Integrated Research Programme on Wind Energy

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Definitions

Acronym	Description
EERA	European Energy Research Alliance
JP	Joint Programme
IRPWind	Integrated Research Programme
SP	Sub-programme
R&D	Research and Development
R&I	Research and Innovation
IP	Intellectual Property
EC	European Commission

Contents

Executive Summary

The IRPWind conference is an annual event aimed at transferring knowledge on wind energy research among the **E**uropean **E**nergy **R**esearch **A**lliance **J**oint **P**rogramme on Wind (EERA JP Wind) members. Over the years, the goal of the conference was broadened, making an effort to inform and discuss with industrial participants as well.

In the edition of 2016, a total of 121 participants took part in the 2-day event, with both industry and national programmes representatives joining in. A mix of plenary presentations and parallel sessions for the EERA JP Wind sub-programmes, covered the complete range of technical research topics and sought for ways to integrate with industrial requirements on R&D and IP/technology in general.

The maximum number of parallel sessions was limited to two. This was one of the conclusions of the conference survey from 2015. Also the rooms of the plenary sessions had a larger capacity than previous years. Both changes helped to make the parallel sessions more accessible. Together with the informal network dinner on the first day, the conference organisation received very positive feedback during the event. This was also reflected in the online survey that was filled out by 83 participants.

Improvements lie not so much in the organisation of the conference, as in the effectiveness of involving industry in it. Further increasing the participation of industry in the last edition of the IRPWind conference will be key. The first draft of the 2017 programming reflects this ambition.

1 Introduction

The IRPWind conference (deliverable 4.03) is defined as an annual dissemination event between EERA JP Wind partners. Both EERA JP Wind projects are presented as well as outcome of national projects. The event aims to share knowledge (also across EERA sub-programmes) and to provide an opportunity for all EERA JP Wind members to network and discuss offshore wind related research topics.

The ultimate goal of Work Package 4, "transfer of knowledge", is to disseminate and exploit developed knowledge amongst the research community as well as industry representatives, therefore further equalizing the level of expertise on wind energy across Europe. Besides the research community and the industry, national program agencies as well as European Institutions such as the European Commission are involved.

The event is organised for the EERA JP Wind community but some targeted external invitations were made. Appendix A shows the complete list of attendees.

2 IRPWind conference 2016

The third edition of the IRPWind Conference was held in Amsterdam on September 19th and 20th 2016. The set-up of the conference was similar to the previous editions and took the form of presentations held in several parallel sessions, reporting on research progress and results of national and European research projects on offshore wind energy. Plenary sessions were also held at the beginning and end of the conference.

Having taken the lessons learned from the first two editions, this year's conference aimed at covering all the Technology Readiness Levels. The European Academy of Wind Energy (EAWE) represented the research community, whilst the industry was participating under the European Technology & Innovation Platform on Wind (ETIP Wind) umbrella

2.1 Registrations

In May 2016, the first round of invitations was sent out to a mailing list of 280 registered persons. The list included attendees of the previous conferences (259 addresses), complemented by industry contacts (21) specifically invited to attend the Avatar event that took place on the first day of the conference. Out of the resulting 280 invitations, 135 persons accepted and finally 121 actually attended the conference.

Amongst the participants, 14 (i.e. 12%) represented the industry. The total number of registrations reduced by 13% with respect to 2015. As mentioned above, the full list of attendees can be found in Appendix A.

2.2 Day 1, September 19th

Matthijs Soede (European Commission, DG R&I Policy Officer and IRPWind Project Officer) kindly opened the two-day conference. Peter Hauge Madsen (DTU) then introduced the outline of the IRPWind conference 2016, followed by a status update from Mattias Andersson (DTU) on the IRPWind project.

Subsequently, the parallel sessions started. Using the feedback from the previous conference editions, the parallel sessions were hosted in 2 plenary halls with a capacity of, respectively, 75 and 200 persons.

The lunch was organised in the posters area, improving the contact between the presenters and the rest of the conference attendees. The afternoon presentations consisted of 2 other parallel sessions, one of which was the Avatar event, organised by Gerard Schepers of ECN. The conference hosted a strategic session between EERA JP Wind and EAWE in the afternoon.

In the first of 2 plenary presentations in the afternoon of day 1, Carlo Bottasso, EAWE Director, presented on the role of the European Academy of Wind Energy. His presentation was followed by Jasper Vis (DONG) on the Borssele I and II offshore wind farms in the Dutch part of the North Sea.

Figure 1. Carlo Bottasso, Director of EAWE delivering his presentation

Afterwards, the poster session combined with networking drinks resulted in plenty of active discussions. The registration process yielded 12 poster participants, of which 11 provided permission to be published as an abstract. These abstracts are presented in Appendix D.

The first day of the conference was concluded by an informal dinner on the canals of Amsterdam, which successfully gathered almost 90 participants.

2.3 Day 2, September 20th

The second day was opened by Erik Miranda (Vestas), introducing the innovative multi-rotor project which had just been realised weeks before the conference.

The whole day consisted of parallel sub-programme sessions, followed by 3 plenary presentations in the afternoon. First, Henrik Stiesdal (Stiesdal A/S wind power pioneer) gave his view on innovation in the wind industry and what role the research community and industry could or should play. He advocated for the research community to be more active in practical innovation. Several examples of personal innovation were shared.

