European Wind Energy Technology Platform (TPWind)

The Working Groups of TPWind

Work Programs

Contents

Prepared by the TPWind Secretariat

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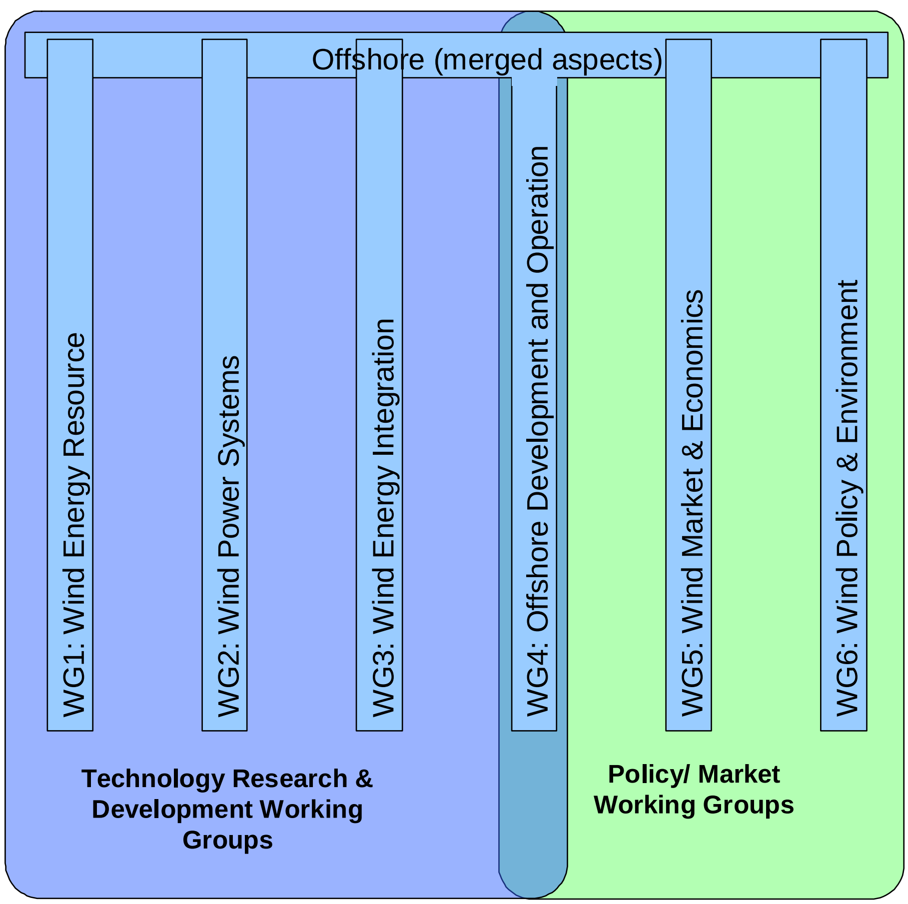
Introduction

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.



WG1: Wind Energy Resource (E. Petersen)

This Working Group has to focus on developing the state-of-art for all areas for which the working group is responsible to enable the full deployment of wind energy. Particular emphasis shall be put on offshore and extreme climate resources. Key areas in this thematic may include: *Advanced siting and wind characterization models. Wind resource mapping, advanced wind power forecasting techniques. Advanced measurements techniques including remote sensing.*

<u>Wind resources mapping:</u>

Wind atlases have to be updated and especially all of EU-27 mapped through a new European Wind Atlas, High-resolution offshore wind atlases must be provided. For both onshore and offshore, remote sensing techniques (satellite and lidar) are of great interest.

<u>Advanced sitting techniques:</u>

At project scale, reliable and accurate models are needed. The combined use of micro-scale and meso-scale models (numerical wind atlas) shall be further developed using CFD (RANS and LES) in combination with linear and statistical models. It is expected that future developments in data collection will rely heavily on state-of-the-art satellite applications and telecommunication technology, processing and transfer. Dedicated databases combining satellite / meteo. models / measurements (Lidar) and corresponding models are needed.

At wind-farm scale, the effects of wakes have to be evaluated. Remote sensing sensors (Lidar) and models have to be adapted to small-scale turbulence monitoring and modelling.

<u>Advanced wind/power forecasting techniques:</u>

Global forecasting meteorological models, running on super-fine spatial and temporal grids and supported with spread-around remote sensing observations to increase accuracy, will drive the future wind and power forecasting tools. An integrated IT environment of sensors and models will provide information and alarms to the power system operators

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.

