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Flexible blade length concept reduces cost of offshore wind energy by up to 10 percent

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Abstract

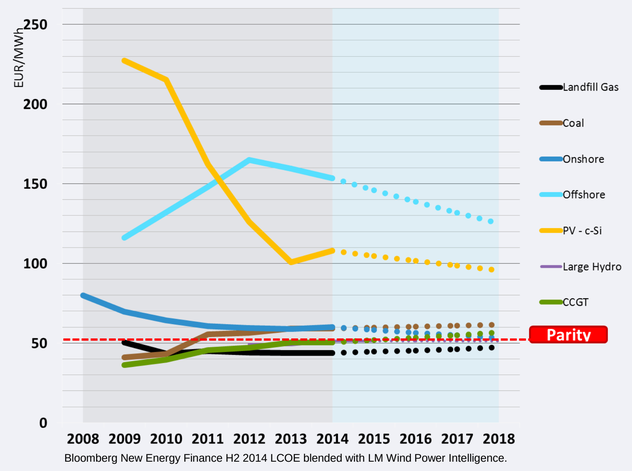
Offshore wind energy is relatively expensive compared to alternative renewable energy sources and the challenge is to reduce the Cost of Energy (CoE). The most critical factor to reach the targeted 9 ct/kWh by 2020 is to increase the Annual Energy Production (AEP) by optimization of the wind turbine performance.

Blades are the engine of the turbine and constitute therefore the key enabler for increasing the AEP. The most efficient way to increase the AEP of a wind turbine is to increase the swept area of the rotor by increasing the blade length. However, increasing the swept area will also increase the loading on the wind turbine. In the offshore wind power plant, wind turbines are inevitably in each other's wake. This courses a loss of energy. Most turbines are actually not loaded to the full designed capacity due to wind conditions on specific sites, or the location of the wind turbine in a wind farm. Hence, there is an untapped potential to increase AEP, if flexible blade lengths could be offered for the same wind turbine.

The flexible blade length can be achieved by splitting the blade into a main blade part, and a tip part that can vary in length. Split blade concepts have been investigated in the past mainly to overcome logistic challenges from the transport of large blades. LM Wind Power performed, with partners, an EU-Project on split blades (JOR3-CT97-0167), where two designs were developed and tested. The conclusion of the EU-project was that split blades are significantly more expensive compared to standard blades. On a 60 meter blade an increase in manufacturing cost of 19% was found, whereas the logistic/transport cost savings due to segmentation were only 5%. Hence, the split blade concept is far too expensive.

The HYLLER (High Yield Low Loads Enlarged Rotor) project explores a new rotor blade, using a flexible blade length concept. The new rotor blade will consist of a standard basis blade part and variable length blade tips. The variable length blade tips are envisioned to have a length of 1/6 to 1/4 of the total blade length

Levelised Cost of Energy(LCOE)



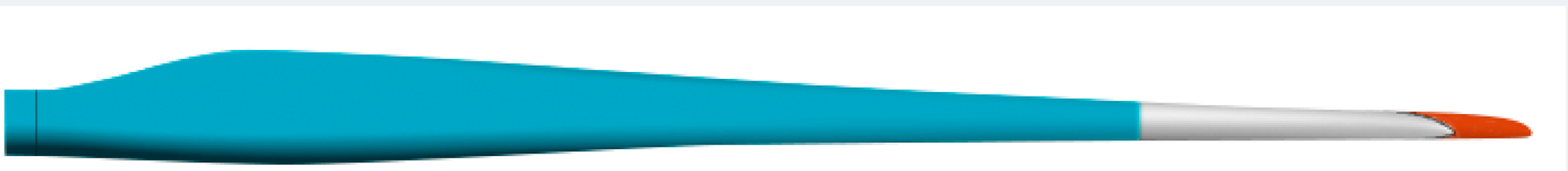
Bloomberg New Energy Finance H2 2014 LCOE blended with LM Wind Power Intelligence.

- **Average cost of onshore wind energy has reduced approximately 40% per decade, equalling that of coal LCOE in 2013**
- **Onshore wind has achieved grid parity in a number of key markets and offshore is following a similar trajectory and rapidly approaching 100 €/MWh (10 ct/kWh)**

Objectives

The general aim of this project is to design and validate a new rotor blade concept that will increase the offshore AEP and thereby reduce the CoE. The rotor blade will consist of two parts, the main blade and the blade tip, and has a variable length.

