International Energy Agency (IEA)
Implementing Agreement for Co-operation in the Research and Development of Wind Energy Systems (IEA Wind)

Annex 30 – Task Extension Proposal, 2019-2022

Offshore Code Comparison Collaboration, Continued, with Correlation, and unCertainty (OC6)

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1 Scope

This is a proposal to extend IEA Wind Task 30 (also known as OC4 and OC5) to expand efforts to advance the overall accuracy of offshore wind computer modeling tools, to improve their predictive capability for estimating structural loads. The objectives of this extension are the following:

- Perform more focused validation projects, based on the issues identified in previous Wind Task 23/30 projects (OC3, OC4 and OC5).
- Develop and employ more rigorous validation practices following ASME guidelines, with a strong emphasis on quantifying uncertainty in test campaigns used for validation.
- Include higher-fidelity modeling solutions in the validation process (when possible), performing a three-way validation between engineering-level tools, higher-fidelity tools, and measured data.

The extended task will engage the current members of OC5 as well as additional participants from the offshore wind industry. The following validation projects were identified as the most relevant to focus on within the extension, as summarized in the following work packages:

WP 1. Validation of nonlinear hydrodynamic loading on floating offshore wind support structures originating from the interaction of wave components, structure motion, and flow through a multi-body structure.

WP 2. Incorporation and verification of advanced soil/structure interaction models for representing the pile/foundation interaction.

WP 3. Validation of aerodynamic loading on a wind turbine undergoing large motion caused by a floating support structure.

WP 4. Validation of the methodology for combining potential flow and viscous hydrodynamic load models for floating offshore wind support structures.

WP 5. (Optional fifth year extensions) Validation of the full-scale dynamic behavior of a floating wind turbine.

The working group will develop refined descriptions for each work package prior to commencement of work. The task will deliver a final report and separate technical papers for each work package at the time of completion. The new task will extend for a period of four years with a total annual budget of €60,000 assuming the participation of 12 countries, with annual dues of €5000 per country, which is the same as the current budget for Task 30.

A fifth work package will be added, and the project extended to a fifth year if data can be obtained from a full-scale floating wind system. Participants will continue paying the annual dues of €5000 per country for the fifth year extension.

2 Introduction

The Offshore Code Comparison Collaborative (OC3) project, and its associated extensions, have been on-going since 2005. The original OC3 project was run as a subtask under IEA Wind Task 23, but all future extensions, OC4 and OC5, were run under IEA Wind Task 30. These projects have proven to be vital to the companies developing and improving the numerical modeling tools used to design offshore wind systems, as well as designers, certifiers, and research institutes who apply these tools for design, research, and instruction. The focus of the OC projects has been on the verification and validation of coupled, engineering-level modeling tools, which include mid-fidelity models that consider the simultaneous loading from wind and waves, as well as the interaction with the structural dynamics of the system and its control algorithms (aero-hydro-servo-elastic tools). Coupled tools are a necessity in modeling and designing floating wind turbines, where wind and waves can interact to create de-stabilizing loads, but are also useful in developing more optimized designs for fixed-bottom structures.

The OC3 and OC4 projects focused on the verification of the coupled modeling tools through code-to-code comparisons of simulated responses for generic, representative offshore wind systems. The OC5 project extended this work to validating the tools by comparing the simulated responses to physical measurements of real systems. The objectives of these projects were the verification and validation of the global loads and motions of the offshore wind system using a series of benchmark problems, excited by a variety of wind and wave loading conditions. Within these projects differences were observed between the modeling approaches and the measured data, and often times the reason for the differences were not well understood. The focus of the proposed OC6 project is to develop more focused validation projects to better understand some of these observed differences and to address other modelling/validation aspects that were outside the scope of the original OC projects. Physical phenomena that have demonstrated a large impact on accurately modeling the global response behavior of offshore wind systems will be the focus of these studies.

The specific validation objectives to focus on within OC6 were determined through a series of meetings with OC5 participants, as well as from offshore wind industry feedback. A phenomenon identification ranking table (PIRT) was developed to identify and rank the most pertinent phenomena of interest. Tables 1 and 2 summarize these findings for floating and fixed-bottom systems, separately. The phenomena ranking was performed independently for fixed-bottom and floating systems, as the associated challenges in numerical modelling are different for these two support-structure types. Though, it should be noted, that different elements may be more important than others for specific design concepts. After the pertinent phenomena were identified, the group collectively decided on: their relative importance, the level of understanding we have of their physical nature, the adequacy of our models to represent the physics, and whether validation could be used to better understand or model that phenomenon. Ranking was assessed across three levels, low “L”, medium “M”, and high “H”. Those phenomena that were determined to be both of high importance and could be better understood through validation are considered the most relevant to address through a validation campaign, and are indicated with a yellow highlighting.

