UpWind

SIXTH FRAMEWORK PROGRAMME

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- Energy Research Centre of the Netherlands (ECN)
- Stichting Kenniscentrum Windturbine Materialen en Constructies (WMC)
- Technical University of Delft (TUDelft)
- Centre for Renewable Energy Sources (CRES)
- Dong Energy
- Garrad Hassan and Partners Ltd
- Germanischer Lloyd
- SAMTECH S.A.
- Det Norske Veritas

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Integral design approach and standards

THE CHALLENGE

The challenge of the work package (WP) 'Standards and Integration' is to efficiently update design standards and the development of an integrated design approach. This will ensure consistency and strengthen the integration of the advanced models within the wind energy technology, improve test methods and design concepts developed in the scientific work packages 2 to 9. In turn the WP provides a consistent scientific background for standards and design tools. The approach rests on three legs:

- Provision of a reference (wind turbine) for communication between and integration of all WP's;
- Development and definition of an integral design method to be applied in the real design of wind turbines, and not the least;
- Development of (pre)standards for the application of the integral design approach, including interfaces, description of data needs, guidelines and proposals for the formal international standardization process.

The technology of wind turbines and the size and impact of wind farms have made so much progress that the design and development has become dependent on the knowledge and interaction of specialists. Consequentially, design teams face increased complexity, both in the individual disciplines and in the design process of the entire system. To deal with the complexity of the individual disciplines, fundamental knowledge and design tools are continuously improved. Although the improvements of the individual technical disciplines are needed to reduce risks and to increase performance, they implicitly work to strengthen the status quo of current concepts and stimulate improvements that are based on the insights of a single discipline.

Further product improvements, which are expected and needed for the wind turbine and wind farm in 2020, can only be achieved when developments are not obstructed by the boundaries between the contributing disciplines.

The keyword for the approach is 'integral design' or 'system engineering' and the challenge for the wind energy community is to find a way of practical implementation.

The UpWind project, which has a mission to provide the prerequisites for taking a quantum leap in the development of the wind energy technology, not only aims at developing these disciplines, but also at finding the practical implementations for integration of disciplines for the design of wind turbines and support structures.

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THE RESEARCH ACTIVITIES

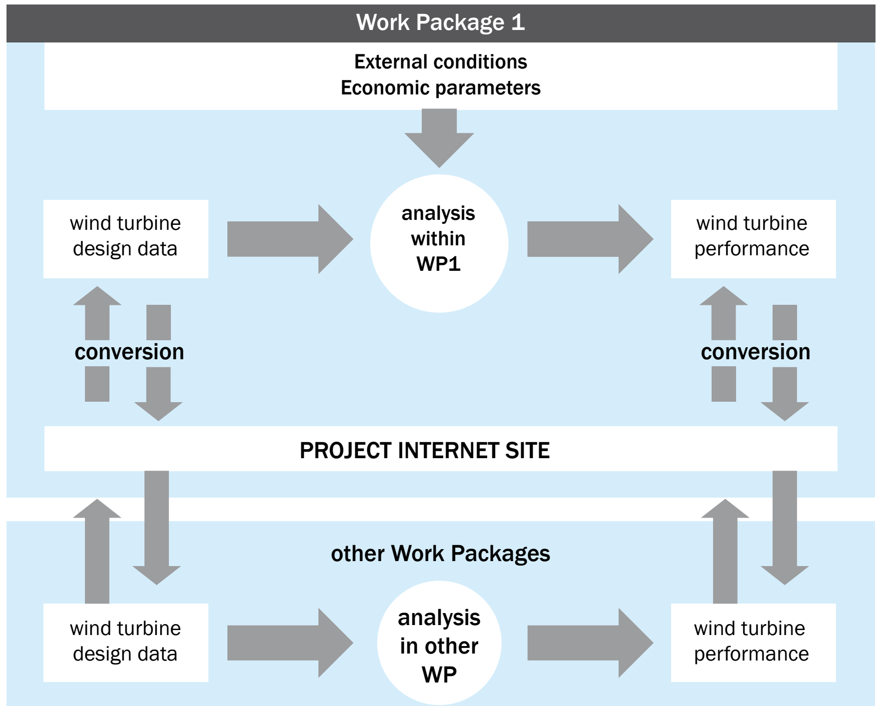
The main research activities for the integral design approach and standards' work package include:

- Defining and updating a reference wind turbine and a reference technical-economic cost model for benchmarking to be used for communication of the design parameters and design developments and the main economic and dynamic performance parameters for all UpWind project activities;
- Development, application and evaluation of an integral design approach methodology in offshore wind turbine design;
- Development of standards in general and for the application of the integral design approach, including definitions of interfaces between models, including data needs, specifications and protocols;
- Definitions and specifications of experimental data to be condensed into input design parameters for the design models or to verify critical design and performance issues.

In practical terms, the above research activities are sub-divided into 4 tasks.

