Integrated Research Programme
on Wind Energy

Project acronym: **IRPWIND**
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Collaborative project
Start date: 01st March 2014
Duration: 4 years

Title "Evaluation report on the results of the mobility scheme P1"

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Contents

1. Executive Summary

In this document, we describe the activity within IRPWind Work Package 5 (WP5) "Mobility of Researchers" and evaluate the

The mobility programme has the following objectives:

1. To ensure an efficient implementation of the CPs and in general of the research activity in EERA;
2. To facilitate the cooperation between EERA research organizations and the broad scientific community to fill gaps in the European Research Area, ERA, in the wind energy sector;
3. To connect relevant National projects/Initiatives to the IRPWind core projects and generally to the EERA JP Wind Energy Joint Sub Programmes, keeping an eye to future emerging technologies and scientific topics;
4. To conduct actions oriented to promote the concept of mobility of researchers as brain gain and foresight schemes to enable effective mobility.

There is an innovative aspect of this programme, it is not meant for educational purpose but rather to support established scientists to create or strengthen cooperation within EERA Partners.

The funding scheme consists of 39 Grants for a period length of 1 month; 18 Grants for a 3 month period and 16 grants for a 6 month period.
A lump sum is allowed to cover travel expenses from/ to home institution.

Applications were submitted online using a template available on the IRPWind website, http://www.IRPWind.eu/Mobility, where also further information and FAQs are available.

Two calls have been launched during the first year. A total of 12 applications were received, 6 in the first call and 6 in the second call. One application was rejected because the host institution was neither a IRPWind Partner nor European. At the end of the first year, 4 grants were completed and evaluated.

The 3 month period scheme is the most popular while none of the applicants has chosen the 6-month option. In the second year Clause 42 for third parties will be requested to include the EERA partners and Industrial actors in the wind energy sector. A more flexible scheme will be adopted and evaluated.

2. Introduction

One major barrier to reach the European Research Area (ERA) is the fragmentation of research activities, programmes and policies across Europe. Therefore, the IRPWind Work Package 5 (WP5) "Mobility of researchers" is designed towards the goal of overcoming this barrier. There are four main objectives:

1. To ensure an efficient implementation of the CPs and in general of the research activity in EERA;
2. To facilitate the cooperation between EERA research organizations and the broad scientific community to fill gaps in the ERA in the wind energy sector;
3. To connect relevant National projects/Initiatives to the IRPWind core projects and generally to the EERA JP Wind Energy Joint Sub Programmes, keeping an eye to future emerging technologies and scientific topics;
4. To conduct actions oriented to promote the concept of mobility of researchers as brain gain and foresight schemes to enable effective mobility.

There is the expectation of creating new collaborations and strengthen the existing ones amongst the EERA participants by proposing a joint work based on actual National and International projects. The envisaged impact would be on increasing number of joint research papers, projects and eventually new patents.

The overall KPI for this WP relates to the overall objective i.e. stimulate mobility. The number of granted mobility period over the number of applications classified according to the different proposed mobility schemes was identified as main KPI. This indicator will enable the evaluation of each scheme and outline the best practice for enhancing mobility for building trust amongst partners.

The document contains:

- The description of the activities within the mobility work package,
- The final reports submitted by the beneficiaries of the grant and their evaluations, and
- Remarks and future actions.

3. Main activities during year 1.

The following tasks have been identified to manage the whole process and assigned to either CNR or DTU or jointly

- Preparation of the call (DTU, CNR)
- Call Announcement (DTU)
- Collection of applications (CNR)
- Reviewers assignment by involving the leaders of the relevant IRPWIND core projects (CP) and EERA Sub-Programmes (SP) (DTU,CNR)
- Collection of reviews (CNR)
- Preparation of the financial information sheet after the approval of the proposals based on the chosen grant scheme (CNR)
- Money transfer for 70% of the grant total cost to the successful applicant home institution (DTU)
- Collection of final reports for each grant (CNR)
- Assignment of review for the final report (CNR, DTU)
- Collection of review reports (CNR)

- Money transfer of remaining 30% of the grant (DTU)
- Annual Reporting (CNR, DTU)

Activity summary:

- The Mobility web page was launched in April 2014, (DTU)
- Two calls were launched with deadline 31 August 2014 and 1 March 2015, (DTU)
- Two contributions to the IRPWind Newsletter were published, (DTU)
- A Video with an interview to two applicants was prepared by DTU and posted on the IRPWind Web page http://www.irpwind.eu/Mobility (DTU)
- Questionnaires for Reviewers and Applicants were designed. (CNR, DTU)
- Design of document templates (CNR, DTU)
- Participation to meetings in Brussels and Amsterdam (DTU, CNR).
- Presentation of the activity at the IRPWind General assembly in Copenhagen. (DTU)
- Preparation of the request for an amendment to the Grant Agreement (Annex 1 modified with a special clause 42 with the terms and conditions). (DTU)

The special clause 42 for financial support to third parties, will allow extending the participation of all EERA members and Industrial actors in the wind energy sector to future mobility calls.

Table 1 shows the funding schemes adopted in the first call.

The funding scheme consists of 39 Grants for a period length of 1 month; 18 Grants for a 3 month period and 16 grants for a 6 month period.
A lump sum is allowed to cover travel expenses from/ to home institution.

Grant Period	1 month	3 months	6 months
Year 1	12	6	5
Year 2	9	4	4
Year 3	9	4	4
Year 4	9	4	3
FUNDING SCHEME	39	18	16
Daily Allowance	164 EU	105 EU	105 EU
Travel expenses	Lump sum 600 Euro		

Table 1 Funding schemes

The call text, including the mobility programme rules, and the Frequent Asked Questions (FAQs) are shown in Appendix 1 and Appendix 2 respectively.

First CALL

Launch: 23th June 2014, Deadline: 31st August 2014

Received applications: 6;
Finalized: 4;
Active: 1,
Postponed: 1

First grant start: 1st October 2014,

Table 2 shows the summary of the applications in the first call.

Applicant	Title of the proposal	Home Institution	Host Institution	Lenght of Grant	Core Project
Javier Estarriaga	Working on the comprehension of the newest composites fatigue theories and their application in wind power industry	CENER	Fraunhofer IWES	1	Structures and Materials
Doron Callies	Comparison of Wind Measurements from Wind Scanners and a 200 m Meteorological Mast in complex terrain	Fraunhofer IWES	DTU Wind Energy	3	Wind Conditions
Hans-Gerd Bussman	Roadmap to Operation and Maintenaince Strategy Selection, ROMSS	Fraunhofer IWES	SINTEF Energy Research	3	Offshore Wind Energy
Ainara Irrisarri	Integrated blade design and 2 bladed downwind rotor design and study	CENER	DTU Wind Energy	3	Offshore Wind Energy
Jens Nørkær Sørensen	Research collaboration within Aerodynamics	DTU Wind Energy	CENER	1	Offshore Wind Energy
Olimpo Ainara-Lara	Working on the coprehension of the neweste composites fatigue theories and their application in wind power industry	University of Strathclyde	SINTEF Energy AS	1	Materials

Table 2. Summary of the applications submitted in the first call.

All applications were granted (Figure 1). However, the second application, listed in Table 2, has been postponed due to health issues.
Four grants but one (Bussman, IWES) ended within the first year. The evaluation grades, are shown in Figure 1.

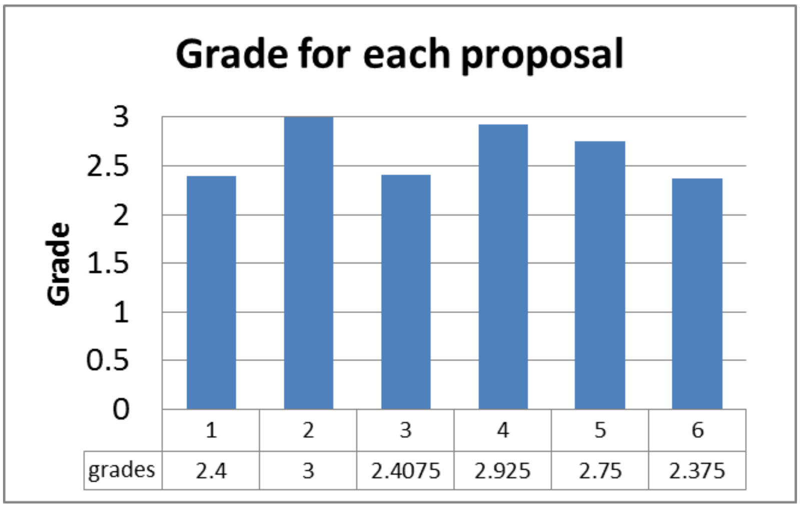


Figure 1. Summary of the grades for the proposal listed in Table 2

Second CALL

Launch: 18th January 2015, Deadline: 28th February 2015

Received applications: 6
Rejected applications:1

STATUS: ongoing review

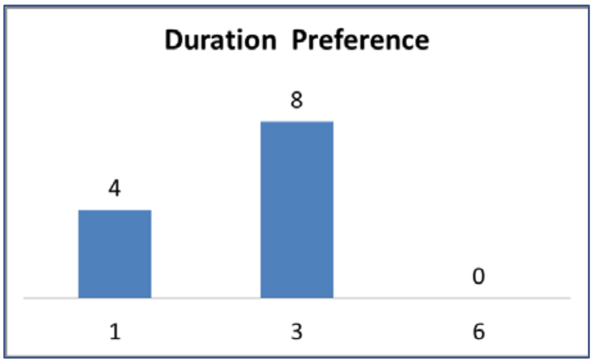
Applicant	Title of the proposal	Home Institution	Host Institution	Lenght of Grant	Core Project
Hannele K. Holtinnen	Wind Power Plant Control for Ancillary Services	VTT	IREC	3	Wind Integration
Hannele K. Holtinnen	Forecasting tools and electricity markets for wind power	VTT	LNEG	3	Wind Integration
Xabier Munduate	Research collaboration within Aerodynamics	CENER	DTU Wind Energy	3	Offshore
Nikola Vasiljević	Measurements of the induction zone, wind turbine wake and free flow in the complex and forested terrain with the hybrid WindScanner system	DTU	LNEG	3	Wind Integration
Edwin Wiggelinkhuizen	Offshore Grid Development Scenarios	ECN	IWES	1	Wind Integration
Malte Jansen	Bringing best practice market design solutions for integrating large amounts of wind power to Europe	Fraunhofer IWES	OUTSIDE Europe	3	Wind integration

Table 3. Summary of the applications submitted in the second call.

The last application in the list (Jansen, IWES), was rejected because the applicant is a Ph.D. student and the request was for a stay outside Europe (USA).

The closing date was 28 February and the evaluation process is ongoing.

The statistics from the two calls is shown in Figure 2 – 4.