The objectives to be focused on within OC6 are a subset of the highlighted phenomena in the PIRT tables. These will be investigated through measurement data obtained across multiple test campaigns, including testing of two floating semisubmersibles, a spar, and a monopile. When possible, multiple phenomena will be investigated for the datasets examined.

TABLE 1: Phenomenon Identification Ranking Table for Fixed-Bottom Offshore Wind Systems (highlighting indicates important phenomena to investigate through validation campaigns)

Phenomena	Importance	Physics Understanding	Model Adequacy	Validation Needs
Fluid Dynamics				
2D wave elevation variation in farm	L	M	L	L
Short-crested waves	M	H	M	H
Ability to model real spectra/directionality	M	M	M	M
Environment-Structure Interaction				
Multi-body flow interaction	M	M	L	H
Breaking/steep wave loads	H	M	L	H
VIV/VIM - substructure	L	L	L	H
Viscous load model	M	M	M	H
Member-level loads (including concrete)	H	H	M	M
Wave current-body interaction	M	M	L	L
Soil/structure interaction	H	M	L	H
Marine growth influence on loads	M	H	H	L
Multi-scale	H	M	H	H

TABLE 2: Phenomenon Identification Ranking Table for Floating Offshore Wind Systems (highlighting indicates important phenomena to investigate through validation campaigns)

Phenomena	Importance	Physics Understanding	Model Adequacy	Validation Needs
Fluid Dynamics				
Short-crested waves	M	H	M	H
Low-frequency wind spectra/coherence	H	M	L	H
Ability to model real spectra/directionality	M	M	M	M
Environment-Structure Interaction				
Nonlinear excitation – diff/sum/mean	H	M	M	H
Multi-body flow interaction	H	M	L	H
Breaking/steep wave loads	L	M	L	H
VIV/VIM - substructure	M	L	L	H
Viscous load model	H	M	M	H
Potential combined with viscous	H	M	M	H
Member-level loads (including concrete)	H	H	L	M
Instantaneous position for wave loads	H	M	H	H
Wave current-body interaction	H	M	L	M

Nonlinear hydrostatics + Froude-Krylov	H	M	L	M
Influence of elasticity on motion	M	H	L	M
Aerodynamic applicability under motion	H	L	M	H
Marine growth influence on loads	L	H	H	L
Multi-scale	H	M	H	H
Sloshing (ballasting, holes)	H	M	L	H
Controls				
Negative damping from blade pitching	H	H	H	H
Moorings/Cables				
Seabed friction – mooring	H	H	M	L
Wave forcing – mooring loads	H	H	H	L
Line hysteresis (mooring/cable)	H	M	M	L

The OC5 project approached model validation through the comparison of global motion/load time series and spectra., as well as through the comparison of associated metrics, such as the ultimate and fatigue loads, and response amplitude operators. There was, however, no defined methodology for assessing whether the validation was successful or not. In OC6, project members will develop and apply a more rigorous validation methodology to provide a prescription for assessing validation success. The procedure starts with identifying the objectives of the validation project, and the associated phenomena to be investigated (as identified through the PIRT). Next, one or more quantities will be defined that represent the phenomenon of interest, and metric(s) will be identified to describe the quantities of interest. The simulated value of the metric is not expected to exactly match the measured one, so a range is needed on the measured value within which the simulated value would be considered acceptable. This data range is based on how certain the measured value is, which is assessed by performing an uncertainty analysis of the test campaign to determine potential sources of error. It is difficult to assess the uncertainty of a test campaign performed in the past, so the OC6 project will seek out opportunities to perform their own validation using targeted, low-cost testing campaigns, when possible. A successful validation will be defined as when the simulated metrics fall within the uncertainty range of the measured metrics.

In addition, the OC6 project will employ higher-fidelity models (such as computational fluid dynamics models) to better understand the underlying physics of the phenomena. This will constitute a three-way validation where both the engineering-level modeling tools and higher-fidelity tools will be compared to measurement data. The results will be used to help inform the improvement of engineering-level models, and/or guide the development of future test campaigns.