Then Bernard van Hemert (Project Manager at Gemini) presented the challenges in the realisation of the 600MW offshore park of Gemini and the potential R&D activities that could take place there. Even though he pointed out the limitations created by the project financing, the Gemini wind farm is open for monitoring and measuring. Both technical as well as ecological topics could be discussed.

Mauro Villaneuva from Gamesa delivered the closing presentation, shedding light on what economy of scale could look like in the offshore wind industry.

The match-making events between EERA JP Wind and the industry were scheduled in the conference booklet, but unfortunately had to be cancelled at the last moment. The organisation considered that the event that would have taken place in Hamburg at the WindEurope Summit 2016 only one week after the IRPWind conference would be a more successful podium to launch the Intellectual Property Repository platform of EERA. This consideration proved to be a good decision, as the match-making session subsequently held at the WindEurope Summit 2016 was successful.

2.4 Available material

The complete list of presentations can be found in Appendix C. The PDF versions of the presentations of the conference have been uploaded to the Sharepoint site of IRPWindconf.eu. All attendees of the IRPWind conference have received log-in details. Posters and presentations of last year's IRPWind conference are accessible through the same link.

https://www.irpwindconf.eu/do/login/

Figure 2. Henrik Stiesdal on innovations in offshore wind

3 Feedback and lessons learned

3.1 Feedback

A company specialized in online surveys was subcontracted to develop a survey tool that was sent out to all IRPWind registered attendees. This resulted in 83 reactions, of which 51 were fully and 28 were partially completed. Compared to 2015, the amount of returned questionnaires is 5% lower. However, the amount of open answers provided in this survey are more relevant.

In particular, the aim of the survey was to receive feedback on the way EERA JP Wind looks for interaction with its stakeholders.

The full list of questions is available in Annex XYZ

1. What type of organisation do you represent?
    a. Research community 85.9% (87.4%)
    b. Industry 11.3% (9.2%)
    c. National program 0.0% (2.3%)
    d. Other 2.8% (1.1%)
2. Which of the below media do you use to stay informed on EERA's JP Wind activities?
    a. www.irpwind.eu 76.8%
    b. Bi-annual newsletters 24.6%
    c. IRPWind's LinkedIn group 18.8%
    d. Conferences 65.2%

   e. Other,namely: 20.3%

3. Which websites do you visit to stay informed on wind energy news?
   http://energy.gov/
   http://www.sciencedaily.com/
   http://www.renewableenergyworld.com/
   http://www.ewea.org/
   http://www.offshorewind.biz
   http://www.rechargenews.com/
   http://www.windpowermonthly.com/
   http://www.4coffshore.com/
   http://www.innwind.eu/
   http://www.offshore-stiftung.de
   http://wab.net
   http://www.windmonitor.de
   http://www.nwea.nl
   http://www.offshore-energy.biz/
   http://energiwatch.dk
   http://www.linkedin.com
   http://www.renewableenergyworld.com/wind-power/tech.html
   My companys internal press clipping
   http://www.eletaen.gr
   http://about.bnef.com/
   http://www.reuters.com/
   http://www.theguardian.com/international
   http://renews.biz/
   http://www.ft.com/
4. Would you expect to find EERA JP Wind/IRPWind related news there?
   a. Yes 63.8%
   b. No 36.2%
5. What would be the frequency of contact you expect from EERA JP Wind/IRPWind?
   a. EERA JP Wind newsletter current frequency
   b. EERA JP Wind conference current frequency
   c. www.irpwind.eu updates current to more frequent (50% and 45%)
   d. IRPWind LinkedIn updates current frequency
6. How effective is the IRPWind project in speeding-up the process of bringing EERA JP Wind R&D efforts to the market?
   55% indicates the effectivity scores 4 out of 5,
   22% scoring 3 out of 5 and
   12 % 5 out of 5.
7. What would be your suggestion to further improve this process?
   a. more funding for basic research and industrial development
   b. more contact with industry, more collaboration between EERA partners in view of research projects
   c. more frequently messages, better coordinated
   d. strategic alignment with industry, EU national efforts and US efforts to accelerate outcome or gaining critical mass on a subject
   e. no recommendations as I am new to EERA wind

f. currently no. Industry is well represented in IRPWind Meetings which is important. Industry presentations and panel discussions are promoted and this shall be maintained.
g. It is already doing the necessary effort.
h. common objectives
i. involve industry in research projects
j. it is efficient (conference is done: YES), but to become more effective (finding and connecting partners) IRPWind can take a more active role such a leading role for creating specific partnerships particularly when the need is expressed.
k. I propose to iterate the IRPWIND experience in the future with possible extension of the Partnership to new Partners (as an example Politecnico di Milano-POLIMI is not partner at the moment being a recent member of EERA, but very active as partner of the two EU H2020 Projects LIFES50+ & CL-WINDCON)
l. try to get more industry present.
m. the short term delivery of solutions to the market are done by companies, which sometimes is done in collaboration with RTOs/universities. But never via an Alliance/Network. The added value is in other areas.
n. no suggestions
o. no
p. –
q. make communications simpler and more into mainstream media.
r. direct topic oriented meetings with industry
s. difficult to say. Some of the developments resulting from research will never be implemented, but some of them can be implemented very fast. So, the effort is clearly worth.
t. involve industry more intensive in IRP conferences
u. maybe include list of publications on the progress
v. –
w. if EERA is focused on applied research then industry participation would be accelerating bringing EERA JP Wind efforts to the market
x. –
y. more engagement by the Management Board for an active participation of all members
z. outside world will probably not understand the difference between IRPWind and EERA JP Wind.
aa. better open window for the market where they can see who offers which service... but takes a lot of effort to get into the database.
bb. better cooperation with industry
cc. I do not have any
dd. add links to publically available deliverables
ee. I have only been very little involved. But I appreciate that the industry is invited and involved in conferences and I think that contributes to speeding up the efforts.
ff. even closer contact between research and industry
gg. reduce politics and increase work

hh. more coverage of results and lobbying policy makers
ii. none
jj. more publicity
kk. to date it's mainly an effort of the research community, I and I would like to see more of 'whose feet are in the mud'.
ll. increase the industry involvement in EERA JP Wind projects.
mm. the WP managers are too busy to do a good job. Selecting persons having fewer positions would help.
nn. Collect industry needs on an individual basis (as they are likely to speak more
oo. if competitors are not present),which can be more than what is stated in ETIP SRIA, organize and prioritize such needs, and try to satisfy them by designing collaborative R&D projects, either EC or MS (i.e Eureka) funded.
pp. no further suggestions
qq. more meetings.
rr. try to involve more industrial partners in IRPWIND conference
ss. involving more often stakeholder to joint exchanges
tt. more information flow and networking opportunities
uu. industry collaborate with individual organizations not an entire alliance, so difficult. But conference is nice for overview and networking
vv. more for general public publications - results from collaboration on linkedin etc.
ww. try to link industry and research partners in more effective manner
xx. no
yy. always good to focus on application of results
zz. closer cooperation with industry. More intimate relation with ETIP.

1. Are you planning to visit next year's edition of the IRPWind conference?
   a. Yes 82.4%
   b. No 3.9%
   c. Maybe 13.7%

3.2 Lessons learned

The IRPWind conference of 2017 should keep:

- Plenary presentations by industry with a strong innovative character
- The 2-day programming
- Around 100-150 participants
- The opportunity to plan EERA JP Wind related activities around the conference
- More networking opportunities, e.g. standing lunches
- The amount of parallel sessions: maximum 2
- The size of presentation rooms: capacity of ~75-90 people/room
- The length of the SP sessions
- The availability of data from previous editions through irpwindconf.eu
- An industry event which makes people register for the conference.

The IRPWind conference of 2017 should improve on:

- An earlier finalization of the programme: key-note speakers should be confirmed already in May
- Increased participation of industry and national programmes – more targeted invitations

Conclusions

As in the previous editions, the efforts to bring the wind industry, national programmes and research community in one room are appreciated by all 121 participants. We still see opportunities for further integrating the research vision of industry with that of national programmes and researchers. Once more, it has proven to be difficult to keep the momentum of intense contact of the conference in the months after.

It is suggested that less intense, but more frequent contact between industry and the research community on an EERA JP Wind/IRPWind level will promote the integration of R&D activities. The monthly newsfeed that will be re-initiated in 2017 can help drawing more attention to EERA JP Wind and the conference subsequently. Communicating in alignment with ETIP Wind's SRIA will create common ground for understanding priorities in wind research. Presenting the IRPWind conference programme of 2017 as such can help to further increase its success as well.

Like in previous editions, the organisation will also take into account the feedback received from the survey. Improvements lie not so much in the organisation of the conference, as in the effectiveness of involving the wind industry in it. Further increasing the participation of the industry in the last edition of the IRPWind conference will be key. The first draft of the 2017 programming reflects this ambition. The last edition of the IRPWind conference within the IRPWind framework is promising to become the most successful one of the 4.

Appendix A. List of attendees 2016

No.	Title	Last name	Institute Company
1	Mr.	Amezqueta	CENER (Spain)
2	Mr.	Anaya-Lara	University of Strathclyde
3	Mr.	Andersson	DTU Wind Energy
4	Mr.	Antoniou	Fraunhofer IWES
5	Mr.	Argyle	Lougborough University
6	Mrs.	Ataov	METUWIND, METU Aerospace Eng.
7	Mr.	Bacher	DTU Compute
8	Mrs.	Backer	Vestas Wind Systems A/S
9	Mr.	Badger	DTU Wind Energy
10	Mr.	Barth	ForWind - Center for Wind Energy Research
11	Mrs.	Barton-Stam	ECN Wind Energy
12	Mr.	Basu	TU-Delft
13	Mr.	Bedon	ECN Wind Energy
14	Mr.	Belloli	Politecnico di Milano
15	Mr.	Berthelsen	MARINTEK
16	Mr.	Beurskens	ECN/SET Analysis
17	Mr.	Bottasso	Technische Universität München
18	Mr.	Brand	ECN
19	Mr.	Broersma	Suzlon Energy Ltd.
20	Mr.	Caboni	ECN Wind Energy
21	Mrs.	Calidonna	CNR ISAC
22	Ms.	Ceyhan Yilmaz	ECN
23	Mr.	Clausen	DTU Wind Energy
24	Ms.	Comech	CIRCE
25	Mr.	Croce	Politecnico di Milano
26	Mr.	Cronin	Siemens Wind Power A/S
27	Mr.	Cruz	CIEMAT
28	Mr.	Cutululis	Technical University of Denmark
29	Mr.	Dominguez-Garcia	Catalonia Insitute for Energy Research (IREC)
30	Mr.	Durstewitz	Fraunhofer IWES
31	Mr.	Dyck	Phoenix Contact Electronics
32	Mr.	Eecen	ECN Wind Energy
33	Mr.	Ejsing Jørgensen	DTU
34	Mrs.	Frøysa	CMR/NORCOWE
35	Mr.	Gancarski	CENER
36	Mr.	Golightly	GO-ELS Ltd
37	Mr.	Gonzalez-Salcedo	CENER
38	Mr.	Gutierrez Guzman	RWTH Aachen University
39	Mr.	Hanssen	1-Tech SPRL