SUBTASK A: REFERENCE WIND TURBINE AND COST MODEL

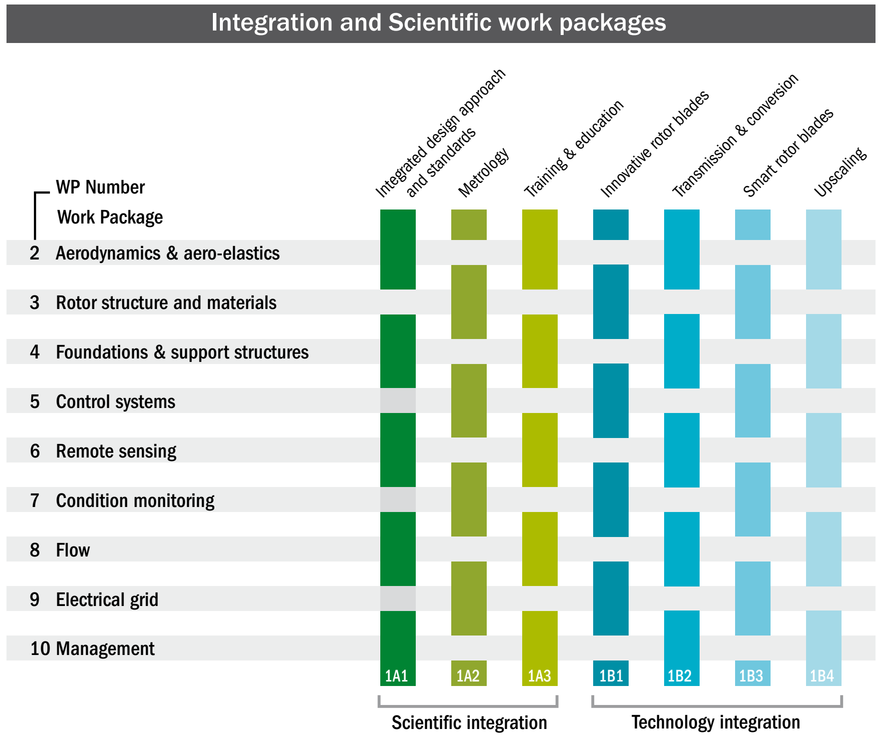
The subtask is dedicated at facilitating the integration of the different activities in all the horizontal (and vertical) work packages throughout the project. For this, a reference wind turbine will be defined to provide a basis for communication and comparisons. The design parameters and the main characteristics, including results of parameter sensitivity studies, will be defined and kept up to date. Input data will be provided from the other work packages. The data will be made easily accessible to all partners in the project.



SUBTASK B: INTEGRAL DESIGN APPROACH METHODOLOGY

Other technology sectors, such as air-transport, have experienced a development similar to wind energy with respect to increasing complexity and focus on specialists. For some of these technologies "Knowledge Based Engineering" (KBE) is investigated as a means to increase productivity of the design teams and to reduce the boundaries between disciplines. KBE tries to model not only properties of a product, but also the knowledge about the product that captures the engineering intent behind the design. KBE can be used in Design and Engineering Engines (DEE), to automate the multi-disciplinary processes. This automation is not intended to replace the design team, but rather to replace routine activities and to improve efficiency and consistency of information exchange. As a result, design teams will have more time for their creative contributions and thus can increase their productivity. Core element of the DEE is a (multi-) model generator in which the parametrical description of the product resides. It gets input from a concept generator and (re)generates the input for the analysis tools: the discipline silos. Typically, the discipline silos are commercial off-the-shelf analysis tools. The Knowledge Based Engineering tools reside in the concept generator.

Thus, the objective of this activity is to assess the feasibility of this approach for wind turbine design and to develop the knowledge needed to generate a DEE for this purpose. It is noted that the analysis tools in the discipline silos are external tools and are not part of the development undertaken in this activity. However, this activity will contribute to and make use of the common formats developed in this task, as these represent the interfaces between the model generator and the analysis tools. The reference turbine will be used as a case study.



Horizontally the scientific work packages are displayed and vertically the integration work packages.

SUBTASK C: DEVELOPMENT OF (PRE) STANDARDS FOR THE APPLICATION OF THE INTEGRAL DESIGN APPROACH

This subtask is dedicated to the development and formulation of standards in a broad sense, and for the application of the integral design approach of subtask B. Hence the subtask C aims at integrating the design models, experimental methods and concepts arising from the horizontal work packages.

SUBTASK D: INTEGRATION, REVIEW AND PLANNING WORKSHOPS

This subtask focuses on coordination and cross-cutting activities.

RESULTS AND EXPECTATIONS

So far cost functions for the components of the wind turbine, for which the input from parallel project activities is needed have been developed.

This WP works in close cooperation with the WP Upscaling (1B4).

The final results of the work package include:

- Guidelines for the integral design approach, including guidelines for design models, experimental methods and concepts arising from the scientific WP's;
- Recommendations and pre-standards to be submitted for IEC/ISO and CEN/CENELEC for the revision or development of international standards for design and tests of wind energy systems.