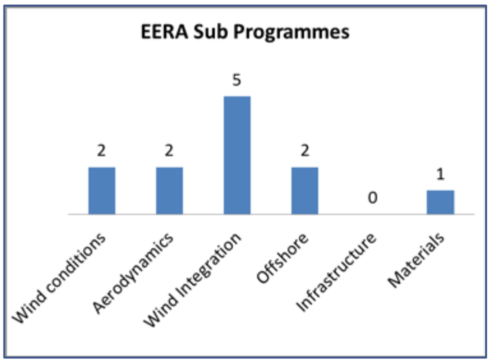


Figure 2 Scheme preference

Figure 3 EERA JP Wind subprogram preference in the calls

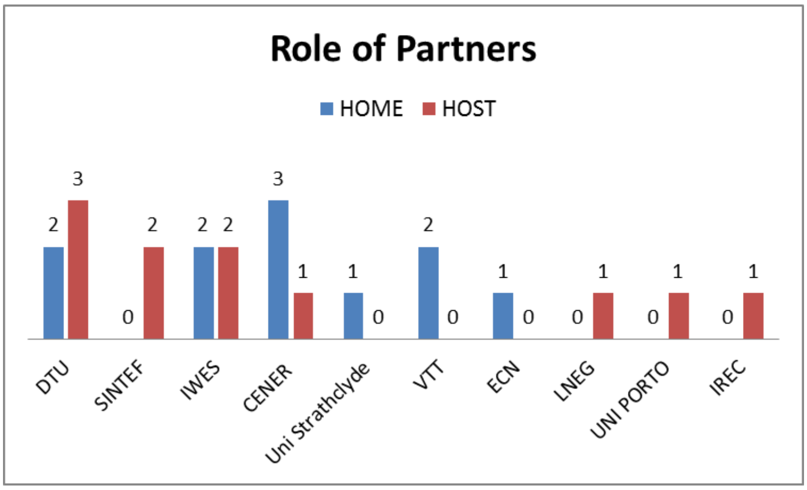


Figure 4. Role of the IRPWind partner institutions that have been active in the two calls either as Home or Host Institution. Note that, in this figure, the statistics does not include the rejected application.

4. Final mobility reports and their evaluation

4.1 Javier Estarriaga (CENER)

4.1.1 Final report

Funded by EU

Final Report for Mobility grants within IRPWIND

Applicant details

Applicant Name	Javier
Applicant Surname	Estarriaga
Home Institution	CENER
IRP Partner? *(yes/no)*	yes
Home Institution Postal address	C) Ciudad de la Innovación,7 31621 Sarriguren (Navarra) Spain
E-mail	jestarriaga@cener.com

Host institution details

Institute name	Fraunhofer IWES
IRP PARTNER?	yes
Contact person	Alexandros Antoniou
Country	Germany
E-mail	alexandros.antoniou@iwes.fraunhofer.de

Relevant Programme and scheme

CORE PROJECT? YES/NO *YES*	**(C) Structures and Materials**	**RELEVANT EERA SUB-PROGRAMME Max 2** (Please erase the non-relevant)	**(C) Structures and Materials**
Length of the grant scheme *(Please erase the non-relevant length)*	**(01) 1 month**	**Start date:**	**13th of October 2014**

WORKING ON THE COMPREHENSION OF THE NEWEST COMPOSITES FATIGUE THEORIES AND THEIR APPLICATION IN WIND POWER INDUSTRY.

1.- Description of the work and major results.

During the stay, the main tasks in which the researcher has been involved have been the writing of a report titled "Study of the state of the art & selection of a fatigue calculation methodology in composites (applied to wind turbine blades design)" as well as a presentation showing the final conclusions of this report.

Big efforts have been dedicated to the research of life prediction in composites subjected to fatigue loads over the last decades. However, due to the complicated failure mechanisms in composite materials, at the moment there are not reliable life prediction models available. Some tasks within WP 7 of IRPWIND project, intends to cast light on this complicated issue.

The aim of the study has been to select the most appropriate methodology regarding fatigue calculation in composite materials applied to wind turbine blades design.

Several aspects of different existing methodologies have been analysed, like:

- The number and kind of tests required for the whole fatigue material characterization
- The sequence load effects
- The correlation with tests (if it is a validated theory)
- The global complexity of the theory
- The strength degradation
- The stiffness degradation
- The multiaxiality
- The computational feasibility
- The multi R-ratio analysis, etc.

N different theories have been assessed by taking into account M different criteria. Each criterion has been weighed between 1 and 3 depending on its significance, and has been marked between 0 and 3 for each theory. Multiplying weights by ratings provides a score for each theory and criterion. Adding the scores provides a final score for each theory. The best approach is the one with highest total score.

Table 1 shows a template of the decision matrix used.

		THEORY 1		......		THEORY N	
	WEIGHT	Rating	Score	Rating	Score	Rating	Score
CRITERION 1							
...							
CRITERION M							
	TOTAL SCORE						

Table 1 Decision matrix template

The following theories/guidelines have been analysed.

SUNG HA	MICRO-MECHANICS OF FAILURE (MMF) FOR CONTINUOUS FIBRE REINFORCED COMPOSITES
KRÜGER	ENERGY-BASED FATIGUE APPROACH FOR COMPOSITES COMBINING FAILURE MECHANISMS, STRENGTH AND STIFFNESS DEGRADATION
PHILIPP.	LIFE PREDICTION METHODOLOGY FOR GFRP LAMINATES UNDER SPECTRUM LOADING
HASHIN	A FATIGUE FAILURE CRITERION FOR FIBRE REINFORCED MATERIALS
OPTIM.	IMPLEMENTATION OF OPTIMAT IN TECHNICAL STANDARDS
VDI	VDI 2014. CYCLICALLY LOADED LAMINATES
GL	GL-GUIDELINE FOR THE CERTIFICATION OF WIND TURBINES EDITION 2010_R0
DNV	DNV-DS-J102-DESIGN AND MANUFACTURE OF WIND TURBINE BLADES OFFSHORE AND ONSHORE WIND TURBINES

Table 2 List of theories/guidelines to assess

The approaches were quite different, from micro to macroscopic scale, and from particular models based on scientific research to widespread guidelines.

With regard to the different criteria, those showed in Table 3 have been taken into account. Note that the significance of each criterion is weighed from 1 to 3:

	WEIGHT (1-3)	CRITERIA
TEST.	3	TESTS REQUIRED FOR THE WHOLE FATIGUE MATERIAL CHARACTERIZATION
SEQ.	1	TAKES INTO ACCOUNT SEQUENCE EFFECTS
CORR.	3	CORRELATION WITH TESTS (VALIDATED THEORY)
COMPLEX.	2	GLOBAL COMPLEXITY OF THE THEORY
STR.	1	ACCOUNTING FOR STRENGTH DEGRADATION
STIFF.	1	ACCOUNTING STIFFNESS DEGRADATION
MULTIAX.	3	ACCOUNTING FOR MULTIAXIALITY
MULTID.	3	APPLICABLE TO MULTIDIRECTIONAL LAMINATES
COMPU.	2	COMPUTATIONAL REQUIREMENTS
R-RATIO	3	ACCOUNTING FOR MULTI R-RATIO ANALYSIS

Table 3 List of criteria to take into account

The methodologies shown in table 2 have been assessed and ranked according to the list of criteria shown in table 3 (details of the assessment and the matrix decision in Annex-A).

There are 4 most valued approaches, with similar total score (above 50 points). We refer to the so-called Philippidis, Optimat, VDI and GL. In fact, all of them have several similarities:

- the approaches are simple, and can be used along with the results of a FE calculation
- are widely correlated with tests (in fact, GL and VDI are standards for the industry so certain grade of validation by means of testing is required)
- a relatively large amount of tests are required to construct proper CLD's (constant life diagrams) in order to take into account mean stress corrections depending on R-ratio values
- do not take into account stiffness degradation
- the approaches apply Rainflow counting algorithm and Miner´s sum
- take into account complex stress/strain states
- are applied to multidirectional laminates

Taking into account CENER technicians' background and expertise, available technical means as well as the vision and mission of the technological centre -more focused on applied research than in scientific research- a calculation methodology has been set out. It combines different aspects of the most marked approaches, and it could be summarized as follows:

- An only multidirectional laminate is considered for the material characterization. The lay-up will be symmetrical and will contain all the different kinds of ply which are going to build the blade.
- Three S-N curves will be constructed for R-ratios=0.1, 10 and -1. The load will be applied uniaxially in direction 0º, and characteristic values according GL will be used to construct the curves. Each S-N curve will be tested at 4 different load levels. UTS/UCS values will not be taken into account in the linear regression (log-log formulation). The lowest load level will correspond to 1e7 cycles. All the test data will be collected in terms of strains.
- A CLD will be built using the S-N curves information.
- The basis of the proposed methodology is explained through the next VDI 2014 statement: "the effect of all of the instances of damage in the laminate which precede fatigue failure can be assessed by the loading on and damage to the UD lamina in the laminate which is most endangered by fibre failure".
- A FE model will be used to calculate the strain states in each part (element) of the blade. The quasi-static method will be used. This method consists on loading the blade with static unit loads, scaling each strain field by its corresponding load sequence, and afterwards combining all the strains. This is done for all the load cases.
- The fatigue analysis will be reduced to the external ply. It is assumed that this ply, whatever its fibre orientation, it will present the most critical strain state. Then, it is required to rotate this strain state in other coordinate axes (using Mohr´s circle), considering the fibre orientation of all the constituent plies.

In order to develop the methodology it will be necessary to:

- Construct a CLD in terms of strains by testing a multidirectional laminate with a lay-up including all the different plies involved in the manufacture. (uniaxial loading in 0º direction at three different R-ratios (R=-1, R=0.1; R=10)
- Carry out a quasi static analysis by means of a FE-software: unitary static calculations scaled by load spectrums to obtain strain-time histories.

- Create an in-house tool that allows the user :
  - to carry out the post-process of the strain tensor components for each element of layer 1 (external surface of the blade)
  - to align strain tensor longitudinal component with the fibre direction of any ply that appears in each element (making use of Mohr´s circle). Hence, we will obtain different longitudinal strains depending on the axis in which they have been calculated.
  - to apply Rain flow counting algorithm
  - to obtain the life prediction (N) for each longitudinal strain (making use of the constructed CLD).
  - to calculate the damage, using longitudinal strains as damage metric
  - to apply Miner´s rule for each element and for each longitudinal strain ($D= \Sigma n/N$). We take the highest values of damage to be conservative.
- Post-process the damage

At last, a testing campaign has been set out in order to validate the accuracy and goodness of the selected approach in relation to other already existing approaches.

2.- Compliance to the expected results, Key Performance indicators KPIs and the advancement of Technological Readiness Level according to the application.

The objective of the stay has been achieved: It has been written a complete and clear report showing the main points of the analyzed theories, choosing the correct approach for further development, and it has been established a framework for the appropriate collaboration within CENER and Fraunhofer IWES regarding fatigue in composites.

Before the stay, we considered that the KPI of the work done would be the number of fatigue theories analyzed and summarized in order to choose the best modeling approach. The number of variables taken into account would also be a good indicator: e.g. material strength and stiffness, loading conditions, environmental factors, long term factors, safety factors… At last, 8 different theories/methodologies have been assessed, taking into account 10 different criteria. Therefore, we consider we have dealt with most of the expected issues.

