Upscaling

UpWind

SIXTH FRAMEWORK PROGRAMME

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THE CHALLENGE

The wind turbine market has grown rapidly and so has the capacity of the wind farms and the size of the wind turbines. During the last 2 decades wind turbines have grown in capacity from 250 kW to 5000 kW and in size from a 25 m rotor diameter to over 125 m respectively.

This work package (WP) targets at research and technology needs for successful upscaling of wind turbines, while securing reliability. For this the optimum technology and economics of future wind turbines, varying in size and concept and for various applications, need to be analysed.

For land application transport, installation and siting limitations might limit the maximum size of wind turbines to a lower value than wind turbines for offshore applications. For offshore the cost structure of wind farms, dominated by the cost of support structures and foundations, requires wind turbines to be as large as possible.

With the growing size of the turbines the technology has developed equally rapid. Constant speed, stall controlled machines with fixed blade pitch equipped with induction generators directly connected to the grid have dominated the market in the early days. Nowadays these are no longer produced. Variable speed turbines with individual blade pitch systems which are connected to the grid via power electronics are main stream.

For further growth of the wind turbine market, in particular for offshore applications, the development of larger machines than those which are now being used is a necessity.

The largest prototypes of wind turbines have a diameter of slightly over 125 metres and a rated power of over 5 MW. The uncertainty about the maximum physical dimensions achievable and installable depend on load mitigation, controllability, and innovative materials.

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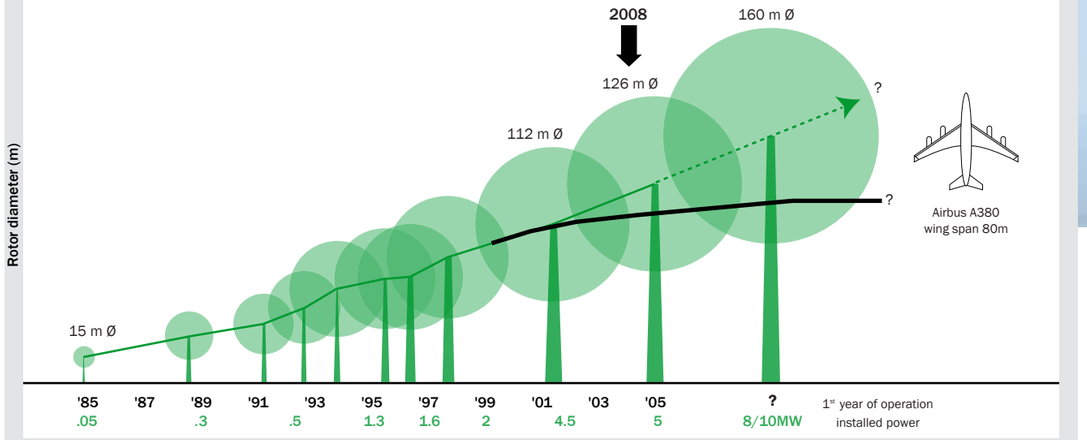

OBJECTIVE

The objective of the WP Upscaling is to identify R&D needs for the expanding future market of large scale machines.

Three parameters will be analysed in this respect: ex-factory cost, transportation, installation and operating and maintenance cost, design limitations. Based on scaling trends and cost models, component and total system “ex-factory” cost will be estimated.

Evaluation of transportation, installation, operating and maintenance costs will indicate the economics of wind energy for very large turbines of present day technology.

The outline design, based on scaling trends and experienced engineering judgement and cost analysis of a 20MW wind turbine will reveal major problem areas in up scaling present day design concepts.

Fundamental technological barriers will be identified. It will probably show that new, disruptive technology must be developed to design very large machines of around 20 MW installed power.

THE RESEARCH ACTIVITIES

Based on a systematic analysis of the growth in the scale of wind turbines over the last two decades, this task will involve the development of scaling trends to characterize key design parameters as a function of turbine size. Such parameters will include the mass, capacity and cost of major components as well as the complete turbine system, cost per rated kW, and cost per unit rotor swept area. The scaling trends will be used to outline a 20 MW design. For this the scaling trends will be applied to a reference wind turbine. The reference wind turbine is an artificial wind turbine representative for the present largest machines on the market i.e. 5 MW rated power, 125 m rotor diameter, 3-blades, variable speed and power control by pitch to vane. A critical assessment of the upscaled design will be undertaken in order to determine the engineering feasibility, cost implications, investment risks and overall fundamental barriers, as concerns technology, design tools and concept, which might prevent such large scale wind turbines. The identified barriers may be related to the cost of energy, the manufacturing process, the installation process, the structural integrity, etc. The identified barriers can be used to give direction to the future long term research activities. The results from economic analyses and the conceptual evaluations can be used to inspire the development activities of industry. An iterative procedure is foreseen in which new designs will be proposed to cope with the barriers.

In parallel with the upscaling of a reference wind turbine with a state-of-the-art concept, other promising concepts for the future market are being investigated. For the offshore market the ease of installation and maintenance and the robustness of the design are far more important than for onshore. The typical offshore design drivers are likely to result in quite a different optimum concept from present common technology.

RESULTS AND EXPECTATIONS

The final result of this WP will include a description of the upscaling process and the identification of major barriers, including an outline design and a cost analysis of a 20 MW wind turbine. The technical and fundamental barriers affecting the development of very large wind turbines are being identified and the developments needed to overcome these barriers will be formulated. Additionally, a vision on promising concepts for the future (offshore) market will be formulated.