40	Mrs.	Hasager	DTU Wind Energy
41	Mr.	Hauge Madsen	DTU Wind Energy
42	Mr.	Hermans	ECN
43	Mr.	Hethey	EA Energy Analysis
44	Ms.	Holttinen	VTT Technical Research Centre of Finland
45	Mr.	Islam	Technical University of Denmark (DTU)
46	Mr.	Jansen	Fraunhofer IWES
47	Mr.	Jensen	DTU Wind Energy
48	Mr.	Jensen	DTU Wind Energy
49	Mr.	Jorgensen	DTU
50	Mr.	Jørgensen	SINTEF
51	Mr.	Karimirad	MARINTEK
52	Ms.	Kentel	Middle East Technical University
53	Mr.	Knudsen	DTU Wind Energy
54	Mr.	Koutoulakos	Nuon/Vattenfall
55	Mr.	Kunneke	Delft University of Technology
56	Mr.	Lahuerta	Knowledge Centre WMC
57	Mr.	Lampropoulos	CRES
58	Mrs.	Lo Conto	Politecnico di Milano
59	Mrs.	Lo Feudo	CNR ISAC
60	Mr.	Loeven	Siemens Wind Power A/S
61	Ms.	Lourens	Delft University of Technology
62	Mr.	Lutz	University of Stuttgart
63	Mr.	MAKRIS	CRES
64	Mr.	Mann	DTU
65	Mr.	Marti	ORE Catapult
66	Mr.	McKeever	ORE Catapult
67	Mr.	Meijer	TKI Wind op Zee
68	Mr.	Miranda	Vestas Wind Systems A/S
69	Mr.	Molins	Universitat Politècnica de Catalunya
70	Mr.	Murphy	University College Cork
71	Mr.	Nitzsche	Delft University of Technology
72		Oggiano	IFE
73	Mr.	Papathanasiou	ECN Wind Energy
74	Mr.	Perez	TECNALIA
75	Mr.	Petrovic	ForWind - Center for Wind Energy Research
76	Mr.	Piel	ForWind Hannover, Information Systems Institute
77	Mr.	Raijmaekers	Knowledge Centre WMC
78	Mr.	Rettenmeier	WindForS c/o University of Stuttgart
79	Mr.	Rinne	VTT Technical Research Centre of Finland
80	Mr.	Riziotis	National Technical University of Athens
81	Mr.	Rodriguez Ruiz	CTC

82	Mr.	Rohrig	Fraunhofer IWES
83	Mr.	Rosemeier	Fraunhofer IWES
84	Mr.	Roukis	CRES
85	Mr.	Schepers	ECN Wind Energy
86	Mrs.	Sempreviva	DTU
87	Mrs.	Serri	RSE S.p.A.
88	Mrs.	Sezer Uzol	METUWIND, METU Aerospace Eng.
89	Mr.	Simao Ferreira	Delft University of Technology
90	Mr.	Skytte	DTU Management Eng
91	Mr.	Soede	European Commission
92	Mr.	Sørensen	Aalborg University
93	Mr.	Sørensen	DTU Wind Energy
94	Mr.	Stefanatos	CRES
95	Ms.	Stephansen	CMR
96	Mr.	Stewart	NTNU
97	Mr.	Stiesdal	Stiesdal A/S
98	Mr.	Swendsen	SINTEF
99	Mr.	Tande	SINTEF
100	Mrs.	Teuwen	Delft University of Technology
101	Mr.	Ugarte	CENER
102	Mr.	van Aalst	Photographer
103	Mr.	van der Laan	DTU Wind Energy
104	Mr.	van der Putten	TNO
105	Mr.	van der Weijde	TNO
106	Mr.	van Hemert	Gemini Wind Park
107	Mr.	van Kuik	Delft University of Technology
108	Mr.	van Roermund	ECN Wind Energy
109	Mr.	van Wingerde	Fraunhofer IWES
110	Mr.	Vassilopoulos	Ecole Polytechnique Federale de Lausanne
111	Mrs.	Veum	ECN Policy Studies
112	Mr.	Villanueva	GAMESA
113	Mr.	Vis	DONG Energy
114	Mr.	von Terzi	GE Global Research
115	Mr.	Wagenaar	ECN Wind Energy
116	Mrs.	Wagenknecht	Fraunhofer IWES
117	Mr.	Wiggelinkhuizen	ECN Wind Energy
118	Mr.	Wittkampf	ECN Business Development
119	Mr.	Zarouchas	Delft University of Technology
120	Mr.	Zasso	Politecnico di Milano
121	Ms.	Zeni	WindEurope