3 Objectives and Expected Results

The main activities of the proposed extension project are:

- Discussing and evaluating numerical modeling strategies for offshore wind systems
- Discussing and outlining best validation practices, including the assessment and importance of uncertainty
- Discussing methods for incorporating higher-fidelity models in the validation procedure

- Developing a suite of benchmark models and simulations with corresponding physical measurements that have quantified uncertainty
- Running simulations and processing the simulation results
- Comparing the results in a side-by-side fashion to physical response data

These above activities fall under a broader set of objectives which include:

- Assessing the accuracy and reliability of results obtained by simulations to establish confidence in the predictive capabilities of the codes
- Training new analysts how to run and apply the codes correctly
- Identifying and validating the capabilities and limitations of implemented theories
- Investigating and refining applied analysis methodologies
- Identifying further research and development needs

The past verification and validation work by the OC3, OC4, and OC5 projects has led to dramatic improvements in model accuracy as the code-to-code and code-to-data comparisons have helped identify deficiencies and needed improvements in existing codes. These results are important because the advancement of the offshore wind industry is closely tied to the development and accuracy of the applied numerical models.

4 Approach and Methodologies

The new OC5 extension will be named the Offshore Code Comparison, Continued, with Correlation, and unCertainty (OC6), and will be performed through technical exchange among a group of international participants coming from universities, research institutions, and industry. Past participation in the OC3, OC4, and OC5 projects has included the United States of America (U.S.), Germany, France, Italy, Denmark, the United Kingdom (UK), Spain, the Netherlands, Finland, Norway, Sweden, China, Portugal, Greece, Japan, and Korea.

Most of the coupled aero-hydro-servo-elastic codes that have been developed for modeling the dynamic response of offshore wind turbines have been tested and further developed within OC3, OC4, and OC5. These projects have highlighted areas of the tools where further investigation is needed to understand their accuracy and correct use. The goal of OC6 is to perform more focused validation projects and development to address the identified issues and limitations within the previous OC projects.

Draft Work Plan

<u>WP1:</u> Validate the nonlinear hydrodynamic loading on floating offshore wind support structures
Period: January 2019 – December 2019
Coordinator: NREL

A floating semisubmersible wind turbine design, developed by the DeepCwind consortium, was used for the verification of numerical modeling tools within OC4, and then for validation (based on tank testing at MARIN) within OC5. The results in OC5 showed a persistent under-prediction (about 20% on average) of the motion and structural loads in the system across all load cases, including wave-only and combined wind-wave conditions. Similar levels of under-prediction have been observed by other floating wind developers for semisubmersibles. The OC5 results indicate that much of this under-prediction originates from the low-frequency response of the system at the surge/pitch natural frequencies resulting from nonlinear hydrodynamic loading. This work package will therefore focus on better understanding this low-frequency response behavior and the applicability of engineering-level hydrodynamic models for predicting the nonlinear hydrodynamic loading.

In support of this work, a simplified version of the OC5-DeepCwind semisubmersible was re-tested at MARIN in October, 2017 without a wind turbine. Further testing at MARIN is planned for June, 2018. A full uncertainty assessment of the tests will be performed to characterize the uncertainty margins in the nonlinear hydrodynamic response levels observed in the tests. The tests in June will include a series of constrained tests, including keeping the structure fixed and measuring the integrated force over the structure in current and wave conditions; and, measuring the integrated force over the structure when forced to oscillate at a variety of frequencies. These tests will allow us to better examine the individual components of the hydrodynamic loads and to determine whether the 20% load under-prediction is a result of an under-prediction in wave-excitation load or an over-prediction in hydrodynamic damping at the surge/pitch natural frequencies. The hope is to also include higher-fidelity modeling through computational fluid dynamics (CFD) to better inform the understanding of the hydrodynamic loading components.

A potential additional outcome of this work will be the development of a recommended practice on how to approach CFD modeling for floating wind systems. The decision to develop this recommended practice will be based on the level of participation from CFD modelers, the success of the validation, and the interest in developing a recommended practice (previous meetings have shown some level of interest).

WP2: Develop and verify an advanced soil/structure interaction model for representing the pile/foundation interaction.
Period: January 2020 – June 2020
Coordinator: NREL

Much of the OC6 project will focus on characteristics related to floating wind turbines, due to the higher level of complexity and therefore uncertainty in the ability to model these systems. On the fixed-bottom, side, one of the areas with high uncertainty and significant impact is the ability to accurately model the interaction between the soil and the wind turbine foundation. The characteristics of the soil/structure interaction can significantly affect the global response characteristics and design optimization for a fixed-bottom offshore wind turbine.

To address this issue, the OC6 project will integrate and verify an advanced soil/structure interaction model, compared to what is presently included in most coupled offshore wind modeling tools. The Norwegian Geotechnical Institute (NGI) has developed a dynamic library (.dll) that models the soil-foundation interaction in terms of the nonlinear stiffness, hysteretic damping, and degradation. The modeling approach has been validated against full-scale data from large-depth monopiles and shallow-depth bucket/caisson foundations during the REDWIN project. The intent for this work package is to couple the developed .dll to the wind turbine modeling tools in the OC6 project, and verify the coupling by comparing to the results already examined within the REDWIN project.

