goal
Scientific sub-programmes • Wind conditions and climatic effects • Aerodynamics, loads and control • System integration • Offshore Balance of Plant • Structures, materials and components • Planning & deployment, social, environmental and economic issues	**Joint Projects** Project with a specific goal that is being executed by a (possibly closed) consortium of participants who have the resources and projects to deliver SMART deliverables that contribute to this goal

Source: Mattias Andersson, DTU

LESSONS LEARNED: IRPWIND LESSONS LEARNED ARE INPUT FOR NEW STRUCTURE

In general, the lessons learned from the IRPWind project have been used to define the new EERA JP Wind structure. The EERA JP Wind will build on the project's success, such as EU-wide collaboration, organising joint experiments and sharing data as well as the mobility scheme. A key example is the uptake of the yearly IRPWind conference.

One of the main lessons learned is that, in order to be a lean and independent organisation, the core activities such as running the sub-programmes and management should be self-funded. This will ensure that management and administrational overheads are limited and partners' commitment is high.

In addition, as all members of the scientific advisory board joined the Joint Programme, an industrial advisory board was created. The board strengthens the link with industry and exploits synergies with ETIPWind.

SUCCESS: EERA JP WIND 2.0 PARTNERS ARE PART OF THE STRATEGIC LEADERSHIP FOR WIND R&D

The value of EERA JP Wind 2.0 is to be part of the strategic leadership for Wind R&D. This includes the development of R&D priorities and promoting them, influencing EU and national funding priorities, maintaining a dialogue with European industry and contributing to ETIPWind, and having access to a marketplace for shaping EU proposals to increase the success rate of applications to calls and tenders.

In addition, the EERA JP Wind is a network of leading R&D groups which gives members better access to the European wind energy research area. Partners will be able to share and exchange knowledge and data and to join collaborative projects. The joint use of research facilities leads to the creation of open datasets. The mobility of senior researchers across research groups has proven to create new links and collaboration.

The partners of EERA JP Wind see great value in the EERA JP Wind 2.0 organisation as defined in the IRPWind project. It will be implemented in spring 2018. With this new organisation EERA JP Wind is ready to continue serving the interests of the many wind energy research groups in Europe.

NOTES

NOTES

IRPWind

www.IRPWind.eu

About IRPWind

IRPWind is an integrated research programme that combines strategic research projects and support activities within the field of Wind Energy, with the aim of leveraging the long term European research potential. The concept behind this programme is built on the success of existing initiatives supporting the SET Plan Agenda such as the European Energy Research Alliance Joint Programme on Wind Energy, whose organizational structure and participation is mirrored in this consortium. IRPWind moves beyond the delivery of research projects and integrates capacities and resources around the development of high risk technologies, allowing Europe to maintain its global competitive leading position in terms of research excellence and implementation of wind power technologies. The ultimate goal of IRPWind it to accelerate the route to market for breakthrough innovations, and ultimately to contribute to reaching the ambitious European objectives for wind energy generation towards 2050.

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