Appendix B. Conference programme 2016

19-Sep	Plenary hall 1	Plenary hall 2	Side events room 1
8.30	Registration		
9.30	Piotr Tulej (EC) - Opening of the conference		
10.00	Peter Hauge Madsen (DTU) - IRP-Wind conference 2016		
10.15	Mattias Andersson (DTU) - IRPWind in 2016: status update		
10.30	SP7 - Wind integration - Economic and social aspects - Sub-programme meeting, status update - Policies and support mechanisms for wind energy - Economic and social aspects of wind intergration - Project proposal workshop	SP2 - Aerodynamics - Status of the sub-programme - Unsteady aerodynamics (surge and pitch) - The Innotip project - Workshop project proposals	
11.30			EERA JP Wind & Industry Open match-making session 1
13.00	Lunch + poster		

14.00	SP6 - Research facilities - Introduction and session program presentation - 1st call Joint experiment: ScanFlow - 2nd call Joint experiment: characteristics - Marinet II - SP new features presentation and open discussion	Avatar - Industry event - Introduction of the project - Advanced aerodynamic modelling - Flow device aerodynamics - Roadmap for further improvements	EERA JP Wind & EAWE Closed strategy session
15.30			
16.30	Carlo Bottasso (EAWE) - The long-term research strategy in Europe		
17.00	Jasper Vis (DONG) - Three challenges of offshore wind integration		
17.30	Drinks + poster		
18.15	Bus to centre		
19.00	Boat and dinner		
21.15	Bus back to conference location		

20-Sep	Plenary hall 1	Plenary hall 2	Side events room 1
09.00	Eric C.L. Miranda (Vestas) - The multi-rotor project		
09.30	SP3 - Structures and materials - Reliability level of wind turbines - Subcomponent testing of wind turbine blades - Material testing of wind turbine blades - Creep/Fatigue interactions in composite materials	SP5 - Offshore wind energy - Progress of offshore wind energy research - Benchmark of offshore wind models - Hybrid lab test of semi-sub for offshore WTGs - Wind farm models and control systems	
10.30			EERA JP Wind & Industry Open match-making session 2
12.00	Lunch + poster		
13.00	SP1 - Wind conditions - Status of the sub-programme and challenges - Overview and status on the New European Wind Atlas - NORCOWE's OBLEX-F1 measurement campaign at FINO1 - Wake modelling including Coriolis force - Coastal experimental site of Lamezia Terme in Italy - Presentation and suggestion of the H2020 LCE -06 proposal	SP4 - Wind integration - Status of sub-programme and IRPWind WP8 - Discussion on Horizon 2020 opportunities – LCE7 and LCE21 - Wind power in balancing markets - WPP/WPPC technical requirements - Possible Power Estimation of Down-Regulated OWPs - Control reserve provision by fluctuating RES in Germany	
15.30	Henrik Stiesdal (Wind power pioneer) - How does R&D support offshore innovation?		
16.00	Bernard van Hemert (Gemini) - Innovation and Project Finance on Gemini - a mission impossible?		
16.30	Matthijs Soede (EC) - Closing of the conference		
17.00	End of programme		

Appendix C. List of presentations

Check list online

Appendix D. Poster abstracts (11/12)

1 Numerical Simulations versus Hybrid Model Tests for a Braceless Semi-Submersible Wind Turbine

Madjid Karimirad*, Petter Andreas Berthelsen, Harald Ormberg

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In this article, the coupled/integrated simulations performed in SIMA (Simulation of Marine Applications) accounting for time domain analysis are compared versus real-time hybrid model testing (ReaTHM) performed in ocean basis facilities of MARINTEK. Experimental data from a 1:30 scaled model tested at MARINTEK's Ocean Basin in 2015 using real-time hybrid model testing (ReaTHM) is used. In this paper, coupled wave-only and wave-wind-included simulations are compared against test results. The hull is considered as rigid, turbine, tower and blades, is modeled using beam elements while bar elements are used to model the mooring system in a coupled finite element approach. Frequency-dependent added mass, radiation damping, and excitation forces/ moments are evaluated using a panel method based on potential theory. Distributed viscous forces on the hull and mooring lines are added to the numerical model applying Morison's equation. The viscous drag coefficients in Morison's equation have been calibrated against selected test data in irregular waves. Simulations show that the drag coefficients change when waves are present. The aerodynamic load model is based on the blade element momentum (BEM) theory, combining the momentum theory and blade element theories. A number of correction factors are applied including, Glauert correction, Prandtl factor, Dynamic wake, Dynamic stall, Skewed inflow and Tower shadow (influence). The results show that the agreement between numerical simulations and test results are very good. In particular, the wave-frequency part of the motion responses are very well presented by numerical model compared to experiments. There are some discrepancies at resonant responses due to differences in excitation forces and damping. However, none of the responses are governed by resonance and the worst case which is the heave motion response is small for the present semi-submersible offshore wind turbine concept.