WP3: Validate the aerodynamic loading on a wind turbine undergoing large motion caused by a floating support structure
Period: June 2020 – June 2021
Coordinator: NREL

Much of the focus of the OC projects has been on the hydrodynamics, due to the projects' offshore focus and higher level of differences observed between individual modeling approaches and measurements related to wave loading, masking differences on the aerodynamic side. Offshore wind structures have very different sizes as compared to other structures in the water, such as oil and gas structures, and the applicability of modeling approaches used in these fields therefore differ. Thus, the hydrodynamic modeling theory used for offshore wind systems is a relatively new field with significant uncertainty. To date, the wind turbines used on land and offshore are largely the same, and the aerodynamic models for land-based systems have been extensively examined. However, for floating offshore wind systems, the compliant nature of the support structure may allow for significant motion of the wind turbine and the rotor diameters are expected to grow in size, which could challenge the applicability of the aerodynamic models used for land-based wind systems.

This work package will therefore focus on examining the validity of present aerodynamic models under large motion. The test data that will be used for validation was collected by the Polytechnic University of Milan. They have created a system that enables the forced motion of a wind turbine within a wind tunnel environment. Only the wind turbine and tower are present, and the motion at the base of the tower is excited by an actuator that is fed motion characteristics based on software simulations of a floating wind turbine. The data that will be used in this phase will be measurements of the base forces of the blades during the forced regular oscillation of the structure in the surge direction. If further tests are available, they will also be incorporated in the work. An assessment of the uncertainty in the test results will be completed to the extent possible, given that the work has already been performed. If possible, CFD analysis will also be used to help inform this work package.

<u>WP4: </u>Benchmark and validate methods for combining potential flow and viscous hydrodynamic load models for novel floating offshore wind support structures.
Period: June 2021 – June 2022
Coordinator: NREL

The hydrodynamic modeling approaches commonly used in mid-fidelity simulation tools are based on using either potential-flow solutions or Morison's equation, or a hybrid combination of the two. Floating offshore wind structures challenge the applicability of these modeling approaches in many ways. First, largely varying member sizes require component size dependent modelling approaches. In addition, the presence of multiple members that are connected to each other, or in close proximity, creates complex flow patterns which may limit the applicability of Morison's equation, which assumes an isolated, infinitely long cylinder.

WP 1 will examine the validity of these modeling approaches, and how to combine them, for the semisubmersible examined previously within the OC4 and OC5 projects. WP4 will examine the validity for a new floating wind turbine architecture developed by Stiesdal Offshore Technology A/S. Stiesdal's TetraSpar is a novel floating support structure that has the low center-of-gravity qualities of a spar for achieving stability, but has the ability to transform its configuration for easier tow-out with a shallow draft. The TetraSpar uses a deployable counter-weight in the shape of a triangle, attached to the main structure through cables. The counter weight can be lifted flush with the structure for tow-out. This transformable configuration also enables the system to act as a semisubmersible after installation if the counter-weight remains flush with the structure. The TetraSpar was tank-tested at DHI (in collaboration with DTU) in both the spar and semi configurations, and this work package will validate the results of these test campaigns. The hope is that having two configurations of the same structure may enable a better understanding of the hydrodynamic loading created by different positioning of members.

Other datasets may be used in this work package (as well as others) to further our understanding of hydrodynamic loading models. Other floating designs that have tank test data to share include the GICON-TLP with vertical mooring lines and a gravity anchor plate. The group has not yet analyzed a tension leg platform (TLP), and there is potential that data from a full-scale demonstration project of the system will be available as well. In addition, tank testing of the Nautilus semisubmersible floating system is available to the group.

A dataset that the OC6 project team would like to generate internally is the testing of individual cylinders of different sizes alone, and in close proximity to other cylinders, as well as being attached to heave plates of varying size. This build-up in complexity would enable us to understand what attributes of a floating wind support structure contribute to the complexity that limits the applicability of the present hydrodynamic modeling approaches. Funding for this testing will be sought from within the MaRINET2 project or from other external sources. By performing our own testing, the project would be able to better understand the uncertainty in the test campaign.

An additional interest of participants of the project is the possible development of a set of recommended practices for setting the hydrodynamic coefficients when incorporating components of Morison's equation, based on the level of findings from the work.

<u>WP5:</u> Benchmark and validate the full-scale dynamic behavior of a floating wind turbine (optional fifth year extension).
Period: January 2023 – December 2023
Coordinator: NREL

WP 5 is not part of the core OC6 proposal, but is instead an optional funded extension for a fifth year, beyond the original four years. The focus of this extension will be model validation using data from a full-scale floating wind system. The extension will be performed if full-scale test data is available to the project, and if participants are interested in approving the work. Presently, we have proposals from at least two projects (Stiesdal TetraSpar and GICON-TLP) that are willing to provide test data once their full-scale demonstration project moves forward.