3.- Description of the benefit for the researcher, the host and home organization and IRP programme.

Regarding the host and home organization, all the generated know-how is available for their usage in its relevant on-going projects related with fatigue. The usage of a more accurate fatigue damage calculation methodology, may achieve more optimized blade designs and may accelerate the development of ground breaking technologies for reducing costs of wind energy generation. Apart from this, the collaboration bridge cooperation gaps between CENER and Fraunhofer IWES.

For the researcher, besides the technical advances, the stay has been a good oportunity to profit from an inter-cultural point of view, i.e. getting to know other working methods, language, and way of life. I have to give thanks to Fraunhofer IWES staff for the pleasant treatment and hosting.

Apart from this, the stay is also linked with the IRPWIND WP7. The tasks focused on the study of Fatigue of composites are:

- TASK 7.1.2 Experimental campaign on blade subcomponents
- TASK 7.1.3 Validation and development of blade design tools
  - Assessment of most promising advanced approaches. Basic description of the theory and calculation methodology for fatigue in composites. Development of the methodology.
  - Tests correlation
- TASK 7.3.1 Material models
  - Validation of methodology & materials characterization by means of tests

The work done during the stay is within Task 7.1.3 and allows CENER to go ahead with further steps of this project.

4.- Future perspectives. (Future research, availability of databases to other parties, expected publications and dissemination activities.)

Regarding the future work, it is planned to:

1. Review of the proposed methodology by CENER and IWES staff
2. Go on with IRPWIND WP7 tasks (development of the new approach):

   - Write a detailed test plan:

     It is planned to validate the accuracy of the method by means of tests. The challenge is to create a clear and exhaustive test plan that allows us to perform the testing campaign without exceeding the budget and deadline of this IRPWIND WP7 task and of course, to validate the proposed methodology. The tests are planned to be done in the composite materials laboratory of CENER (Polígono Industrial Rocaforte G2-H1. 31400 Sangüesa (Spain)) as part of a further task of the project.

     - At the moment, it is planned to obtain a complete CLD for a multidirectional laminate including all the different kinds of ply which are going to be used in the blade. Apart from this, we suggest to construct a second CLD following GL guideline (static strengths, synthetic slopes for each material, and formula to calculate the cycles, and a third one following VDI approach. Once we have the three CLDs, we can define a test plan for some coupons, and make comparisons between the different predictions according CLD1, CLD2 and CLD3, and the actual failure observed from testing. This exercise will cast light on the accuracy of using these assumptions or the need of doing the whole testing campaign to create a proper CLD.
     - Returning to the selected approach, it is said that all the tests are to be done in coupons made of a multidirectional lay-up that include all the kinds of ply that appear in the blade. It does not mind the part of the blade in which the damage is being calculated, we will always use the same laminate test results. This issue can be problematic, because, who knows exactly what lay-up must be chosen? Apart from this, is it valid such a simplistic approach? In this sense we suggest to create a second CLD for other different lay-up (for example thinking in cap lay-up, one laminate with most of the layers aligned with 0º) and check if this second diagram is similar or not to the former.

- Programme the in-house tool to calculate the damage (Once the method has been implemented into a code, it is planned to release the code free downloadable from CENER web page).
- Tune the methodology according to the test results

3. Open to collaborate with IWES in developing this fatigue calculation methodology
    - Follow-up of testing results
    - Periodical meetings by telecon
    - Publication of the correlation (simulations-tests) in a Scientific Journal

4.1.2 Evaluation report

Mobility Call N°:	1
Mobility scheme:	(01) 1 Month
Granter Name/Hosting Institution:	**Javier Estarriaga/ Fraunhofer IWES**

Evaluation of the final report [1]

Were the goals described in the proposal reached? Please comments if NO	☑ yes ☐ No
Does the report include major results? i.e. **highlights and new insight** and advancement of the state of the art? Please comments if NO	☑ yes ☐ No
Was the used methodology effective ? Please comments if NO	☑ yes ☐ No
Are future perspectives clear? (Future research, availability of databases to other parties, expected publications and dissemination activities). Please comments if NO **Expected publications and dissemination activities are clear. Future research and availability of databases to other parties are not clear.**	☐ yes ☐ No
Has the work been a benefit for the researcher, the host and home organization and IRP programme? Please comments if NO	☑ yes ☐ No
How do you evaluate the report?	1 2 (3) 4 5
Is any missing information in the report? Please comments if yes **A full technical report is referenced in the report, which contains important technical information that can be of benefit to the IRPWIND project, yet there are no information on availability of the report to IRPWIND partners.**	☑ yes ☐ No

[1] 1 (negative) - 2(Poor) - 3 (Sufficient) - 4 (Good) -5 (Excellent)

4.2 Jens N. Soerensen (DTU)

4.2.1 Final report

Final report for the IRPWIND Mobility Program

Name of grant holder: Jens Nørkær Sørensen
Title of stay: Research collaboration within Aerodynamics
Place of stay: CENER, Pamplona, Spain
Period of stay: October 19 – December 5, 2014

Description of the work and major results

During the stay at CENER, I collaborated with the aerodynamics group at Department of Wind Energy. On a daily basis I had discussions with the head of the group, Xabier Munduate, and some of the scientists in the group, and I was shown around the facilities at CENER. During the stay I also gave some lectures, both at CENER and at the nearby located University College of Engineering of Vitoria-Gasteiz. A main part of the stay was to finalize a monograph on the momentum theory, including various aspects related to the implementation of this theory in the Blade-Element/Momentum (BEM) theory. Some of this work was already initiated at the start of the stay. During the stay, my work mainly concentrated on modifying the momentum equation to take into account the influence of the pressure in the wake. This part was successfully solved during the stay. I started collaborating with Maria Aparicio Sanchez of CENER on the implementation of the new technique in the open source code FAST. This part was also finalized during the stay.

Compliance to the expected results

The stay fully complied with my expectations and the goals that were stated for the stay. The key performance index for the stay is that following publications are published in 2015:

1. Monograph on wind turbine aerodynamics
2. Paper on new analytical model for determining the length of the near wake behind a wind turbine.
3. Paper on new tip correction.
4. Report dealing with guidelines for implementation of rotor body forces in actuator disc model.

Status for this is that the monograph is finished and is expected to be published as a text book in the spring of 2015. The two papers are submitted to the Wind Energy journal. The report dealing with the implementation of body forces in the actuator disc model will not be made separately, as the technique is described in the monograph.

Benefits

The stay has helped CENER and DTU Wind Energy to be more closely linked. The collaboration on the implementation of the modified momentum model will be continued and may, hopefully, result in a common journal paper. Furthermore, the stay has opened for mutual use of the infrastructure on the two institutions. Hence, as a part of an EU-sponsored project, it is anticipated that CENER is going to use the wind tunnel at DTU to investigate the aerodynamics of airfoils with leading edge flaps.

Future perspectives

- The collaboration between the two institutions is expected to be strengthened in the future.
- A monograph entitled ‘General Momentum Theory for Horizontal Axis Wind Turbines’ will be published by Springer Verlag in the text book series ‘Research Topics in Wind Energy’.
- Two journal papers will be published din Wind Energy in 2015.

4.2.2 Evaluation

Mobility Call N°:	1
Mobility scheme:	3
Granter Name/Hosting Institution:	**Jens H. Soerensen/CENER**

Evaluation of the final report [1]

Were the goals described in the proposal reached? Please comments if NO	X yes ☐ No
Does the report include major results? i.e. **highlights and new insight** and advancement of the state of the art? Please comments if NO I should say partially YES. Probably the limited length of the report does not allow highlighting properly the importance of the achieved advancements in a more general framework	X yes ☐ No
Was the used methodology effective? Please comments if NO	X yes ☐ No
Are future perspectives clear? (Future research, availability of databases to other parties, expected publications and dissemination activities). Please comments if NO	X yes ☐ No
Has the work been a benefit for the researcher, the host and home organization and IRP programme? Please comments if NO	X yes ☐ No
How do you evaluate the report?	1 2 3 X 5
Is any missing information in the report? Please comments if yes	☐ yes X No
Rate the overall experience as described in the final report.	1 2 3 X 5

Other Suggestions?
Abstracts of submitted works should at least be included in the final report.

[1] 1 (negative) - 2(Poor) - 3 (Sufficient) - 4 (Good) -5 (Excellent)

4.3 Ainara Irrisarri (CENER)

4.3.1 Final report

IRPWIND FINAL REPORT

1. Description of the work and major results

The work presented at this document has been developed in the context of a collaborative project between CENER and DTU Wind through an IRPwind mobility programme grant for a 3 months stay of Ainara Irisarri (CENER) at DTU Wind.

In this context, DTU Wind and CENER have designed 2 bladed upwind and downwind rotors using Hawtopt2 (DTU's tool for Integrated Blade Design); have evaluated the designs and compared them to the reference 3 bladed DTU 10MW upwind rotor; and have evaluated the impact of tower shadow at different configurations.

2 bladed upwind rotor design

Based on the reference 3 bladed DTU 10MW upwind rotor, a 2 bladed rotor has been obtained scaling it to maintain solidity. Using that scaled 2 bladed rotor as starting point, an optimization has been performed with HawtOpt2, with the objective of increasing AEP and decreasing blade mass. Some constraints have been set related to chord, tip deflection, relative thickness, etc. and different optimization solutions have been tried.

Among those cases, a solution that gives a 0.44% higher AEP and a 18.31% lower blade mass with respect to the scaled 2 bladed rotor has been obtained. Comparing to the 3 bladed rotor, the AEP has been reduced a 0.98%, and the blade mass a 9.23%.

Comparing to the scaled blade, the designed blade has a lower chord distribution, a higher twist distribution, and a thinner t/c distribution. The mass and stiffness spanwise distributions have also decreased, especially at root sections. This has led to lower flapwise and edgewise blade root bending moments (around 20% lower).

2 bladed downwind rotor design

As in the previous case, a blade optimization has been performed with the objective of increasing AEP and decreasing blade mass. As starting point, a scaled 2 bladed rotor has been used, but this case, for being a downwind configuration, the tilt and cone angles have been removed, and the pre-bending has been reduced by a factor of 2/3, and pointed to the opposite direction (to the wind direction).

Some constraints have been set related to chord, tip deflection, relative thickness, etc. and different optimization solutions have been tried. However, for this downwind case, the tip deflection constraints have been set with no clear criterion, so, they could still be improved to get a better result.

A solution that gives a 0.84% higher AEP and a 11.56% lower mass with respect to the starting point has been obtained. Comparing to the 3 bladed rotor, the AEP has been reduced a 0.59%, and the blade mass a 1.74%.

Comparing to the scaled solution, the designed blade has a lower chord distribution (except at maximum chord area, where the chord is almost maintained as in the starting point), a higher twist distribution, and a thinner t/c distribution. The mass distribution has decreased from root to midspan, and has increased from midspan to tip. Stiffness distributions have decreased all along the span, especially at root sections. This design has led to lower blade root flapwise bending moments (around 10% lower), and higher blade root edgewise bending moments (around 12% lower).