Specific objectives include:
- To optimize the blade tip design;
- To develop a light-weight and durable joining concept;
- To develop a cost efficient manufacturing concept for the blade tip that can be easily automated;
- To validate the new rotor blade including joint in a high-fidelity, laboratory environment



Concept of flexible blade length

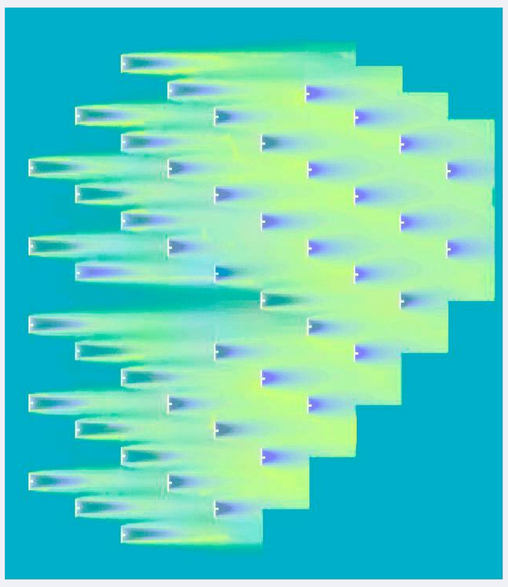
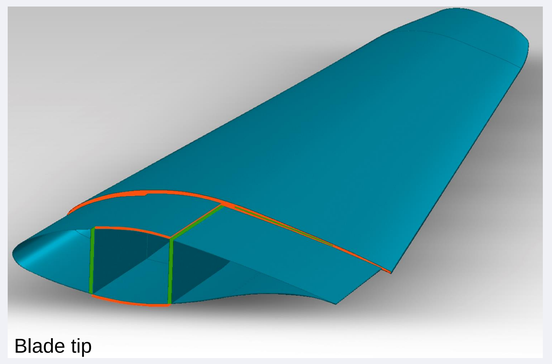


Illustration of wake simulation

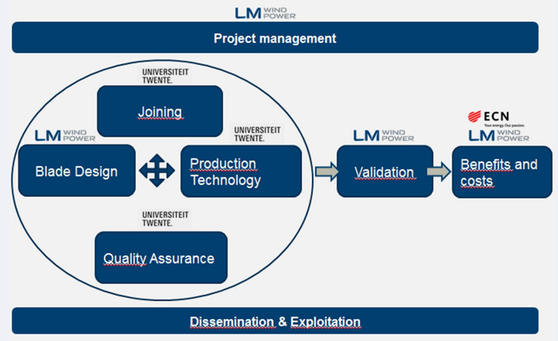
Methods

LM Wind Power, ECN and Twente University are analyzing the wind farm optimization and designing a flexible blade length concept that maintains the cost at the equivalent level of standard single-size blade and that maintains the root mass moment. The concept enables separate manufacturing of the blade and tip part followed by a traditional joining technique leading to a permanently assembled blade.

The challenge is to develop a flexible blade length concept which will enable realization of the potential AEP increase of a wind power plant while maintaining the cost at the equivalent level of standard single-size blade. The solution is a flexible blade length concept which enables separate manufacturing of the blade and tip part followed by a traditional joining technique leading to a permanently assembled blade. The concept enables central production of the blade tips and decentralized assembly, e.g. on-site or near site, to take advantage of manufacturing scale effects and create flexibility. The manufacture of the blade tips is performed by a one-shot manufacturing technology, which enables the tips to be lighter and cost efficient. Therefore the blade cost and blade characteristics, e.g. blade weight and root mass moment of the flexible (variable) blade concept will be comparable to a standard, single-size blade.



Blade tip



Work packages within the project

Conclusions

By varying the rotor diameters along the wind farm and by using more optimal blade geometries, a significant increase in AEP and overall wind power plant performance can be achieved. Based on the analysis of the Horns Rev offshore project (wake characterization), assuming a flexibility to change the rotor diameter of up to 10% on a layout matrix, a potential increase of the AEP by 8% – 10% and an equivalent decrease in CoE has been estimated.

For questions or suggestions, please contact project manager Frank Bianchi, frb@lmwindpower.com

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