2 Multiscale analysis of White Etching Cracks (WEC) – From tribological contact to full-scale wind turbine nacelle

F. Gutiérrez Guzmán[1], G. Jacobs[1,2], R. Schelenz[2] and G. Burghardt[1]

[1] IME – Institute for Machine Elements and Machine Design
[2] CWD – Center for Wind Power Drives, Aachen, Germany

The Center for Wind Power Drives (CWD) controls and organizes the interdisciplinary research activities of the RWTH Aachen University in the field of propulsion systems of wind power drives. Those research activities include not only fundamental scientific research, but also industry-related research and development projects. Among other research areas, the CWD concerns itself with multi-physical problems in drive trains of Wind Turbine Gearboxes (WTGs).

The CWD is equipped with a 4-MW WTG system test bench, which is in operation since 2014. The test bench has a highly dynamic direct drive with a nominal capacity of 4-MW and a maximum torque of 3.4-MNm. A backlash-free, hydrostatic load unit enables a test environment of complex wind loads in five degrees of freedom (DoF). Therefore, the test system allows testing under dynamic loading conditions with up to six DoF. Hereby, forces of up to 4-MN and bending moments up to 7.2-MNm are applicable. The simulation of grid disturbances is carried out by a grid emulator, allowing a 20-kV grid connection with a power range up to 22-MVA. This arrangement meets fault ride-through (FRT) requirements and allows a detailed investigation of the grid-code compatibility issues, focusing on the behaviour of the device under test (DUT). The dynamic loads on the rotor flange and the power connection can be calculated using Hardware-In-the-Loop (HIL) models. Given this backdrop, the behaviour of wind power drives may be fully evaluated under real-life conditions in a reproducible manner.

Nowadays, the so-called White Etching Cracks (WEC) are a common cause for premature rolling bearing failures in wind turbine gearboxes, significantly increasing the maintenance costs. These undirected, three-dimensional cracks are usually flanked by regions of altered microstructure and ultimately lead to a cracking or spalling of the raceway.
Ongoing research on both component and tribological contact levels has led to several WEC-critical test conditions that may be linked to operating conditions encountered during field operation. Therefore, it is planned for 2017 to investigate White Etching Crack (WEC) phaenomena on nacelle system level within main gearbox tests. Future research aims for an insight into critical operating stages that could lead to a bearing failure.

3 Time-domain coupled structural finite element analysis of fowt

Climent Molins, Alexis Campos, Daniel Alarcón & Pau Trubat

A coupled aero-hydro-servo-elastic 3D structural analysis numerical model in the time domain was developed at the UPC-BarcelonaTech. The model computes a fully dynamic time domain nonlinear FEA for FOWT's, integrating all the effects of the external forces and the structural stiffness to obtain the displacements at each point of the structure at each time step. With this approach, the dynamic interaction between the wind turbine and the structure, as well as the effects on the internal forces are implicitly considered in the formulation.

The model integrates the hydrostatic and hydrodynamic forces exerted by the waves and currents as well as the aerodynamic loads including the wind turbine, and the mooring system dynamics. For the hydrodynamic loads, Morison's equation in combination with regular and irregular Wheeler's stretched Airy waves and regular Stokes 5th order nonlinear wave theory are used to compute the resulting forces. The mooring system can be computed dynamically or in a quasi-static way. Aerodynamic loads are computed with Aerodyn standalone NREL module, which has been coupled to the structural model. The drivetrain and control system are implemented in the overall wind turbine dynamics, leading to a fully coupling between the structure and the wind turbine dynamics.

The whole structure (substructure and tower) is discretized with one-dimensional beam elements, based in Euler-Bernoulli theory, in which a corotational formulation is implemented to deal with the large displacements. The numerical model has been implemented as a modular tool, which allows to add newer capabilities (material non-linearity, diffraction-radiation effects, etc).

This tool allows a complete and comprehensive structural assessment for both the tower and the whole floating substructure.

4 BLACKBIRD Wind-Wave Hybrid Tension Leg Floating Vertical Axis Wind Turbine

Christopher Golightly, GO-ELS Ltd

The BLACKBIRD is an offshore floating Wind-Wave Hybrid concept. It consists of a single linear axis tension leg [TLP] moored floating Vertical Axis Wind Turbine [VAWT] combined with a linear magnetic-geared tubular permanent magnet [LMGIPMG] wave energy generator or convertor [WEC]. The WEC incorporates a linear magnetic gear into a permanent magnet generator. The WEC forms part of a composite material high buoyancy submerged unit which supports the VAWT above water, acting as a damper to wave motion as well as generating power in tandem with the VAWT. The floating unit is restrained with high tension connections to the seabed using simple plug-in ball connectors, leading to a high stiffness linear structure with minimal exposure above sea level.

The VAWT is a lightweight high speed GRP constant section twin blade design. The VAWT rotor generator and WEC power processing modules are at sea level, mounted jointly on a free rotating swivel yaw bearing linked through water line to the damped tension leg line. The support floating unit with WEC is positioned at maximum wave energy levels, directly below the VAWT. The linear direct drive WEC is directly built into the floating structure. The central stator column is the main moving part, tied directly to the lower tension leg. Energy is generated via combined controlled movement of the inner stator member in tandem with damped movements of the high buoyancy support structure with outer translator.