AEP and blade mass results of upwind and downwind design cases can be seen at table 1, together with the results of the 3 bladed upwind rotor and the scaled 2 bladed downwind rotor.

At both design cases (upwind and downwind), as a stress-strain analysis has not been included into the optimization process, a failure criteria check has been performed. It has been confirmed that the designs do not collapse. In fact, they are conservative, and could be optimized even more.
Relating to the tip to tower closest approach, the analysis has not been performed, but it is recommended to be done to confirm that the designs are valid.

Tower shadow effect

Upwind and downwind tower shadow effect analysis has been done through HAWC2 simulations, thus, through tower shadow models implemented in HAWC2.
As expected, tower shadow effect is strong at root, and becomes softer as moving towards the tip. Downwind tower shadow effect is 6-7 times stronger than upwind tower shadow effect.

It is seen that at upwind cases, AEP increases a 0.13% when considering the tower shadow model. This could be related to the model implemented at HAWC2, that increases the AoA at sections close to the root at all azimuth positions except at the blade-tower passing. However, this AEP value analysis indicates that such AoA increment could be extremely strong, as it is unexpected that AEP can increase when considering tower shadow effects.

At downwind cases, the tower shadow effect causes the AEP to decrease a 1.47%. The fact of decreasing is as expected, but the amount seems to be very high: extremely strong downwind tower shadow effect. However, there is not available information to know if this represents the reality, or if the model makes the effect to be stronger than it really is.
Even if the real AEP decrease may be lower, what is clear is that optimizing the blade design instead of doing a simple scaling, reports an AEP increase of 0.84%, and the tower shadow effect reduces the AEP in the same order. This indicates that for reducing the cost of energy, designing blades or devices that minimize the tower shadow effect can be as crucial as doing a good blade design.

At table 2, AEP results of the different configurations with and without tower shadow can be seen.

Conclusion

A lot more of work could be done in order to achieve better designs, but at this point, the fact is that the Integrated Blade Design tool HawtOpt2 has been tuned and tried for 2 bladed rotor configurations, both upwind and downwind, and that there exist 2 bladed upwind and downwind rotor designs that increase the AEP and decrease the blade mass comparing to the 2 bladed downwind rotor configuration that existed before.

Through this work also the tower shadow models implemented in HAWC2 have been evaluated shortly. It has been seen that the upwind model seems to give unexpected results as the AEP increases when considering the tower shadow effect. The downwind model behaves as expected, but its' effect seems to be extremely strong. Even if the models could be improved, what is clear is that designing blades or devices that minimize the tower shadow effect is crucial for reducing the cost of energy. This would be a very interesting working line to improve the cost of energy of wind turbines, especially for downwind configurations.

2. **Compliance to the expected results, key performance indicators KPIs and the advancement of technological readiness level according to the application**

Due to the preliminary stage of the optimizations that has been reached, the obtained results have changed a bit from what was planned. The reason for those changes has been that taking design conclusions and rules at this preliminary optimized design stage could bring to erroneous considerations.

The obtained results have been:

- A 2 bladed upwind and a 2 bladed downwind wind turbine, designed using an integrated blade design tool.
- Conclusions about differences between 2 bladed upwind and downwind systems and 3 bladed upwind systems.
- Analysis of tower shadow effects at 2 bladed upwind and downwind and 3 bladed upwind wind turbines.

As Key Performance Indicators, the comparison between 2bladed upwind, 2bladed downwind and 3bladed upwind concepts for Power produced, Blade mass, and loads have been presented.

Using the Integrated Blade Design-Optimization framework, integrated blade design has moved from a preliminary design stage were rated power, rotor diameter, hub height and wind class are defined (TRL 2), to a more detailed design where an optimized blade geometry and structure are achieved using an optimization tool (TRL 3).

The advancement of TRL from 2 to 3 has been proved by the improvement seen from the scaled 2 bladed downwind rotor, to the optimized 2 bladed downwind rotor.

3. Description of the benefit for the researcher, the host and home organization and IRP programme

- Benefit for Host organization:
  - Set up the Hawtopt2 software for 2 bladed upwind and 2 bladed downwind rotors, evaluate it and use it.
- Benefit for Researcher and Home organization:
  - Learn how to use the open source Multidisciplinary Design Analysis and Optimization framework (OpenMDAO) to create an Integrated Blade Design tool based on the softwares commonly used in CENER individually.
- Common benefits:
  - Get optimized 2 bladed upwind and downwind rotors, and compare them with scaled 2 bladed rotors and with a 3 bladed upwind rotor.
  - Get some insight on tilt, cone and prebend needs of downwind rotors.
  - Get results to include on Innwind project deliverables.
- Benefits for IRP programme (and in general, the wind turbine sector):
  - DTU Wind and CENER are now closer to having an Integrated Blade Design software, that would lead to more optimized blade designs, leading to better cost efficiency of wind energy.
  - The investigation of 2 bladed downwind rotor concepts and tower shadow effects will lead to bring down the costs of offshore wind turbines, what is perfectly aligned to one of the objectives into the Offshore wind energy core project of the IRPWIND programme.

4. Future perspectives (future research, availability of databases to other parties, expected publications and dissemination activities).

There are some tasks that have not been completed at this project due to the lack of time, as said before, that would be very interesting to continue with this project:

- Rerun the upwind and downwind optimizations with stress constraints, using as inputs the extreme loads obtained at the first loop, combined with frequency or fatigue constraints.
- Write a document comprising rules for 2Bladed downwind rotor design.
- Take conclusions about advantages-disadvantages of 2 bladed downwind systems compared to 3 bladed upwind systems.

Also a new investigation line has been proposed: review tower shadow models, designing blades or devices that minimize the tower shadow effect.

The dissemination of the project developed will be done by:

- Presentation of the results on the Work Package Meeting of the INNWIND project, on May 2015.
- Publication of the work report on the IRPWIND bi-annual newsletter, on 2016.
- Publication of the work on a conference or journal paper.

	3B Up	2B Up	2B Down	2B Down scaled
AEP (kWh)	49404798	48919360	49111161	48703863
%diff AEP_wrt 3Bu		-0.98%	-0.59%	-1.42%
%diff AEP_wrt 2BdScaled	1.44%	0.44%	0.84%	
Blade mass (kg)	41700	37853	40976	46334
%diff mass_wrt 3Bu		-9.23%	-1.74%	11.11%
%diff mass_wrt 2BdScaled	-10.00%	-18.31%	-11.56%	

Table 1: AEP and Blade Mass results of the different configurations

	3B Up	2B Up	2B Down	2B Down scaled
AEP (kWh) - Tower Shadow ON	49404798	48919441	49111161	48703863
%diff AEP_wrt 3Bu		-0.98%	-0.59%	-1.42%
%diff AEP_wrt 2BdScaled	1.44%	0.44%	0.84%	
AEP (kWh) - Tower Shadow OFF	49337079	48856538	49839397	49430581
%diff ON-OFF	**0.14%**	**0.13%**	**-1.46%**	**-1.47%**

Table 2: AEP results of the different configurations with and without tower shadow

4.3.2 Evaluation

Mobility Call N°:	1
Mobility scheme:	3
Granter Name/Hosting Institution:	**Ainara Irisarri – DTU – CENER**

Evaluation of the final report [1]

Were the goals described in the proposal reached? Please comments if NO	☐ **yes** ☐ ~~No~~
Does the report include major results? i.e. **highlights and new insight** and advancement of the state of the art? Please comments if NO	☐ **yes** ☐ ~~No~~
Was the used methodology effective? Please comments if NO	☐ **yes** ☐ ~~No~~
Are future perspectives clear? (Future research, availability of databases to other parties, expected publications and dissemination activities). Please comments if NO	☐ **yes** ☐ ~~No~~
Has the work been a benefit for the researcher, the host and home organization and IRP programme? Please comments if NO	☐ **yes** ☐ ~~No~~
How do you evaluate the report?	~~1 2 3 4~~ **5**
Is any missing information in the report? Please comments if yes	☐ ~~yes~~ ☐ **No**
Rate the overall experience as described in the final report.	~~1 2 3 4~~ **5**

[1] 1 (negative) - 2(Poor) - 3 (Sufficient) - 4 (Good) -5 (Excellent)

Other Suggestions?
The final report is great, but is not in any style resembling EERA or IRPWind
I would like to have a publication from the work with a clear indication that is has been part of EERA JPWind and IRPWind. If that would be possible, that would be great.

4.4 Olimpo Aynara-Lara (University of Strathclyde)

4.4.1 Final report

Table of contents

Executive Summary

This document reports the major outcomes and findings achieved during the 1-month research stay at SINTEF Energy in Trondheim, Norway. The main activity planned for the visit was focused on identifying control requirements and specifications for offshore wind power plant control systems with particular emphasis on the control boundaries, control structures and new grid event measuring techniques. The main achievements can be summarised as follow:

Survey on offshore wind power plant control structure and topologies. This task aligns and support work being conducted in WP6.3.	√
Investigation on a hierarchical control structure based on the Power Adjusting Controller. This task supports work being conducted in WP6.3 and WP8.1	√
Assessment of a new technique to measure the frequency of a power system for control design purposes. Task relevant to WP6.3 and WP8.1	√
Design and implementation of a basic control loop to damp vibrations in the drive-train of a wind turbine. This work supported the preparation of a technical presentation and paper at the EERA Deepwind Conference 2015. This task aligns and supports work being conducted in WP6.3	√

Supported by:

1. Introduction

The EU has a binding target of 20% of energy to come from renewables by 2020, with an associated CO2 emissions reductions target of 20% (relative to 1990) and a 20% reduction on energy usage by the same date. This is the so-called 20/20/20 target. By way of example, the UK target is for 15% of energy to be sourced from renewables by this date. For this target to be met, over 30% of electricity will need to be generated from renewables and it is anticipated that 31 GW of this will come from wind power with 13 GW onshore and 18 GW offshore by 2020. At present 6 GW of wind power have been installed onshore and 3.5+ GW offshore. To increase offshore capacity by at least a factor of five in 5 years, whilst minimising the cost of energy, presents very significant challenges. Future wind power plants operating in power systems with a large amount of renewable energy will experience and increased need to be able to contribute to power system operation and security in a more pronounced way. Transmission System Operators (TSOs) wish to see a wind farms as just another power plant in the system that complies with grid codes and provides ancillary services (AS) such as frequency and voltage support and damping of post-fault oscillations [1]. However, the realization of an optimal wind power plant control strategy that incorporates ancillary services provision in an effective manner requires a series of paramount challenges in terms of models, intelligent controllers, market structures and overall system optimisation to be addressed.

