Operation and Maintenance

of Offshore Wind Turbines - Numerical tools for reducing the O&M costs

Workshop organized by EERA-Wind

SUB-PROGRAMME 3: OFFSHORE WIND ENERGY

June 30 and July 1, 2011
Aalborg University, Aalborg, Denmark

Organising committee:

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EUROPEAN ENERGY RESEARCH ALLIANCE
SUB-PROGRAMME 3: OFFSHORE WIND ENERGY

Background and Motivation

Operation and Maintenance (O&M) costs constitute a substantial part of the cost of energy (COE) for offshore wind turbines. O&M costs may easily make up to 20-25 % of the total levelised cost per kWh produced over the lifetime of the turbine. If the turbine is fairly new, the share may only be 10-15 per cent, but this may increase to at least 20-35 per cent by the end of the turbine's lifetime. As a result, O&M costs are attracting large attention, as manufacturers attempt to lower these costs significantly by developing new turbine designs that require fewer regular service visits and less turbine downtime.

Due to the relative infancy of the wind energy industry, there are only a few turbines that have reached their life expectancy of 20 years. These turbines are much smaller than those currently available on the market. Estimates of O&M costs are still highly unpredictable, especially around the end of a turbine's lifetime; nevertheless a certain amount of experience can be drawn from existing, older turbines.

Within EERA-Wind a research theme has been formulated on '**Numerical tools for reducing O&M costs**'

Aim of the Workshop

The aim of the workshop is to present and discuss numerical tools for reducing O&M costs. The results of the workshop will published in a report '***Predictive tools for O&M***. *Development tools for application of predictive maintenance methods*'.

Particular emphasis is on the following three topics all being critical for offshore wind farms:

- ✓ tools for selecting more robust design of components and need for redundancy
- ✓ tools for doing predictive maintenance, hereunder models of component degradation
- ✓ establish a database with operational and failure data for validation of tools

Maintenance of offshore wind farms consists of three parts: preventive, corrective, and condition based maintenance. At present, the O&M costs are dominated by corrective maintenance. To reduce the O&M costs it is necessary to lower the amount of corrective maintenance by shifting some parts to preventive maintenance and some parts to condition based maintenance. To minimise the O&M costs the following topics are foreseen.

- ✓ The conceptual basis for predictive O&M should be based on a rational theoretical basis. A Bayesian approach and application of risk analysis tools have proven efficient in other industries and could be further developed for application for offshore wind energy. Application of predictive

methods requires that damage development can be modelled and reliability estimated. Application of risk based methods implies that both cost and reliability aspects are combined and therefore data and models for these are needed – see topics below. Robustness of design in the sense that 'the wind turbine (system) is designed, fabricated, installed and operated in such a way that it will not be damaged due to accidental, unforeseen incidents and consequences of human errors to an extent disproportionate to the original cause' require. A risk based approach can be used to develop guidelines for robust design using information on reliability of components and systems, system redundancy and consequences of component failures.

- ✓ Numerical tools for quantifying the O&M aspects need to be further developed to estimate the different contributions of the three maintenance types to the total O&M costs and to assess the impact of different components with each a different reliability and maintainability on the overall O&M costs.
- ✓ The most important data to be used as input for the quantification of corrective maintenance with the O&M costs models are failure rates and reliability data of wind turbine (and balance of plant) components. Such data, especially reliability data, are hard to obtain. Databases with operational and failure data should become available and the industry should exchange such data. Parties involved should collect in a similar and structured way. Next, information about local weather conditions, capabilities of vessels, and logistic aspects are needed as input and should be collected centrally and exchanged. This RT could focus on structuring the format for data collection, setting up procedures for analysis and reporting, and developing a central database that can be accessed by industrial parties, keeping in mind the confidentiality aspects.
- ✓ To move from corrective maintenance to condition based maintenance, the diagnostics should be strongly improved. The R&D institutes can commonly develop (1) methods for low cost load monitoring (sensors, measurement equipment, and data reduction and analysis software) like the Flight Leader concept, (2) develop methods to relate mechanical (fatigue and ultimate) loads with component degradation and assess the remaining lifetime (e.g. for composite materials, bearings, gearboxes, sub-structures, and connections), and (3) develop methods to measure component degradation and remaining lifetime directly through improved condition monitoring systems. Once the remaining lifetime can be measured, estimates can be made with the O&M cost models of the expected amount of condition based maintenance.
- ✓ If the diagnostics function correctly, operators can intervene manually or automate the decisions making process. For both situations the large amount of data should be reduced first. The turbines should be equipped with redundant sensors and actuators to some extent. In case the decision making process is automated, developments should focus in implementing it in the turbine and wind farm controllers. This RT could focus on developing methods for data processing, the use of redundant sensors and actuators and development of fault tolerant control.

Who should attend
Researchers and/or practitioners from the participating research organizations in EERA-Wind with expertise or interest in Operation and Maintenance.

Presentations
All participants are invited to give a presentation at the workshop. After the workshop participants are invited to submit papers to be included in the EERA-Wind report '***Predictive tools for O&M***.

Venue
The workshop will be held at:
Department of Civil Engineering
Aalborg University
Sohngaardsholmsvej 57
9000 Aalborg
Denmark

Aalborg is easily accessible from Copenhagen airport with more than 25 connections each day
Further details on how to reach Aalborg University are available on
http://www.civil.aau.dk/gaest/transport/?languageId=1

A list of hotels can be found at
http://www.civil.aau.dk/gaest/overnatning/?languageId=1

Cost of the workshop
The charge for attending the workshop is 50 Euro to cover costs for coffee/tea breaks and lunches. The fee is paid in cash at the registration desk June 30.

Notification of participation
Please indicate your interest to participate in the workshop by sending an e-mail to Vivi Søndergaard: **vs@civil.aau.dk** with the following information:

Title of presentation (preliminary), if any:
Name:
Professional title:
Research Institution / University:
Address:
Tel.:
E-mail: