European Wind Energy
Technology Platform
(TPWind)

The Working Groups of TPWind

Work Program Proposal

Working Group 2 - Wind Power Systems

Prepared by the TPWind Secretariat

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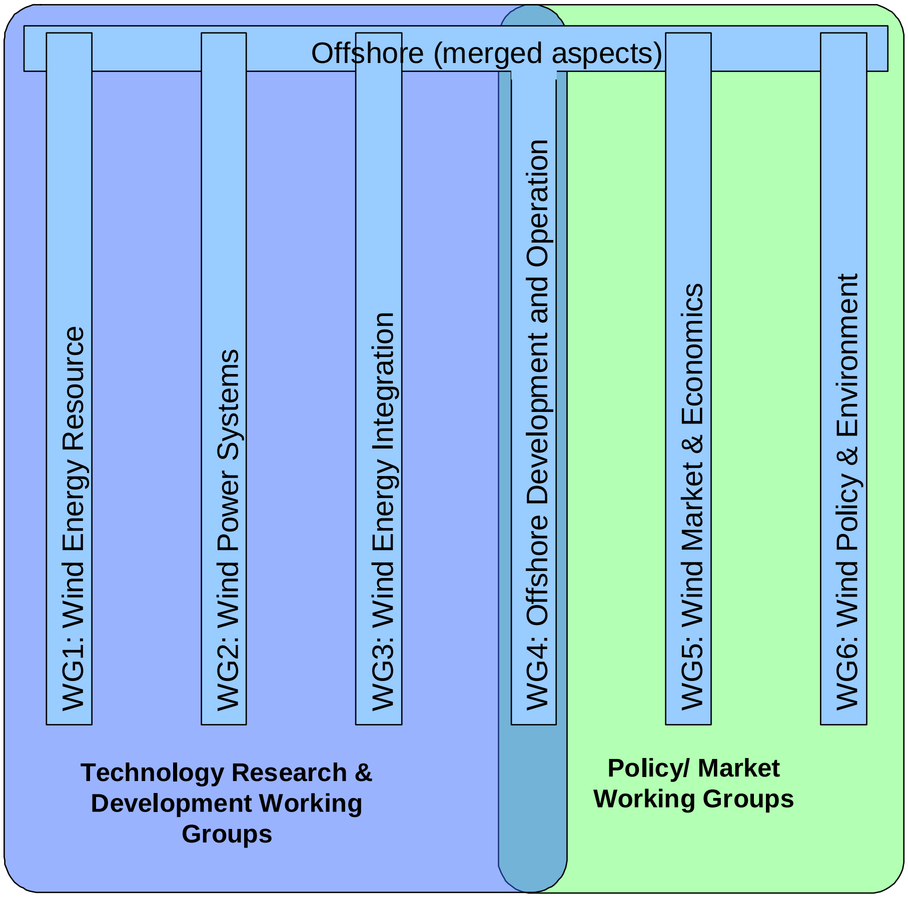
Introduction

As endorsed during the Second Steering Committee meeting of the European Wind Energy Technology Platform (Milan, May 9th 2007) the Working Groups of the Platform are:

- WG1: Wind Energy Resource,
- WG2: Wind Power Systems,
- WG3: Wind Energy Integration,
- WG4: Offshore Development and Operation,
- WG5: Wind Market and Economics,
- WG6: Wind Policy and Environment.

Moreover, it has been decided that each Working Group is dealing both on onshore and offshore aspects. The WG4 is focused on offshore-specific aspects.

In the following, a short description of the foreseen topics covered by each Working Group is provided, enabling to select the right experts for each Working Group.



WG2: Wind Power Systems (J. Beurskens)

This Working Group focuses on aspects enabling costs reductions on the wind-turbine side (onshore and offshore). Key areas in this thematic may include: *Materials, Drive-trains, Blades, O&M and Wind turbine design and efficiency increase.*

Materials:

Costs in the wind industry are depending on the costs of construction materials. Steel prices on the global market are volatile. Steel might be replaced by alternative materials (alloys, composites, plastics..) from indigenous sources.

Regarding the foundations, the problem of concrete is the same as for steel and copper. Novel support structures, including foundation concepts, especially for offshore applications offer a room for better economics.

Advanced component manufacturing and assembling techniques shall be developed to facilitate massive production and reduce the cost of the turbines.

Drive-Trains:

Drive-trains are being loaded in an extreme complex and heavy way. Replacing the presently often used combination of gearbox and fast running generator, by a slow running direct-drive generator leads to heavy systems, especially for multi MW turbines. Two development strategies could be pursued: Optimising the balance between relatively slow running generators and gearboxes with a reduced transmission ratio and secondly: develop novel concepts (more compact architecture, extreme strong magnetic field strength and dedicated power electronic converters) of direct-drive generators. In all cases the mechanical loading of the drive train, and especially of the gearbox on all its components, needs to be understood fully. Apart from the external loads this should also include loads caused by deformations of gear box components.

Blades for very large wind turbine rotors:

Blades are complex devices in terms of design & fabrication. Distributed aerodynamic control along the blade is required to secure structural stability, limit loads and optimise output due to the highly variable wind field in the rotor plane. There is also a need to fully understand the external conditions for load determination. This particularly applies to extreme conditions. The lack of understanding is a serious constraint in predicting life time accurately for very large turbines. Larger blades intended for offshore operation will turn at higher speeds (due to the relaxed noise constraint), have thinner chords and larger airfoil thickness to further reduce weight.

The wind speed, and thus the energy content of the wind, is increasing with the height. Higher towers and larger rotors lead to improved economies of wind energy exploitation. As far as present technology allows, up-scaling of rotors however is limited due to material constraints and fundamental blade control difficulties.

Blades may be fabricated from cost-effective composite hybrids with increased strength to mass ratio. Add-ons in the composite matrix, nano-particles included, will enhance material damping, yield stresses and fatigue resistance. These add-ons might even allow for detailed health monitoring of the blades.

Remote monitoring & predictive maintenance tools:

Advanced condition monitoring techniques will allow for preventing maintenance and reduce O&M costs for offshore wind, in particular

As reliable monitoring systems for early failure detection and accurate interpretation of signals are not yet available, R&D in this area is urgent. In particular access technologies for offshore and remote terrain applications are crucial in bringing the availability to acceptable levels.

Turbine efficiency:

The capacity factor (or equivalent full load hours) is related to the power curve of the turbine and the local wind regime. Power curve (rated power, cut-in and rated windspeed, specific installed power (installed power per m^2 swept rotor area) and system efficiency need to be optimised, depending on the site.

The whole conversion chain from air particle to electron has to be scrutinised and optimized through coupling aerodynamic models with mechanical and electrical models. Turbines shall be designed in integrated CAD-based environments with multi-disciplinary multi-objective optimization tools. Probabilistic design methods will first apply to structural design and later to the $Aero^3$ (aerodynamic, aeroelastic, aeroacoustics) design. Advanced computational fluid dynamics techniques with prevail in the $Aero^3$ design.

Moreover, MIMO control schemes (multi-input, multi-output) shall apply aiming to control the power output and, at the same time, the turbine loading. Control input shall be given by "global-motion "sensors (rotating speed, individual blades) but also distributed sensors (active aerodynamic control, for instance).

New-generation power electronics may contribute in cost-effective power and power-quality control. At the longer run, they might even drive on-board storage devices.