This hybrid combination is moored via a GRP reinforced low carbon footprint concrete tension anchored seabed unit containing a seawater hydrogen electrolysis unit with combined electricity storage facility. The seabed unit contains inflow and outflow pumping systems able to store energy during periods of high wind and wave generation. Power is generated during high activity periods and converted into hydrogen via the hydrolysis unit, which is used to store energy within the seabed unit. In times of low production from the VAWT and WEC, this hydrogen is allowed to flow outwards which powers pumps generating electricity which is then transmitted to shore together with the outflowing hydrogen via a combined HVDC cable and hydrogen gas pipeline.

5 Tailoring the design of a trailing edge sub-component test

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The new design guidelines promote the implementation of structural sub-component testing in the wind turbine rotor blade design certification process. These could enhance the structural reliability and augment the structural optimization of the rotor blade segments or components along the blade span. Moreover, design changes or even local repairs can be evaluated and re-certified while avoiding the full-scale test costs.

In the current study, a generic tailoring procedure is introduced for the design of a trailing edge sub-component test. A step by step methodology is described towards the selection of the specimen geometry, the load introduction position and the experimental setup. The numerical model used is based on a 34 m wind turbine rotor blade structure available in IRPWind WP7. The design objective of the sub-component test is to match the static and dynamic structural response of the aforementioned rotor blade full-scale certification test results.

Therefore, analytical and numerical models are developed and the derived structural responses are discussed. Although the proposed methodology is not limited from the test setup, the presented study case is developed for a configuration adapted to a universal, uniaxial 2.5MN hydraulic testing machine.

6 Wind power in electricity markets: Ancillary Services and use of forecasting tools.

Mobility grants for winter 2015-16

Hannele Holttinen, Principal Scientist
VTT Technical Research Centre of Finland Ltd

Wind power will increasingly be operated in electricity markets as part of the grid integration of renewables. Offering wind power for system support: ancillary services markets, is one especially topical research area. During three mobility periods, different market related work was conducted by research scientist from VTT, Finland visiting IREC, Barcelona and LNEG, Lisbon. Results have been presented in EEM2016 conference and presentations in Barcelona, Lisbon and Porto.
In addition, the mobility time was used to visit energy companies in Spain and Portugal, with interviews on the ongoing energy transition. These results are used in linking Irpwind with Finnish National project EL TRAN.

7 Wind resource and extreme wind assessment over Central Mediterranean Basin: a mesoscale model approach

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The effective expansion of wind energy requires an exhaustive understanding of the wind resource over large areas. To cope with this issue a possible approach is the use of mesoscale atmospheric models, to develop an accurate climatological study of the wind at medium-high spatial resolution. Atmospheric models offer several advantages for wind resource assessment, such as the ability to simulate, with reasonable accuracy, complex wind flows in areas where surface measurements are inadequate or non-existent.
In this work we present some results of 30 years of numerical simulations with a state-of-the-art mesoscale model (RAMS – Regional Atmospheric Mesoscale Modeling) operatively used by CNR-ISAC. Two grids of 10km resolution are adopted and the ERA-40 Reanalysis are used as boundary conditions; model's grids cover the Italian peninsula and the central Mediterranean Basin. It should be emphasized the computational effort needed to perform 30-year simulations at medium-high resolutions.

The main objective of this work is to study extreme winds and the ability of the model to simulate them. Firstly, we have analysed wind speed (WSP) and wind direction (DIR) over the whole area and for the whole ERA-40 period. Identical analyses have been performed for 4 different directions sectors (0°-90°, 90°-180°, 180°-270°, 270°-360°).
Secondly, we have identified 30 "extreme wind" case studies, one for each year, in order to study the phenomenology associated with these events and the ability of the model to well simulate them. Although a mesoscale model cannot substitute in-situ measurements because their low spatial and temporal resolution, it can provide useful information for the identification of the areas most affected by the development of particular anemological regimes and extreme winds, especially in zones with poor wind measurements such as the offshore Mediterranean area.

Keywords: wind resource, extreme winds, mesoscale model, wind climatology

8 Two years of IPRWIND Mobility Programme: building the best schema for "brain gain".

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In this work, we give an analysis of mobility on the base of more than two year of project.

The innovative aspect of this programme is that the mobility scheme has not high training purposes but rather to enforce cooperation for established scientists within EERA Partners.

Existing literature and reports discuss mobility of researcher are mainly oriented to early stage, training or "migration of researcher". "Brain drain" and "brain gain" papers are more oriented to new work opportunities and for researchers.

On the base of submitted applications results and challenging issue are showed.

Analysing existing literature some underlying consideration were compared and analysed in order to capture main features that could be compared with mobility implemented in IRPWIND and give suggestions to implement the best possible mobile schema.

Finally some points of discussion are described as input to collect useful information to build the best scheme in the context of IRPWIND project.

9 An Investment Evaluation and Risk Management Tool for the Wind Energy Sector

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In only a few years, financing for European wind energy projects has changed radically. A period in which investors became more comfortable with investing in this technology has changed to times with a lack in available capital. Major players of the energy and banking sectors are capital constrained, the public markets are ambivalent at best, and the main economic, technical, and regulatory risks are not well understood, resulting in high equity and loan capital risk premiums that unacceptably increase the cost of finance.