Validation of full-scale systems has very different objectives from scaled model testing, and is one of the areas of interest expressed by present OC5 participants. Open-ocean tests typically have less data available in terms of the number and type of measurements, and the variety of datasets available in terms of the environmental conditions. Systems deployed in the open ocean must rely on nature to provide the excitation of the system, which are difficult to measure. And, unlike a basin situation, where wind can be turned on with no waves (and vice versa), one cannot examine the response of the structure to individual excitations. In addition, no simple tests such as free-decay tests are typically available for tuning model properties. However, full-scale systems do capture the unscaled, real physical response characteristics of a commercial system. The coupled characteristics can be different than tank tests where conflicting scaling values can create different response behavior. Sharing often proprietary wind turbine design properties is also a challenge in full-scale systems.

This extension could also potentially be used to begin to validate the internal loads within floating support structures as well. This has not yet been addressed for two reasons. First, many of the modeling tools do not yet incorporate flexibility in the support structure for floating wind systems.

And, second, there is no point in examining member-level loads until the global loads are well understood. If the work in the OC6 project advances the tool capabilities to the point that member-level loads are of interest, and measurement data is available, then this would be an interesting topic to investigate.

5 Time Schedule with Key Dates

Figure 1 below shows the approximate dates and timelines for expected milestones and meetings for the proposed extension project. The timeline assumes a 4-year effort that begins in January 2019 and extends until December 2022. The possible/optional 5th year extension for WP 5 in 2023 is not shown here or further discussed in the sections below.

As shown in Figure 1, the model development for each WP is expected to be initiated before the conclusion of the prior WP. For WP 1, development work for this work package will be performed prior to the initiation of OC6.