2. Major Outcomes

2.1 Offshore wind power plant controls review

Although very little details are available regarding their design and performance, modern wind farms are fitted with state-of-the-art supervisory controllers that provide a variety of functions enabling the control of effective active and reactive power and implementation of all functionalities required by grid codes at the Point of Connection (PoC). The current state-of-the-art for WPP control is to let turbines operate normally at their individual optimal settings and to distribute proportionally to them down-regulation set-points. Other control functionalities include power limitation, balance control, power rate limiter (increase only) and delta control [2]. The focus of recent WPPC research is provided in [3]. It has mainly been focused on maximizing power production and steady-state load mitigation and optimised down regulation, using both centralized and distributed approaches but the contribution to grid operation has been almost totally overlooked. Regarding provision of AS, significant research has been conducted dealing with frequency support [4] including the impact of turbine frequency support on loads using a full-scale demonstration setup [5].

Several controllers used to vary the power output are discussed in the literature. Various of these are propriety systems developed by wind turbine manufacturers such as Siemens, Mitsubishi, and Vestas [6][7][8]. A controller for providing synthetic inertia and droop control was proposed by Morren *et al* [9]. The provision of inertial response from variable speed wind turbines can be obtained by controlling the power output in response to frequency changes thereby making these turbines appear more like

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conventional generators with synchronously connected inertia. There have been various approaches proposed in the open literature, which generally involve modification of the turbine controller. The principle of this approach is to modify the demanded torque in response to a change in system frequency by adding a supplementary torque control loop as shown in Figure 1. The modified demanded torque is given by:

$$T_d = T_{ref} + T_{inertia} \tag{1}$$

where T_d is the modified demanded torque, T_{ref} is the demanded torque in normal turbine operation, $T_{inertia}$ is the added torque corresponding to the change in system frequency.

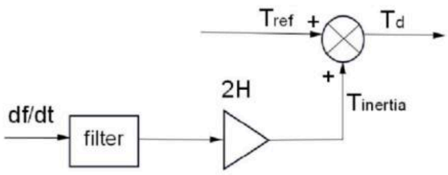

Figure 1. Inertia controller schematic.

It was shown in [10] that variable-speed wind turbine controllers can be modified to give a response similar to inertia in response to changes in network frequency. The turbine controller is modified by adding a supplementary control loop which is independent of normal wind turbine operation (as shown in Figure 2), and responds to system frequency changes using the derivative of system frequency, $d\omega/dt$. Results presented in [10] suggest that the proposed inertia response method is a 'one-shot' scheme that probably responds in proportion to the rate-of-change of frequency (ROCOF). The same inertial control strategy was presented in [11].

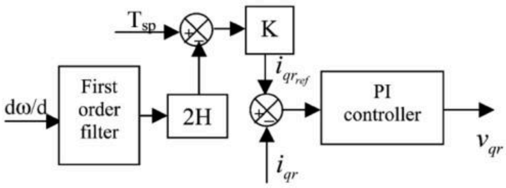

Figure 2. Supplementary control loop for inertial response from a DFIG, taken from [10].

The impact of inertia response on power system frequency from fixed-speed and DFIGs has been examined in [11]. Figure 3 shows the supplementary control loop proposed in this reference. Here the supplementary control torque T_{SC} is added to the reference torque T_{ref} (in normal turbine operation) to provide the modified demanded torque as shown in Figure 3. The addition of the supplementary controller can give a similar response to the inertial response of the conventional generator.

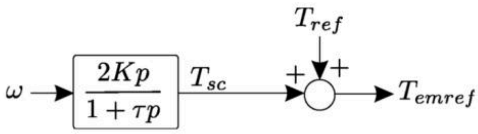

Figure 3. Supplementary control loop for dfig controller, taken from [11].

The size of the response will be dependent on the value of the control constant K. Under normal operation, the controllers of variable-speed wind turbines will keep the turbines at its optimal speed in order to produce maximum power. The controller gives a torque set point that is based on measured speed and power. The torque set point is an input for the converter control that realizes the torque by controlling the generator currents. The additional torque term will adapt the torque set point as a function of the rate-of-change of the grid frequency df/dt .

2.2 Investigation on a hierarchical control structure based on the PAC

A holistic and hierarchical structure control approach built upon the Power Adjusting Control (PAC) concept was investigated in more detail during this stay [12][13]. The hierarchical structure of the wind farm controller is shown in Figure 4.

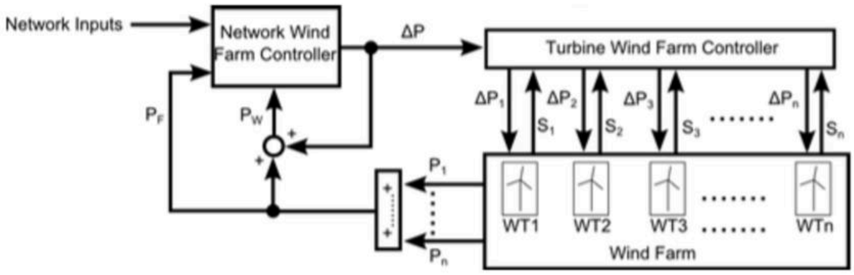

Figure 4. Supplementary control loop for dfig controller, taken from [12].

To determine ΔP, the adjustment to the power output from the wind farm required to meet some operating requirement, the network wind farm controller acts in response to network inputs, i.e. inputs related to the grid side operation of the wind farm such as power demand or grid frequency, to the total power generated by the farm, P_F, and to the unadjusted total power that could be generated from the wind, P_W. For example, to provide synthetic inertia, ΔP might be set proportional to the rate of change in grid frequency. To determine ΔP1, ... , ΔPn, the adjustments for each wind turbine in the farm, the turbine wind farm controller acts in response to turbine inputs, i.e. inputs related to the status of the n wind turbines in the farm, and to ΔP.

This hierarchical control approach enables a wind power plant to provide the full range of ancillary services including synthetic inertia at the wind farm level rather than single turbine level, offering several advantages. Tighter control of the extent of ancillary service delivered is possible without the need for tight additional feedback loops that would interfere with turbine full-envelop controllers and so turbine performance.

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Turbines' contributions can be adjusted sufficiently fast to compensate for each other as their individual contributions are affected by wind speed variation, wake interaction effects and the turbine state. Full advantage of the aggregate behaviour can be utilised to provide higher quality of provision. The wind farm controller is highly decentralised and scalable to large farms with essentially only a feed-forward modification to the PAC of each turbine. In contrast to adjustment of set points through the supervisory controller, it enables continuous dynamic modification of them at both fast and slow timescales.

2.3 Investigation on novel technique to measure grid frequency.

Enhanced controllers can enable modern variable-speed converter-connected wind turbines to mimic synchronous machine dynamic characteristics and provide a 'synthetic inertia' response [14]. However, this means that variations on the system frequency have first to be detected by wind farm controllers. In this research stay a new measuring technique was investigated whereby a fully instrumented small synchronous generator (which features Power System Stabiliser, PSS, and Automatic Voltage Regulator, AVR, controls, governor droop control, reactive power, reserve, curtailment, etc.) is connected at the PoC to which the WPPC is slaved in order to provide a wide range of ancillary services by scaling up the response of the small generator (see figure).

By slaving the wind farm (or more accurately the WPPC) to the generator then so will the wind farm. In the case of voltage support and reactive power, feed-forward to the substation will do with the WPPC only ensuring that the required power from the wind farm to do so is delivered. The relationship of the wind farms to the generator is not a fixed one, e.g. at any given time, it might be decided to provide 0% or 50% rather than 100% of the equivalent service provided by the generator. Some aspects will have higher priorities than others; the relative benefits for the operators as opposed to the grid, grid code requirements, etc. would all inform the choice. Other aspects that could well influence the choice could be related to communication aspects, timing etc., how much the grid operators are willing to pay. The controller that realises the master slave relationship of the generator to the wind farm will need to deliver combinations/scenarios. So it needs to be quite a sophisticated controller.

2.4 Contribution to conference paper on active damping control for offshore wind farms

Further work was conducted in collaboration with research staff at SINTEF Energy in the research associated to the following paper presented at the EERA Deepwind Conference 2015:

Merz, K., Anaya-Lara, O., Tande, J. O., "**Applications of active damping control for offshore wind farms",** EERA Deepwind 2015, Trondheim, February 2015.

In the research conducted for this paper an active damping and load reduction control algorithm was implemented on top of a modern, but established torque and pitch control system. Blade pitch is used to damp tower fore-aft motions, and generator torque is used to damp tower side-to-side motions. Priority has been given to collective blade pitch control and a full turbine model has been employed when designing the control algorithm. The wind turbine model involves a beam model of the turbine structures (blades, drive-train, nacelle, support structure, and foundation), models of the electric system and the blade pitch actuators, and a stochastic description of turbulence, which captures the appropriate cross-correlations between points along the blades. The model also includes communications and processing delays, which may require phase compensation.

The main contribution to this research during the research stay was the development of a control loop to mitigate drive-train oscillations (vibrations) using the torque control of the wind turbine generator. The control loop was designed using the NREL 5MW reference wind turbine [15]. The turbine was modelled in GH Bladed where a linearised model was obtained. The linearised model was then implemented in Matlab/Simulink where the control was later design as shown in Figure 7 in the Appendix. Some key responses of the wind turbine illustrating the performance of the control loop are presented in Figure 5 and Figure 6.

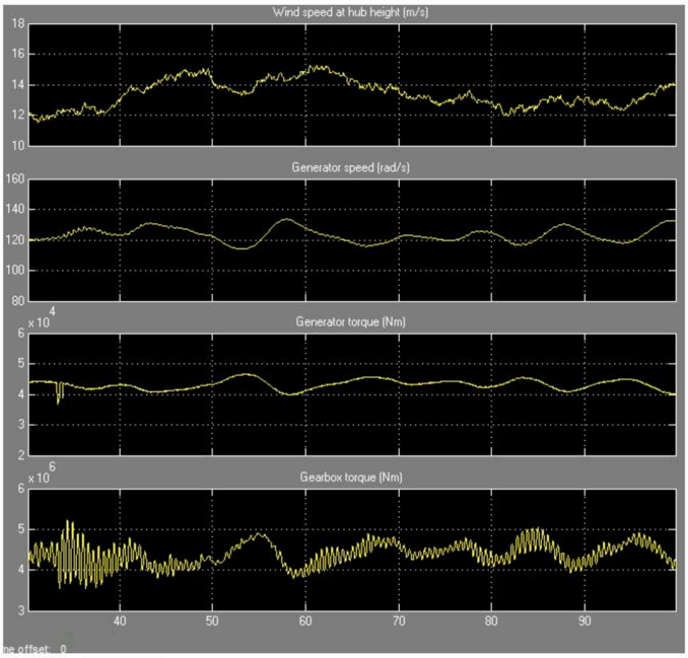
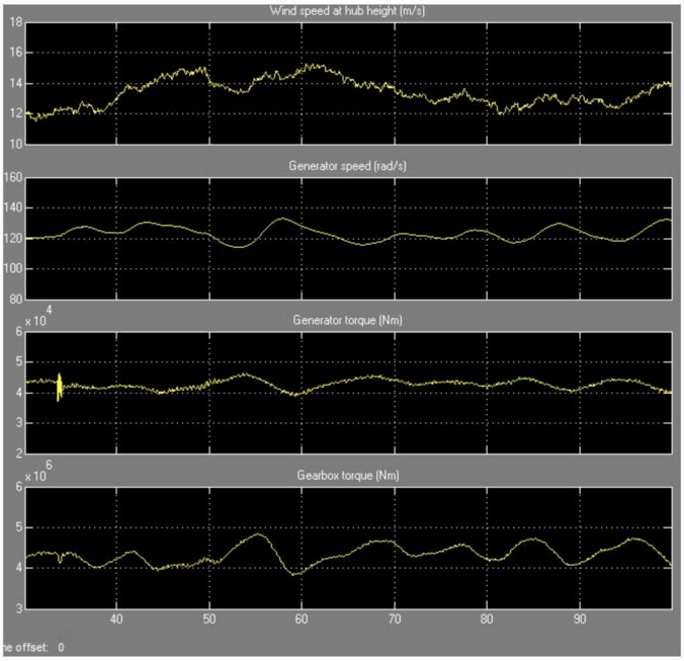


Figure 5. NREL 5 MW wind turbine key responses without control loop to mitigate drive train vibrations.