WG3: Wind Energy Integration (J. Buddenberg)

The scope of this Working Group work extends from the single (large) wind farm level (onshore and offshore) to the large-scale integration in the power system level. The layout and basic structure of the grid need to be adapted to large amounts of variable electricity supply. However not only the physical design of the grid should be the focus but also the evaluation of the impact of energy management measures, which might increase the capacity of the grid. This aspect will make necessary a close interaction with the TP smart grids. Key areas in this thematic may include: *Grid codes/communication standards, Grid structure and planning, Grid operation and energy management (prediction tools, probabilistic capacity planning, storage facilities), Energy market integration (converting stochastic wind energy production into energy market products, providing additional grid services to TSO´s and DSO´s)*

<u>Grid codes/communication standards:</u>

In Europe, different technical specifications exist for grid integration of Wind Turbines. This does not only relate to the electrical specifications (grid codes), but also to communication and management standards of Wind Turbines/Parks and related facilities.

Standardization of electrical specifications might reduce manufacturing and implementation cost of wind farms and improve the planning processes of wind farms and grid connections (plug and play).

Similar advantages could be generated by standardization of communication and management interfaces of Wind Turbines and related facilities. This would improve the energy management processes and the interoperability of wind farm and grid.

<u>Grid structure and planning:</u>

The objective to archive large-scale wind integration into the power system needs an integrated approach towards grid technology, grid planning, grid structure and grid management.

On the European level the question of transport capacity between the wind rich regions and consumption centers will be important. Particular emphasis should be put on the interconnection capacities between the countries and offshore connections, particularly in the North Sea region (integration of offshore wind). Therefore, grid technologies for transportation of electricity with large volume over long distance might be needed.

Considering a probabilistic approach for grid management, the grid topology might substantially differ from today, and the capacity of grids on all levels might be substantially increased. This could take advantage of smart grid technology and new options for storage. Therefore, the impact and capabilities of smart grids and storage possibilities (fast-response/small-volume to longer-response/large-volume) should be evaluated further.

Grid operation and energy management:

Nowadays, there is a strong focus on the design of planning and operation tools for the European TSOs. These tools are designed for electrical system operation under stochastic demand and production (still well-forecasted) conditions. In the long run this "centralized" approach alone might lead to a dead end. Indeed, the system is putting full control only on wind park management, and might not manage the overall energy system in an optimized way.

Therefore, systems combining energy management systems at TSO and DSO level should be taken into account. Smart grid technologies, in combination with prediction tools, storage facilities and demand side management might lead to new opportunities to increase the integration potential. In this context, tools for predicting wind farm output within a period of maximum 48 hours need to be much more accurate than the present ones. In addition, a need for both large scale and regional forecast will be necessary for advanced grid operation and energy management systems.

Energy market integration:

Beside the need to improve the physical integration of wind energy, tools and management systems of integrating stochastic wind energy into the existing energy markets will be necessary. Again, advanced forecast systems in combination with improved storage possibilities and management measures are the basis to achieve this objective.

This Group will work closely with WG 5, related to Market & Economics. The technical and economical aspects of systems will then be taken into account, in order to enable the integration of the wind energy production on the grid and into the electricity Market.

WG4: Offshore development & operation (A. MacAskill)

Following the declaration of the European Policy Workshop on Offshore Wind Power Deployment (Berlin, 2007), this group is invited to provide a roadmap for a large-scale deployment of offshore wind energy. WG4 focuses on those aspects of offshore operations and development which are not addressed by the other Working Groups. Key areas in this thematic include: *safety and access to offshore turbines, new and improved concepts for offshore wind turbines, design and fabrication of offshore substructures, new concepts for assembly installation and hookup of large scale developments, offshore cables and connectors, operations and maintenance, spatial planning and decommissioning*

Safety and Access to Offshore Turbines

To ensure the safe operation of the offshore facilities and the staff involved in the installation, hookup, commissioning, operations and maintenance of these facilities. This will include examination and review of turbine access systems, escape and casualty rescue and standardization across Europe. Access to the turbine may require several distinct solutions to address weather constraints and transfer of people and equipment.

New and Improved Concepts for Offshore Wind Turbines:

The key drivers for offshore technology are different from those required onshore. Offshore economics favour larger machine and may allow the relaxation of some constraints, such as aesthetics, noise etc., but the offshore environment will impose others such as marinisation, corrosion, significantly increased reliability etc. This could lead to substantial modification of onshore machines or the development of specific offshore designs.

Design and Fabrication of Offshore Substructures

Substructures form a significant proportion of offshore development costs. Novel substructure designs, floating substructures and/or improved manufacturing processes which reduce the cost of substructures will be critical to improving the economics of offshore developments.

New Concepts for Assembly, Installation, Hookup and Commissioning of Large- scale Offshore Developments

The assembly, installation, hookup and commissioning of large scale offshore developments are repetitive processes with complex logistics. Experience in the oil and gas industry has shown that significant cost reductions can be achieved by reducing the volume of offshore works, improving the efficiency with which they are performed and transferring activities to the onshore environment. This will require new or modified assembly, installation, hookup and commissioning processes to improve efficiency and transfer activity from offshore to onshore.