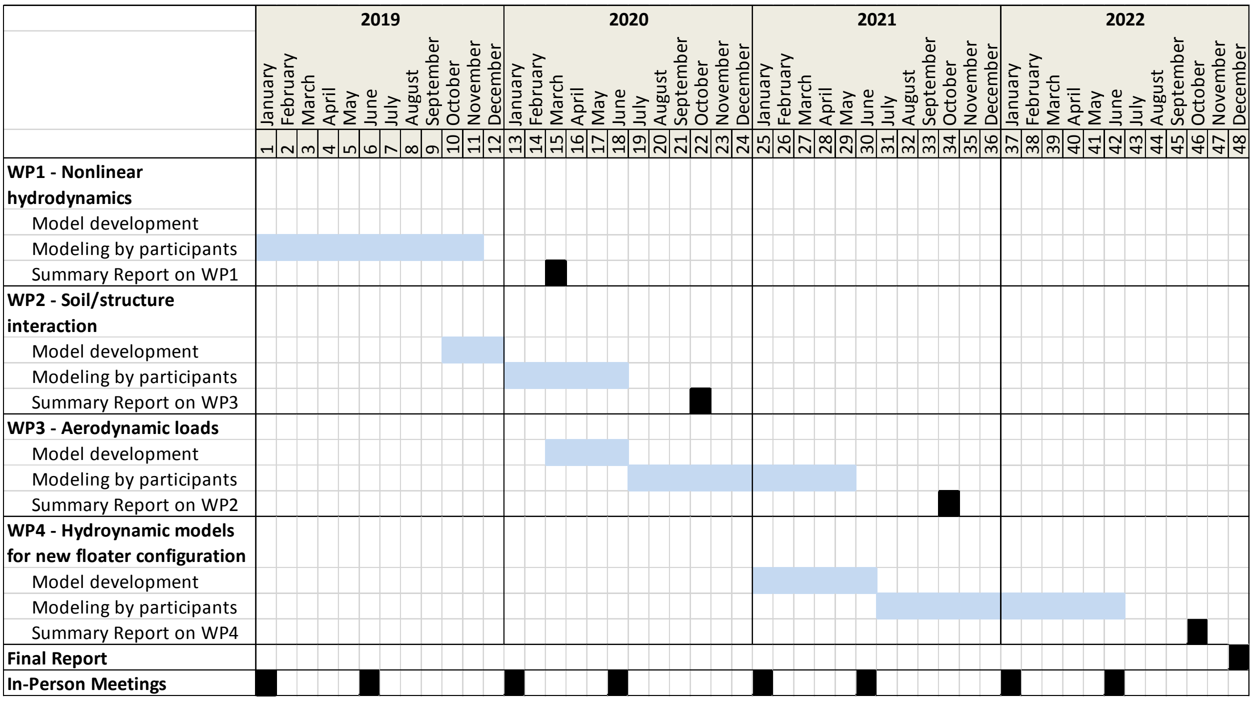

Figure 1: Gantt Chart of Critical Meetings and Activities

6 Reports, Deliverables, and Dissemination of Results

The Annex members will meet in person to discuss the work package at a frequency of approximately twice per year. The project coordinator will arrange, in addition, webcast meetings that occur as needed, but generally at a frequency of approximately once every 1-2 months. Following the completion of each work package, the participants, led by the project coordinator, will write and publish a technical paper or report on the results of the WP (typically a conference paper). Optionally, the participants may decide to also publish these results in more academically prestigious journals. The standard progress reports to the IEA Wind Executive Committee will be delivered semi-annually by a representative from the Annex, and a final report will be written at the end of the project.

Table 3: Planned Deliverables and Schedule

No.	Deliverable	Contributors	Month Due
D-1	WP1 technical report – nonlinear hydrodynamics	OA and others	15
D-2	WP2 technical report – soil/structure interaction	OA and others	22
D-3	WP3 technical report – aerodynamics under large motion	OA and others	34
D-4	WP4 technical report – hydrodynamic models, new design	OA and others	46
D-5	Final Report (all phases)	OA and others	48
D-6-13	Semi-Annual Progress Reports to ExCo	OA	5,10,17,22,29,34,41,46

7 Methods of Review and Evaluation of the Work Progress

Table 4: Milestones and Schedule

No.	Milestone	Contributors	Month Due
M-1	Meeting #1: Agree upon work plan and approach for WP1; Begin WP1	All	1
M-2	Meeting #2: Review preliminary results from WP1	All	6
M-3	Meeting #3: Review final results from WP1, and initiate WP2	All	13
M-4	Meeting #4: Review final results from WP2, and initiate WP3	All	18
M-5	Meeting #5: Review preliminary results from WP3	All	25
M-6	Meeting #6: Review final results from WP3, and initiate WP4	All	30
M-7	Meeting #7: Review preliminary results from WP4	All	37
M-8	Final Meeting: Review final results from WP4, and make recommendations and discuss future work.	All	42
M-9	Periodic Webcast meetings as needed to be organized by subtask leader.	All	As needed

8 Obligations and Responsibilities

Operating Agent

In addition to the responsibilities enumerated in the IEA Wind Implementing Agreement, the Operating Agents will be responsible for developing annex material, organizing scheduled meetings, taking meeting minutes, managing the execution of deliverables, writing reports and editing text for content and quality, progress reporting to the IEA Wind ExCo, maintaining a website for the dissemination of annex material, coordinating publications, and calling for webcast meetings when necessary.

Participants

Members were asked about their interest in participating in an extension of Task 30, focused on the objectives defined in this proposal. Table 5 shows those that have indicated interest in participating in OC6 and the estimated level of effort (person-months) of participants, based on informal discussions between current participants of the OC5 project.

Table 5: Estimated effort from each Participant based on previous annexes**

Country	Participant(s)	Subject Work package	National effort (Direct) Person-month	Related effort (Indirect) Person-month	Total effort Person-month
China	China General Certification Center, Dalian University of Technology	All	24	24	48
Denmark	DTU Wind Energy-campus Risø, Aalborg University, DHI	All	36	36	72
France	Principia, EDF, IFPEN	All	36	36	72
Germany	University of Stuttgart, Rostock University, University of Duisburg-Essen	All	36	36	72
Italy	Polytechnico Di Milano	All	12	12	24
Japan	ClassNK	All	12	12	24
Korea	University of Ulsan	All	12	12	24
Netherlands	MARIN, ECN (part of TNO)	All	24	24	48
Norway	Norwegian University of Science and Technology (NTNU), 4Subsea, Norwegian Geotechnical Institute (NGI)	All	25	27	52
Portugal	Wave Energy Centre, Instituto Superior Tecnico	All	24	24	48
Spain	CENER, Siemens Industry Software, IHCantabria, UPC-BarcelonaTech, Tecnalia	All	60	60	120
United Kingdom	DNV GL	All	12	12	24
United States	National Renewable Energy Laboratory	All	24	24	51
TOTAL			**337**	**339**	**676**

**This table was filled out by assuming 3 person-months of effort directly related to the project per active partner, plus an additional 3 person-months of related projects per active partner per year. These numbers were doubled for the OA.

Under the extension, the responsibilities of the participants would be identical to the successful OC3, OC4, and OC5 projects. Participation is open to all members of the IEA Wind R&D Executive Committee and organizations from their respective countries that are approved by the ExCo representative of their country. It is strongly encouraged that only those who are actively involved with model development and load prediction participate. Participants will attend all meetings and exchange information by email, net-conferencing and telecoms throughout the project. They decide on the details of the project and take part in writing the final reports. Participants agree to run cases using inputs prescribed by committee consensus using appropriate computer simulation software. Participants may join the working group at any time given that they have the approval of their country's ExCo representative and they are current with their dues in the year of entry.