It is worth observing the way in which the gearbox torque response improves with the control loop activated as shown in Figure 5 compared with the response in Figure 6 with no control loop activated.



Wind profile

Generator speed

Generator torque

Gearbox torque

Figure 6. NREL 5 MW wind turbine key responses with control loop to mitigate drive train vibrations.

3. Conclusions

Various research contributions were achieved during this one-month stay at SINTEF Energy in Trondheim. Of particular relevance was the investigation on the hierarchical control structure based on the Power Adjusting Controller (PAC). A better understanding of how this controller works was attained and this is substantial and relevant to other WPs in IRPWIND such as WP6.3 where this controller will be underpinning some of the control approaches to be further developed. It is also worth pointing out that the work conducted on the control loop to damp drivetrain vibrations is similarly relevant to WP6.3 and this cooperation with SINTEF Energy staff will be continued facilitated by the work programme in this work package.

4. Acknowledgement

Dr. Olimpo Anaya-Lara thanks deeply IRPWIND for the support provided for this research stay. Also many thanks are given to SINTEF Energy for hosting the stay and to staff for the fruitful cooperation. Dr. Anaya-Lara also thanks the University of Strathclyde for given permission to conduct this research stay.

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6. Appendix: NREL 5 MW reference turbine – linearised model implemented in Matlab/Simulink

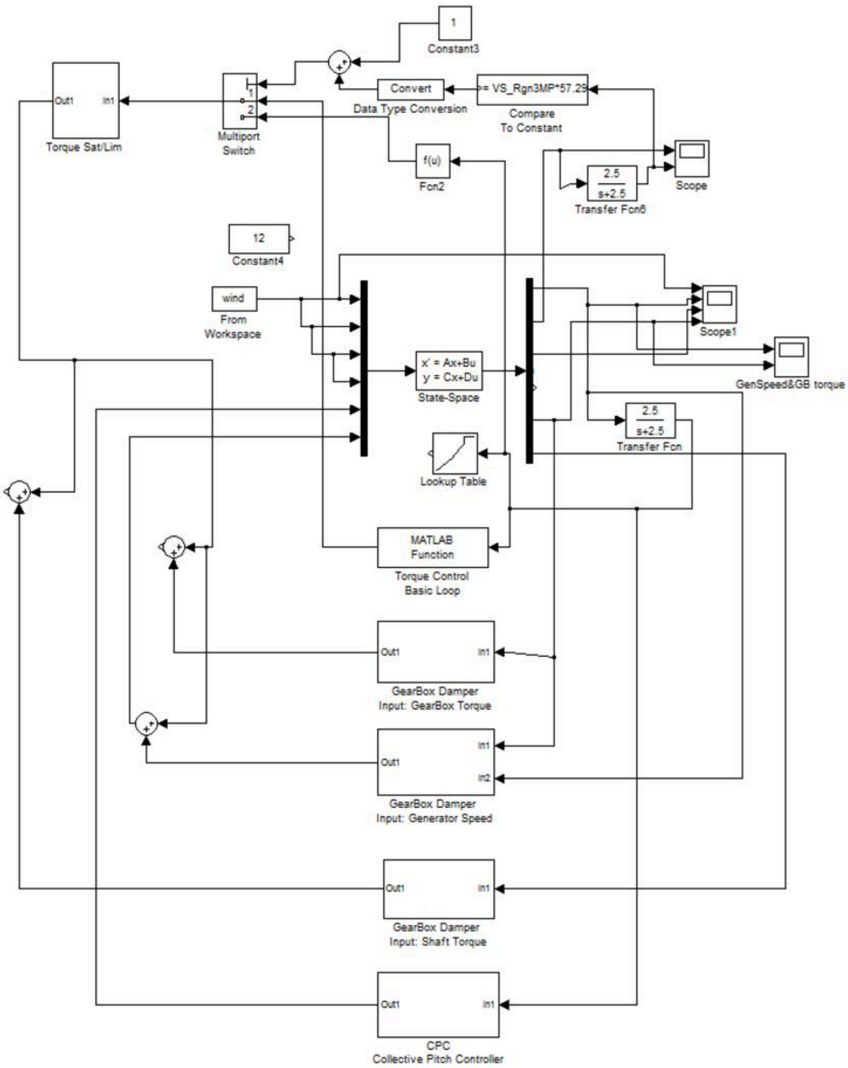

Figure 7. NREL 5 MW reference turbine – linearised model implemented in Matlab/Simulink.

4.4.2 Evaluation

Mobility Call N°:	1
Mobility scheme:	3
Granter Name/Hosting Institution:	Olimpo Ainara-Lara/Sintef

Evaluation of the final report [1]

Were the goals described in the proposal reached? Please comments if NO	X yes □ No
Does the report include major results? i.e. **highlights and new insight** and advancement of the state of the art? Please comments if NO	X yes □ No
Was the used methodology effective ? Please comments if NO	X yes □ No
Are future perspectives clear? (Future research, availability of databases to other parties, expected publications and dissemination activities). Please comments if NO	□ yes □ No
Has the work been a benefit for the researcher, the host and home organization and IRP programme? Please comments if NO	X yes □ No
How do you evaluate the report?	1 2 ***3*** 4 5
Is any missing information in the report? Please comments if yes	□ yes X No
Rate the overall experience as described in the final report.	1 2 3 ***4*** 5

Other Suggestions?
………
………
………
………
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4.1 Hans-Gerd Bussmann (IWES)

4.1.1 Grant Application

IRPWind

Funded by EU

Application for a Mobility grant within IRPWIND

A) Applicant details

Applicant Name	**Prof. Dr. Hans-Gerd**
Applicant Surname	**Busmann**
Home Institution	**Fraunhofer IWES NordWest**
IRP Partner? *(yes/no)*	**yes**
Home Institution Postal address	**Am Seedeich 45 27572 Bremerhaven, GERMANY**
E-mail	**hans-gerd.busmann@iwes.fraunhofer.de**

B) Host institution details

Institute name	***SINTEF Energy Research***
IRP PARTNER?	**yes**
Contact person	**Dr. Thomas Welte**
Country	**Norway**
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C) Relevant Programme and scheme

CORE PROJECT? YES/NO *(Please erase the non-relevant)*	**(A) Offshore Wind Energy**	**RELEVANT EERA SUB-PROGRAMME Max 2** (Please erase the non-relevant)	**(A) Offshore Wind Energy**
Length of the grant scheme *(Please erase the non-relevant length)*	**(03) 3 months**	**Start date:**	**January 5, 2015**

D. Project description

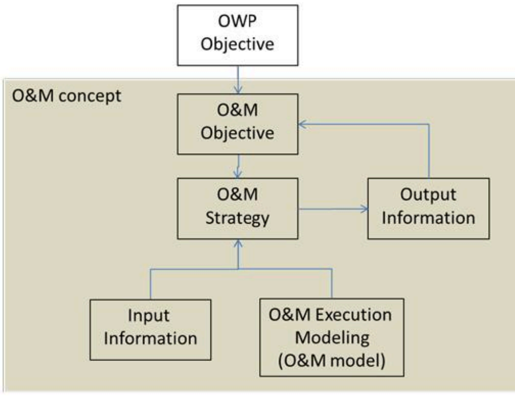
Roadmap to Operation and Maintenance Strategy Selection ROMSS

1. Introduction

- *Research topics, originality*

The aim of this project is to provide a first roadmap to select an appropriate operation and maintenance (O&M) strategy for offshore wind parks (OWP). This includes firstly a consideration of sometimes quite different output information requested by the various stakeholders of OWPs, secondly different concepts of how O&M execution can be modelled, and thirdly different classes of input parameters that are needed to feed the O&M models. Hereby, an O&M strategy is defined as a long-term oriented striving for a defined O&M objective, taking into account the available information and O&M models.

The most important stakeholders in O&M strategies are project operator, banks, venture capital, private equity, insurances, utilities, project planner, turbine and component manufacturer, as well as transport and installation companies. Although they share the interest of being economically successful (general cost reduction), in detail they pursue sometimes quite different O&M objectives and consequently might favor different O&M strategies. One is primarily interested in the optimization of the total financing over the entire park lifetime, one in a quick return of his investment, one in a save planning of all O&M costs (low risk), one in a relaxed operation over the first operational years (guarantee), and so forth.



To use one single holistic O&M concept "for everything and everyone" means to be able to handle all possible O&M strategies including different kind of output information, different modelling approaches for the actual O&M execution and different sets of input data. It is hardly conceivable that such a concept can be squeezed into one single modelling and simulation package. Much more likely appears a methodology to use available knowledge and experiences e.g. through expert interviews to identify the most appropriate O&M model and subsequently to choose a corresponding modelling code (software) to achieve a given O&M objective.

This project will provide a systematic survey of important

- output data and information depending on the interests of the different stakeholders,
- O&M models and simulation approaches used to map the actual O&M operations, and
- input data and information that are necessary for O&M planning and operation and thus for the O&M models.

This survey might be regarded as a first version of a roadmap with which an OWP stakeholder might specify his O&M objectives, strategy and modelling approach. A systematic matching of this wish list with the current state of the art will enable the identification of necessary R&D tasks to finally achieve a comprehensive holistic O&M concept. New O&M concepts with tailored properties regarding input, O&M

modelling, and output will be possible to design and shall become subject of new activities and projects on national and European level.

The readiness level to perform the here proposed project is quite high and it can be started immediately. As described below, both the receiving and the sending institution have substantial experience with the development and application of tools for planning, optimization and execution of O&M operations. Both have defined offshore reference wind parks, as well as both use home-developed and commercial tools for the mapping of O&M operations. The applicant itself has been working the field of offshore wind energy for more than 10 years now and was strongly involved in the development of the competence "Project and Risk Management" at the sending institution.