Cables and Connectors

Purchase and installation of the cables represents a significant cost in offshore development and has proved to be a high risk area during installation and operations. Better infield cabling design, improved cabling technologies and installation processes could result in significant cost reductions and improvements in operational reliability. Pre-installation of the cable ends on the substructures combined with connector technologies (wet or dry) could speed up the installation process and reduce costs: obviating the need for offshore terminations and access to the structure during installation.

Offshore Operations and Maintenance

Effective operations and maintenance strategies which maximize the energy yield from the turbines while minimizing operations and maintenance costs are essential to the commercialization of offshore wind. These strategies must address the complex logistics of offshore wind farms and using the advanced condition based maintenance philosophies and non intrusive maintenance techniques. Better management systems, which monitor and control the turbines and assist in the scheduling and implementation of the offshore activities, will be required.

Spatial planning:

An integrated EU maritime policy is needed; in order to take into account the multiple use of the sea and enable different sectors and industries to share the space at sea in a transparent and fair decision making process. Spatial planning instruments, based on GIS software and environmental databases are needed.

Decommissioning

To develop a vision of the techniques and costs of dismantling offshore wind farms and ensure that where practicable these are incorporated into the windfarm design.

WG5: Wind Market & Economics (A. Santamaria)

This Working group is scrutinizing the economics and market instruments related to wind energy, both onshore and offshore. Key areas in this thematic may include: *cost and financing of wind turbine and wind farm projects, supply chain analysis and proposal for improvements, market instruments for electricity exchanges at EU level, impact of certificates on the wind energy market.*

<u>Upstream –wind turbine and electricity production:</u>

This aspect refers to the investment in electricity generation units, at turbine and wind park scale.

At turbine scale, exchange of materials on the Market implies common rules, and then **certification & tests standards**.

The **supply chain** has to be studied: significant costs reductions have been performed by the car industry, household appliances or electronic devices by standardizing main components and sharing industrial capacities between manufacturers.

At wind park scale, the exchanges can be seen as a black box with input and output. Output is investment, and input is profitability. Investment occurs when the profitability index is sufficient, and guaranteed for a sufficient duration. **Mechanisms enabling a sufficient return on investment have to be optimised for a sustainable development of the market**.

Moreover, the "cost of money" and financial engineering concepts have a huge impact on the cost of a project. Negotiations with financial institutions might lead to significant progresses. Public support can be provided through dedicated low rated founds.

<u>Downstream –electricity transmission & consumption:</u>

The support of electricity exchanges is the electricity grid. Limitations in the electricity grid structure leads to limitations in market exchanges. System integration policies are needed in two aspects:

- Ø **Grid integration policies, strategic grid planning and coherent grid codes**
- Ø **Energy markets integration, policies and regulatory development to ensure access of wind energy to energy markets**

Certificates are tools for linking the upstream and downstream aspects. The impact of certificates on the electricity markets has to be assessed.

WG6: Wind Policy & Environment (A. Zervos)

This Working group is focused on possible improvements of policy and environmental measures at international, EU and member states level, for onshore and offshore. Key areas in this thematic may include: *policy optimization, environmental aspects optimization. Specific weight will be given to administrative and institutional barriers, and the effects that they have on wind development.*

Policy:

- Onshore:

Policy optimization has to be performed at International, EU, National and Regional level. Coherence must be assessed between the different policy levels. **This topic shall provide inputs to the Member States Mirror Group (MSMG) of TPWind for implementation at National or Regional level.**

Key policy issues that have to be addressed include complex administrative procedures, conditions and prices for grid access, support mechanisms, the impact of non competitive electricity markets, the impact of an electricity market with numerous externalities; international standards, rules for international trade, etc.

- Offshore:

A correct policy for offshore is needed if this technology is to deliver substantial electricity production in the medium and long term. The objective of this WG in relation to offshore is then to discuss and propose policy measures that will contribute to the growth of this sector.

Some of the policy issues that need to be addressed are the same than for onshore (see paragraph above). However, offshore has distinctive features that should be addressed separately, for instance, the influence of the grid and the socialization (or not) of its costs; relation with other users of the sea and marine planning; Also the relation between Member States that share an offshore wind farm; eventually, the modification of the payment mechanism for offshore.

Environment:

Environmental impacts of wind farms are more and more known.

Onshore, the **Environmental Impact Assessment** processes might be optimized through sharing the information between countries, and setting a common policy framework.

Offshore, wind exploitation is a relatively new type of marine activity, and proven effects will clearly only be known subject to experience. The experience to date on environmental and social acceptability has been very positive compared to expectations. It is important that there is ongoing dissemination of good quality information on the existing environment and feedback on impacts in the future. Spatial planning or, at least, geographical definition of marine interests in coastal zones, is a valuable planning tool. It helps to diminish conflicts between different marine uses at an early stage in the process.

This group would have to analyze the evidence that exists and try to work out on a common understanding of environmental effects (negative and positive) for onshore and offshore; if possible, define a common methodology for the environmental impact assessment of wind farms, mainly offshore. The group should also contribute to the spread and consolidation of the good practices that exist.