9 Funding

The new annex is expected to begin in the January of 2019. NREL will continue to serve as operating agent, and will transition from a shared OA within OC5 (with Fraunhofer-IWES of Germany) to the sole OA within OC6.

10 Budget Plan

NREL will have lead responsibility for the overall annex operation including maintenance of the website, leading all work packages, organizing and paying for the meetings for these work packages, managing the financial and administrative accounts, and writing the final report. The break-down of how the dues will be used for the total (estimated) four-year budget of €240,000 by NREL is detailed below in Table 6. If an additional 5th year is added to model the full-scale floating system, an additional year of budget would be allocated as shown in Table 7.

The money will primarily cover travel for the bi-annual task and executive committee meetings, maintaining the website and financial accounts, and performing the necessary reporting. Some of the funds will also go towards running and coordinating the regular meetings, but the costs for this work, including the technical development and oversite for the work, far exceeds what the dues will allow for. Additional funds for this work by NREL will be supported by the U.S. Department of Energy Wind Energy Technologies Office.

Table 6: Operating Agent Costs – National Renewable Energy Laboratory

Activity	Level of Effort (person-months)	$USD (4 years)	€ Euro (4 years)
Meetings, coordination work	4	98,400	82,000
Reporting	4	98,400	82,000
Travel costs		72,000	60,000
Website	1	9,600	8,000
Managing financial accounts	1	9,600	8,000
TOTAL	**10**	**$288,000**	**€240,000**

Table 7: Operating Agent Costs – Additional Funds for Optional 5th Year National Renewable Energy Laboratory

Activity	Level of Effort (person-months)	$USD (4 years)	€ Euro (4 years)
Meetings, coordination work	1	24,600	20,500
Reporting	1	24,600	20,500
Travel costs		18,000	15,000
Website	0.25	2,400	2,000
Managing financial accounts	0.25	2,400	2,000
TOTAL	**2.5**	**$72,000**	**€60,000**

11 Management of Task

The Operating Agent, NREL, is responsible for overall Annex management and reporting, as well as maintaining a suitable site for data archive and transfer. NREL will also be responsible for completion of the final report.

NREL is the sole work package leader and will be responsible for leading the work in each phase. This will include communication among the participants, ExCo reporting, quality control and dissemination of the annex material, organization of the required meeting deliverables and Webcast meetings, and work package reports (including abstract writing and submission to present the work at key conferences).

12 Organization

The proposed annex will be organized as shown in Figure 2. NREL will assume overall responsibility and will also oversee all work packages.

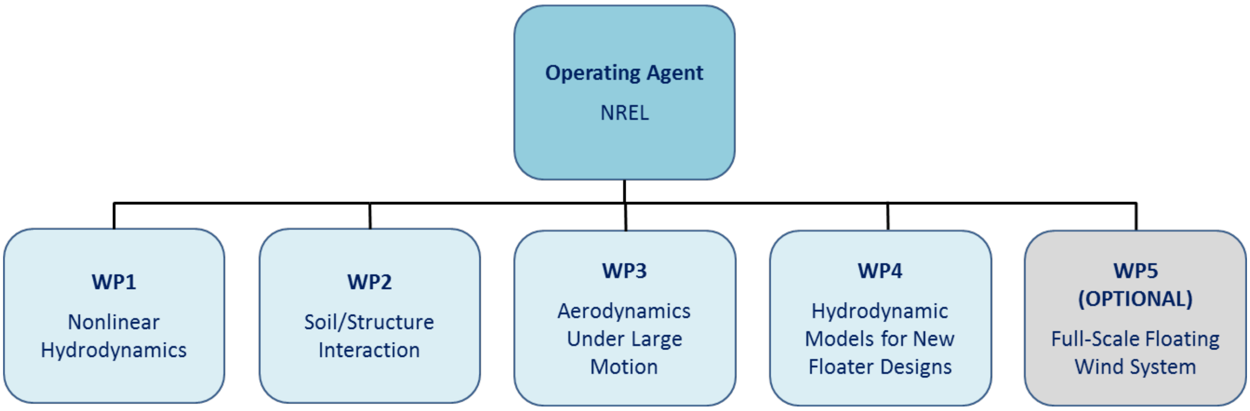

Figure 2 – Proposed New Annex Organization

13 Information and Intellectual Property

(a) **Executive Committee's Powers**. The publication, distribution, handling, protection and ownership of information and intellectual property arising from activities conducted under this Annex, and rules and procedures related thereto shall be determined by the Executive Committee, acting by unanimity, in conformity with the Agreement.