- *Technological Readiness Level (TRL) of the proposed concept.*

The Technological Readiness Level at the beginning of the project of the task "How to select the most appropriate O&M strategy" within a comprehensive holistic O&M concept is 1 to 2.

- *Definition of Key Performance Indicators (KPIs).*

During the course of the project, feedbacks are foreseen from the key groups of O&M stakeholders (operators, finances, insurances, utilities, component manufacturer, O&M service companies) to define the objectives of O&M strategies. A first KPI is the number of companies which agreed to give a feedback. Other KPI are the number of new ideas for new O&M strategies that become apparent at the end of the project and successful follow-up activities within the IRP/EERA context.

- *Description of links to relevant EERA Sub Programmes (SP) and/or IRPWIND Core Projects (CP).*

The specialties of offshore wind energy are subject of EERA JP Wind sub-programme "Offshore Wind Energy" and IRPWIND core projects WP 6 to 8. However, so far "O&M planning and execution strategies" are yet not considered here directly. O&M are major factors of the total life time cost balance of OWP and should be considered already at the time when the actual park layout and turbine including the support structure are selected. Pre-competitive research on the best O&M concept to achieve the most cost effective wind power production would thus clearly fit into the sub-programme "Offshore Wind Energy". Results of European scientific research on O&M concepts and strategies would supply direct contributions to the IRPWIND core projects as vice versa such research would be supported by these WPs. Important links could be tied to WP6 to improve the mutual consideration of O&M issues and turbine design, and especially to WP7. The methods under investigation in WP7 to predict the residual lifetime and damage progression of critical components should directly be considered in new O&M concepts. As well, information about necessary input data for advanced O&M models could be provided to WP7.

2. Description of national projects aligned to the proposed activities in both the sending and the receiving institution

- *Description of national projects from the receiving institution.*

SINTEF Energy Research is host and research partner of the Norwegian Research Centre for Offshore Wind Technology NOWITECH and leading the research tasks in working package 5, "Operation &Maintenance" In task 5.1 "Maintenance Strategies", methods and tools for evaluation and assessment of maintenance and logistic strategies are developed, both on component and system level and with focus on a life cycle cost perspective. In task 5.2 "Surveillance and Condition Monitoring", condition monitoring methods and tools for predictive maintenance strategies are adapted and developed, seeking to integrate condition monitoring and predictive component degradation models into control systems and O&M concepts. And finally in task 5.3 "Production and Maintenance of Materials and Coatings", new and more cost-effective coatings and materials are developed, taking into account initial costs and maintenance requirements. The activities in NOWITECH WP5 have also addressed logistics operations related to large offshore wind farms under rough weather condition, and effective access systems for safe personnel entry on offshore structures have been analyzed.

- *Description of national projects from the sending institution.*
  In the collaborative project COAST (Weather dependence and forecasting methods for the construction and operation of OWPs, national German co-funding), IWES and German industry jointly develop a new method for the planning of offshore operations. Focus of this project is the consideration of weather and waves as a real time function in its full complexity, whereby historical data are combined with real time forecast data in dependence of the actual specific task. Different meteorological and oceanographic models are used and are adapted to the actual park site by model-output-statistics. A combination of the different models finally delivers the prognosis the optimal operations schedule including an error indication.

  Initially supported by public funding, IWES continuously develops a reference wind park that is especially used for the development and demonstration of transport and installation (T&I) and O&M planning tools. This virtual park is located on a free sea route area close to Alpha Ventus / Fino 1. The modular concept started with a description of the turbines, their sites, and wind and wave conditions. For specific issues further properties were defined such as the soil properties. For T&I, IWES has been using standard weather window statistics, standard MS-project and the COAST code, for O&M the commercial ECN O&M Tool, the COAST code, and a further home-build code. IWES is also involved in further reference wind park activities like with regard to Crown Estate 2012, Prognos/Fichtner 2013 and NREL.

- *Foreseen European added value of national alignment.*

The German alignment regarding the O&M of OWPs is focused on the German bay, with comparatively long distances to shore and medium water depths with bottom-fixed structures. However, the Norwegian alignment is on deep water with floating structures. Both, the receiving and sending institution will bring in this matter Know-how and experiences into this project. In this way, the "Expected Results" and their subsequent activities (joint European R&D and demonstration projects, a joint strategy for needed research by the IRP/EERA partner, see below) will fully benefit from the German and Norwegian alignments.

- *Description of the host institute: e.g. infrastructure, experience etc.*

SINTEF is a broadly based, multidisciplinary research concern that possesses international top-level expertise in technology, medicine and the social sciences, and SINTEF's aim is to become the most renowned contract research institution in Europe. SINTEF employs 2100 staff who comes from 70 different countries. The turnover in 2013 was NOK 3.0 billion, more than 90% of which was won in open competition for contracts for industry and the public sector and project grants from the Research Council of Norway and the EU.

SINTEF Energy Research focuses on finding solutions related to power production and conversion, transmission / distribution and the end use of energy both onshore and offshore/subsea, covering all the key areas from indoor climate and energy use in buildings to gas technology, combustion, bioenergy, refrigeration engineering and technology for the food and nutrition industry. SINTEF Energy Research carries out both theoretical and experimental research and, together with NTNU, utilizes and develops joint laboratory facilities as part of its research activities.

Offshore wind power is a key area at SINTEF Energy Research. It is the host and together with NTNU the major institution for the research and developments of NOWITECH. The objective is pre-competitive research laying a foundation for industrial value creation and cost-effective offshore wind farms. Emphasis is on "deep-sea" (+30 m) including bottom-fixed and floating wind turbines.

Work is focused on technical challenges including a strong PhD and post doc programme:

- Integrated numerical design tools for novel offshore wind energy concepts.
- Energy conversion systems using new materials for blades and generators.
- Novel substructures (bottom-fixed and floaters) for offshore wind turbines.
- Grid connection and system integration of large offshore wind farms.
- Operation and maintenance strategies and technologies.
- Assessment of novel concepts by numerical tools and physical experiments.

Total budget (2009-2017) is + NOK 320 millions / M€ 41 / MUSD 55 co-funded by the Research Council of Norway and NOWITECH partners.

3. Work plan

- *Deliverables, milestones etc.*

Week 1:	-	Discussions within SINTEF about the overreaching concept
	-	Development of a first layout of the roadmap (deliverable D1)
	-	Identification of stakeholders to be addressed (D2)
Week 2 to 6:	-	Gathering information from selected stakeholders and additional sources regarding the specific stakeholders interests in O&M concepts
	-	Compilation and structuring of this information (D3)
	-	Collection of currently used O&M models and needed input data
	-	Collection of O&M models that are subject of current R&D
	-	Systematic overview of O&M models (D4)
Week 7 to 11:	-	Final version of the first roadmap (D5)
	-	SWOT analysis of current major O&M models (D6)
Week 12:	-	Draft proposal for future European research and final report (D7)

4. Benefits to EERA objective advancement

- *Contribution to the advancement of the EERA strategy goals, gaps addressed.*

The EERA strategy goals of better integration of European research activities, capacities and resources, as well as priority settings serve the implementation of the SET Plan through public research. The European Wind Energy Technology Platform - TP Wind - has clearly identified O&M strategies as a key technology issue to achieve the European vision for the wind energy share in the future European electricity mix. O&M strategies need to be improved especially when the turbines are difficult to access like in future deep water floating wind turbine systems. Sensor, monitoring, and fault prediction systems are currently of highest research priority, as well as new methods for residual lifetime prediction, easy exchange of components, and access technologies under extreme weather conditions. However, predictions to which extend these new technologies support the various O&M objectives strongly depend on the applied O&M strategy and model. They are thus an essential part an integrated O&M concept.

In order to implement the SET Plan and the EU Renewable Energy Directive, to initiate, coordinate and perform the necessary scientific research is a major task of EERA JP Wind. However, "O&M concepts and strategies" for the planning or in-service phase of OWPs are yet not directly addressed by the sub-programmes and IRPWIND core projects of EERA JP Wind (see Chapter 1). This project thus shall become a starting point to fill this gap and to initiate necessary scientific research on national and European levels.

5. Dissemination and Transfer of Knowledge to other IRP and EERA Wind participants

- *Explain ToK or dissemination strategies and plan of future collaboration with other IRP/EERA partner*
  - Presentation of the results on specific wind conferences like the annual EWEA conference and EERA DeepWind including submission of a paper
  - Organization of a workshop with the stakeholders of O&M concepts and IRP/EERA partner

6. Expected results

- *Methodologies and/or databases and/or best practices functional to the activities of the IRP and EERA strategic agenda objectives.*

The first version of the roadmap will be discussed with O&M stakeholders as well as with IRP/EERA partner. This will be done during a workshop to which the host and sending institution will jointly invite. Goals of this workshop are

- to further specify the O&M selection roadmap,
- to further identify needed research and developments,
- to initiate joint R&D and demonstration projects between O&M stakeholders and the IRP/EERA-partner, and
- to collectively plan the implementation of a joint strategy for needed research by the IRP/EERA partner.

This workshop shall be held within 6 month after the execution of the here proposed project.

- *Assessment of the advancement of the TRL.*

At the end of the project itself (not the results and follow-up activities of the workshop), the Technological Readiness Level shall be 2 to 3. The basic principles of how a holistic concept could be realized by an O&M stakeholder are described and exemplarily demonstrated. Necessary research and development will be initiated, mainly through the workshop. Proof or a detailed analysis of the concept will be still lacking and exemplary applications of the concept will be incomplete.

- *Assessment of the KPIs.*

Feedbacks are foreseen from the key groups of O&M stakeholders (operators, finances, insurances, utilities, component manufacturer, O&M service companies) to define the objectives of O&M strategies. At least one feedback per key group would be the minimum in order to obtain a complete first roadmap.
The number of ideas for new O&M concepts shall be two at least. For demonstration purposes, it would be worthwhile to have an exemplary comparison of different concepts that differ because of e.g., their usage in the planning or operational phase of a project, or their focus being more on the financial or operational-technical side.

The number of specific projects that will become apparent at the end of the activity can seriously be assessed only after the workshop. One specific R&D project and an elaborated IRP/EERA joint research strategy are quite challenging, but also realistic in view of the high engagement of the involved institutions, their already existing broad activities in offshore wind, and their already existing participation in the IRP/EERA network.

4.1.2 Evaluation

The evaluation will be shown in the 2nd yearly report.

5. Conclusive remarks and future perspectives

After one year, the IRPWind mobility programme is taking off gaining popularity. There is no doubt on the interest for the programme as we are receiving an increasing number of questions about rules and procedure for participation.

The 6-month scheme has never been selected, which indicates that applicants prefer short to medium-term stays. Interesting enough, in the second call (Table 5) an applicant indirectly applied for six months, as she wished to spend two 3-month periods in two different institutions.

Many colleagues have expressed their interest in applying for a mobility grant but the general attitude has been to postpone the submission of a proposal to a call with more flexible schemes. Therefore, the following suggestions are under discussion with the IRPWind Scientific Officer:

- Mobility scheme of 1 to 4 weeks for Managers, including the IRP Coordinator and sub-programme Managers, the IRP Management Board members and EERA JPWind Energy Steering Committee members. This scheme is finalized to stimulate the mobility of top managers in the EERA organizations to meet and discuss for laying down strategic action plans. This will likely translate in an effective cooperation and partnerships.