Many investors avoid providing capital especially due to difficult and inaccurate Value-at-Risk analyses, even though the average return of wind energy investments is quite attractive. However, against the background of ambitious expansion targets across European countries, especially in the offshore wind energy sector, the limited willingness to invest leads to extensive funding gaps. This raises the need for comprehensive methodological support enabling investors to make decisions based on a combination of cost-benefit and total risk analyses. To this end, we developed a web-based financial decision support system for assessing wind energy investments and their general financial conditions.

The tool integrates a discounted cash flow model and a risk correlation model through a Monte Carlo simulation. To consider requirements of typical investors, it enables analyses of the probabilistic project value of wind energy investments as well as further key figures, such as the return on investment and different debt coverage ratios. Further, it accounts for different risk management figures, such as product and maintenance guarantees or insurances, and allows to evaluate investments against the background of individual risk aversion and risk-bearing capacity. The tool's applicability to a variety of problems in different contexts, including investment issues [1, 2, and 3] and political issues [4, 5, and 6] has been multiply tested and demonstrated in the recent past.

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10 The Vestas Multi-Rotor Project

Erik C. L. Miranda, Vestas Wind Systems A/S

Mr.C.L. Miranda presented his poster on the Multi-Rotor project but did not grant permission to publish the abstract or PDF of his poster or presentation.

11 Analysis of the vertical structure and PBL at Lamezia Terme coastal site using remote sensing sensors and ground based stations.

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In order to investigate the development of the vertical structure of the coastal wind flow and PBL (Planetary Boundary Layer) under different meteorological conditions and different instruments, a joint campaign with DTU during summer 2009 was conducted at Lamezia Terme coastal site. The following sensors were installed: a LIDAR (WLS7 Windcube), a ceilometer (CL31, Vaisala) and SODAR (DSDPA.90-24-METEK). At the surface, mean and turbulent meteorological parameters where sampled by standard meteorological instruments and by a METEK Ultrasonic anemometer respectively at the height of 10 m. We performed the analyses with several methodologies using these instruments. To perform the analysis during the experimental campaign and to classified a range of the weather conditions we took into account the data collected by the Surface Meteorological stations and by a METEK Ultrasonic anemometer. We fixated on day with a sea breeze well developed (15, 16, 17, 24, 28, 29, 03 July/August 2009, (W-E-W)) and day with background flow (19, 20, 21 July 2009, (W)).
A technique was studied and applied in order to reduce the noise in the Ceilometer data and a methodology to classify the lidar signals in stability classes. The obtained results showed that during the sea breeze regime the instability of atmosphere occurs during the central hours of the day while during the night have a tendency to reach a stability conditions. In previous studies [1,2] we showed that the maximum height measured by WindCube was correlated with the concentration of aerosols along the laser beam path. Therefore, the instrument cannot measure at particular height if the aerosol concentration because in height and it's not homogeneous. The results obtained in earlier studies [1, 2] allowed to focus on the response of the WindCube using the Carrier-to-Noise Ratio (CNR) signal. When the sea breeze is fully developed and the vertical layer is non homogeneous, in terms of aerosol content, because the presence of the Internal Boundary Layer(IBL) with marine aerosols above. In order to investigate the influence of aerosol backscatter on CNR signal, in particular during the well-developed sea breeze, we performed preliminary analysis and we studied the diurnal cycle of CNR at different heights for the breeze day (sector 270°). Results showed that , lifted aerosols, by convection after sunrise, and increase the height of boundary layer and entrain they, cleaner air from above. Up to 100m the shape of signals results similar, each other, but the signal between 80m to 100m shows a different trend which might indicate the front of the breeze. Further analysis will be performed in order to better investigate the IBL behaviour.

12 Boundary-Layer Study at FINO1

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The Norwegian Centre for Offshore Wind Energy (NORCOWE) is performing an offshore measurement campaign at the German met-mast FINO1 which is situated close to the 'Alpha Ventus' wind farm. The campaign takes place from May 2015 until September 2016, and is carried out by Christian Michelsen Research AS and the University of Bergen in close cooperation with the other NORCOWE partners and German research institutions. The key purpose of the campaign is to improve our knowledge of the marine boundary-layer stability, small-scale and large-scale turbulence processes and offshore wind turbine wake propagation effects.

The collected observational data will be used to validate and improve numerical models and tools for i.e. weather forecasting, turbulence models, marine operations, wakes and wind farm layout optimization. In order to provide unique datasets for the study of boundary-layer stability in offshore conditions, simultaneous measurements of wind, temperature and humidity profiles in the MABL are performed. By employing microwave radiometer and scanning lidar remote sensing technology, we are able to map the boundary layer conditions continuously to a high altitude.

Oceanographic conditions were sampled by moored instruments deployed between June and October 2015 in close vicinity to 'Alpha Ventus', to provide information on the interaction between the waves and the lower 200 m of the marine atmospheric boundary-layer. This is the first time that such a combination of meteorological and oceanographic instruments is installed at an offshore wind farm location, and operated for a duration of 15 months.