(b) **Right to Publish.** Subject only to copyright restrictions, the Annex Participants shall have the right to publish all information provided to or arising from this Task except proprietary information.

(c) **Proprietary Information.** The Operating Agent and the Annex Participants shall take all necessary measures in accordance with this paragraph, the laws of their respective countries and international law to protect proprietary information provided to or arising from the Task. For the purposes of this Annex, proprietary information shall mean information of a confidential nature, such as trade secrets and know-how (for example computer programmes, design procedures and techniques, chemical composition of materials, or manufacturing methods, processes, or treatments) which is appropriately marked, provided such information:

(1) Is not generally known or publicly available from other sources;

(2) Has not previously been made available by the owner to others without obligation concerning its confidentiality; and

(3) Is not already in the possession of the recipient Participant without obligation concerning its confidentiality.

It shall be the responsibility of each Participant supplying proprietary information, and of the Operating Agent for arising proprietary information, to identify the information as such and to ensure that it is appropriately marked.

(d) **Use of Confidential Information.** If a Participant has access to confidential information which would be useful to the Operating Agent in conducting studies, assessments, analyses, or evaluations, such information may be communicated to the Operating Agent but shall not become part of reports or other documentation, nor be communicated to the other Participants except as may be agreed between the Operating Agent and the Participant which supplies such information.

(e) **Acquisition of Information for the Task.** Each Participant shall inform the other Participants and the Operating Agent of the existence of information that can be of value for the Task, but which is not freely available, and the Participant shall endeavour to make the information available to the Task under reasonable conditions.

(f) **Reports on Work Performed under the Task.** Each Participant and the Operating Agent shall provide reports on all work performed under the Task and the results thereof, including studies, assessments, analyses, evaluations and other documentation, but excluding proprietary information, to the other Participants. Reports summarizing the work performed and the results thereof shall be prepared by the Operating Agent and forwarded to the Executive Committee.

(g) **Arising Inventions.** Inventions made or conceived in the course of or under the Task (arising inventions) shall be identified promptly and reported to the Operating Agent. Information regarding inventions on which patent protection is to be obtained shall not be published or publicly disclosed by the Operating Agent or the Participants until a patent application has been filed in any of the countries of the Participants, provided, however, that this restriction on publication or disclosure shall not extend beyond six months from the date of reporting the invention. It shall be the responsibility of the Operating Agent to appropriately mark Task reports that disclose inventions that have not been appropriately protected by the filing of a patent application.

(h) **Licensing of Arising Patents.** Each Participant shall have the sole right to license its government and nationals of its country designated by it to use patents and patent applications arising from the Task in its country, and the Participants shall notify the other Participants of the terms of such licences. Royalties obtained by such licensing shall be the property of the Participant.

(i) **Copyright.** The Operating Agent may take appropriate measures necessary to protect copyrightable material generated under the Task. Copyrights obtained shall be held for the benefit of the Annex Participants, provided however, that the Annex Participants may reproduce and distribute such material, but shall not publish it with a view to profit, except as otherwise directed by the Executive Committee, acting by unanimity.

(j) **Inventors and Authors.** Each Annex Participant will, without prejudice to any rights of inventors or authors under its national laws, take necessary steps to provide the co-operation from its inventors and authors required to carry out the provisions of this paragraph. Each Annex Participant will assume the responsibility to pay awards or compensation required to be paid to its employees according to the law of its country.

14 List of Potential Participants

Tables 5 and 8 give an indication of the level of support that is likely for this new annex proposal. Table 8 lists the countries, and the organizations in those countries, that have given expressed interest and input to the OC6 extension.

Table 8: List of Potential Participants for OC6

Country	Interested Institutions	Possible Institutions	Number
China	CGC, Dalian University of Technology	Envision	3
Denmark	DTU, Aalborg University, DHI		3
France	EDF, IFPEN, PRINCIPIA		3
Germany	Rostock University, Stuttgart University, University of Duisburg-Essen (Institute of Ship Technology, Ocean Engineering and Transport Systems)	Ramboll	3
Italy	Politecnico de Milano		1
Japan	ClassNK		1
Korea	University of Ulsan		1
Netherlands	MARIN, ECN (part of TNO)		2
Norway	NTNU, 4Subsea, NGI		2
Spain	CENER, Siemens Industry Software, IHCantabria, UPC-BarcelonaTech, Tecnalia		5
Portugal	Wave Energy Centre, Instituto Superior Tecnico		2
U.K.	DNV GL	Wood	2
U.S.	NREL	Principle Power	2
		TOTAL	30