- Mobility scheme between 4 to 26 weeks for all scientists. This scheme should answer the request for flexibility in choosing the grant duration, solicited by EERA researchers during discussions in the first year trail.

Regarding the first call, reports appear non-homogenous depending also on the different duration: the three-month reports are more detailed with respect to the reports for grants of one month.

A mobility session will be organized during 2015 in connection to the annual meeting. Claudia Calidonna, CNR, and Anna Maria Sempreviva, DTU, will be in charge of the organization. The discussion will be on “How long a mobility grant is long enough?” and “Is the Mobility of researcher a brain gain or a brain drain?”

A LinkedIn discussion on the above issues and questionnaires will be launched during the third year organized by DTU, EWEA and ECN and involving all EERA partners and LinkedIn users.

6. APPENDIX 1

CALL FOR APPLICATIONS FOR MOBILITY GRANTS WITHIN the Integrated Research Programme on Wind Energy (IRPWind)

A call for application is open in the frame of the Integrated Research Programme on Wind Energy (IRPWind) Mobility Programme and the European Energy Research Alliance, Joint Programme on Wind Energy (EERA JP Wind Energy)

The mobility scheme within the IRPWind) has the following objectives:

1) To ensure an **efficient implementation** of

   -The Core Projects in the IRPWind;
   -The research activity of other EERA Joint Sub Programmes (EERA JSP); and
   -The EERA strategic action plan.

2) To **enhance the cooperation** between research organizations involved in the IRPWind and the broad scientific community of the EERA JP Wind Energy established to fill gaps in the European Research Area in the wind energy sector;

3) To **connect relevant National projects/Initiatives** to the IRP Wind Energy core projects and generally to the EERA JP Wind Energy Joint Sub Programmes, keeping an eye to future emerging technologies and scientific topics; and

4) To conduct actions oriented **to promote the concept of mobility** of researchers as brain gain and to foresight and implement best practice schemes for enabling effective mobility within the European Research Area.

1. ELEGIBILITY CRITERIA

The applicant must be an employee of an EERA JP Wind Energy member, hereafter called Home (Sending) organization, and have at least 5 years' experience as a researcher.
The mobility scheme is open for all EERA JP Wind Energy members; however either the sending or the receiving (Host) organization must be an IRPWind partner. As a general rule, the sending Organization will receive the funding of the grant from the IRPWind Coordinator.

The applications should follow a template, downloadable from the IRPWind Home page and be submitted online

2. FINANCIAL RULES

Applications are open for mobility grants of different duration: 1, 3 and 6 months according to Table 1

The grant includes travel expenses and daily allowance (see Funding Model))

Grant Period	1 month	3 months	6 months	Total
Number of Individuals	**39**	**18**	**16**	**73.0**
Number of months	**39**	**54**	**96**	**189.0**
Man/years				**15.8**

Table 1a. Total number of individual grants and number of man-months allocated to the mobility programme within the 4 year duration of IRP Wind Energy

Grant Period	1 month	3 months	6 months
Year 1	**12**	**6**	**5**
Year 2	**9**	**4**	**4**
Year 3	**9**	**4**	**4**
Year 4	**9**	**4**	**3**

Table 1b. Number of individual grants per year

3. FUNDING MODEL

- **Grants for periods of (a) 1 month: 161 Euro/day**

Travel expenses and an advanced payment of 70% of the total grant will be issued immediately,

The remainder of the grant will be issued after the approval of the final report.

- **Grants for periods of (b) 3 months and (c) 6 months: 105 Euro/day**

Travel expenses and an advanced payment of 70% of the total grant will be issued immediately,

The sum remainder of the grant will be issued after the approval of the final report.

- **Travel expenses from/ to home Organization: lump sum of 600 Euros**

Financial scheme is summarized in Table 2

Funding scheme	1 month	3 months	6 months
Euros/day	**161** **Max 4991**	**105** **Max 3150**	**105** **Max 3150**
Travel expenses from/ to home Organization: lump sum of 600			

Euros

Table 2. Daily allowance for each funding scheme

Daily allowance is granted in the following cases:

- Weekends during the grant period
- During National holydays in the host country

Daily allowance will NOT be granted in the following cases:

- Vacation hold during the grant period
- For National holydays in the home country of the recipient.

4. EVALUATION PROCEDURE OF THE APPLICATIONS

Each application will be evaluated by a panel of 2 reviewers;

The panel will assess the application and score it according to fixed criteria and a given grading scale;

The applications will be ranked and the highest scores will be granted according to the criteria identified in Table 3.

The grading score is shown in Table 4.

CRITERIA

EXCELLENCE	IMPACT	IMPLEMENTATION
Quality, innovative aspects and credibility of the research.	Enhancing research- and innovation-related human resources, skills and working conditions.	Overall coherence and effectiveness of the work plan, including appropriateness of the allocation of tasks and resources.
Clarity and quality of knowledge sharing among the participants in light of the research and innovation objectives.	To develop new and lasting research collaborations, to achieve transfer of knowledge between research institutions and to improve research and innovation potential at the European and global levels	Appropriateness of the management structures and procedures, including quality management and risk management
Quality of the interaction between the participating organizations	Effectiveness of the proposed measures for communication and results dissemination	Competences, experience and complementarity of the participating organizations and institutional commitment
Weight: 50%, 1st priority at ex equo	Weight: 30%, 2nd priority at ex equo	Weight: 20%, 3rd priority at ex equo

Grade 0-3	Grade 0-3	Grade 0-3

TABLE 3. Evaluation criteria

GRADES	VALUE
0	Out of scope
1	Sufficient
2	Good
3	Excellent

Table 4. Grading score for each proposal.

5. TIME SCHEDULE OF THE EVALUATION PROCEDURE

- Application deadline: four weeks after the call;
- Results of the evaluation: within two weeks from the application deadline;
- Start of the grant: within two months from the approval.

6. APPLICATION TEMPLATE (MAX 3 Pages)

The application template must be downloaded from www.irpwind.eu\ Mobility and submitted online.

OUTLINE OF THE APPLICATION TEMPLATE:

6.1 Introduction

- Research topics, originality;
- Technological Readiness Level (TRL) of the proposed concept;
- Definition of Key Performance Indicators (KPIs); and
- Description of links to relevant EERA Sub Programmes (SP) and/or IRPWIND Core Projects (CP).

6.2 Description of national projects aligned to the proposed activities in both the sending and the receiving institution, including milestones, funding services, research activity (demonstration, applied research, basic research etc.) Please consider that at least one of the partners should have a national project relevant to the proposal

- Description of national project from receiving institution (please erase if not actual);
- Description of national project from sending institution (please erase if not actual); and
- Foreseen European added value of national alignment.

6.3 Work Plan

- Deliverables, milestones etc.

6.4 Benefits to EERA objective advancement

- Contribution to the advancement of the EERA strategy goals, gaps addressed,

6.5 Dissemination and Transfer of Knowledge to other IRP and EERA Wind participants

- Explain ToK or dissemination strategies and plan of future collaboration with other IRP/EERA partners

6.6 Expected results

- Methodologies and/or databases and/or best practices functional to the activities of the IRP and EERA strategic agenda objectives.
- Assessment of the advancement of the TRL
- Assessment of the KPIs

Application must be supplemented by

- A Curriculum Vitae
- A letter of interest from the host organization.

7. PROCEDURE AFTER THE COMPLETION OF THE GRANT

- A final report will be due within one month of the completion of the grant. The report must be filled and submitted online;
- A questionnaire about the evaluation of the schemes must be filled online by the recipient, the host and the sending institution referents;
- The final report will be reviewed by the panel that evaluated the proposal (The coordinator of the most relevant sub-programme and two chosen from the pool of reviewers);
- The evaluation of the panel approval will be within 2 weeks of receiving the report; and
- The sum remainder of the grant will be issued after the approval of the final report and the submission of the questionnaire.

8. FINAL REPORT TEMPLATE (MAX 3 Pages)

The Final Report must be filled online at www.irpwind.eu\Mobility and submitted online.

9. OUTLINE OF THE FINAL REPORT TEMPLATE:

- Description of the work and major results;
- Compliance to the expected results, Key Performance Indicators KPIs and the advancement of Technological Readiness Level according to the application;
- Description of the benefit for host, home and IRP programme;and
- Future perspectives. (Future research, availability of databases to other parties, expected publications, and dissemination a

7. APPENDIX 2

FAQs

Who is going to apply, the researcher (natural persons) or the organizations?

The researcher should apply in agreement with the home and host organization. The application should also contain a letter of intent between host and home organization.

What will the grant cover?

Funding will cover:

- A lump sum for travel expenses and
- A daily allowance depending on the duration of the period.

The longer the period, the smaller is the daily allowance because a long-term accommodation would cost less than a short-term one.

Who will be reimbursed? The researcher (natural persons) or the research organisations?

The IRPWIND Coordinator has allocated the funding for the mobility work package and will forward funding to the sending organization against invoice before the start of the grant.

Funding will be transferred to the sending organization for practical reasons e.g. to optimize funding avoiding monetary lost by international fund transfer fees;

In case the sending organization is not an IRPWIND participant, the coordinator will transfer funding to the host organization, against invoice, before the start of the grant.

How will the funding for the grant be paid?

The sending Organization will issue the payment to the grant recipient according to the following procedure: travel expenses and 70 % of the total amount will be paid immediately. The balance will be paid at the end of the grant period after the approval of the reports.

The sending organizations will issue a declaration of conformity that the refunded sum conforms to the financial rules.

What if the home (sending) Organization is not a participant in IRPWIND?

In case the sending organization is not an IRPWIND participant, the grant recipient will receive funding from the host organization. In this case, host organization will issue a declaration of conformity that the refunded sum conforms to the financial rules

Will the visits be only to research organizations inside the consortium or outside as well?

At least one of the partners should be an IRPWind partner.
All organizations members of the EERA JP Wind Energy can enter the funding scheme. This will likely (i) increase the cohesion in the EERA JP Wind Energy group including associated partners and (ii) give the possibility to integrate new innovative ideas that might come from the "outsiders".

Is the mobility scheme aimed to educational purpose?

The mobility scheme is not for educational purposes but for strengthening the research in Europe. To be eligible, a scientist must be employed by one on the EERA Wind Energy Participants and have at least 5 years' experience as a researcher.

Can all EERA JP Wind Energy participants apply for a mobility grant?

The mobility schemes are open for all EERA Wind Members; however either the sending or the receiving organization must be an IRPWind partner (for administrative reasons). As a general rule, the sending Organization will receive the funding of the grant from the IRPWind Coordinator.

If the sending Organization is not an IRPWind partner, funding will be forwarded to the host organization.

Can the grant period be split in shorter periods?

The grant periods must be carried out continuously and the reports should be presented within 2 months from the end of the grant.