Extending the lifespan of wind turbines

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The Spanish technology centre Cener gives an overview of the first results coming from the testing phase on wind turbine software, the blade configurations and the control strategies developed during the European Windtrust project

Today wind is the second largest renewable energy source in Europe, after hydro. Electricity production by offshore wind turbines, however, is more expensive than fossil fuel alternatives, and power generation by onshore turbines is still more expensive than nuclear power plants.

The Windtrust project aims to prepare the design of improved wind turbines to reduce the costs of electricity generation from wind energy. Alvaro Gonzalez Salcedo is a specialised technician in the wind energy division at the National Renewable Energy Centre (Cener) in Sarriguren, Spain, one of the Windtrust partners. He gives an overview of the first results coming from the testing phase of the project.

Why could Cener contribute to the project?

Cener has a cutting-edge technological infrastructure. Our wind turbine test laboratory is unique both for its size (30,000 m^2) and facilities. In addition, we have an experimental wind turbine test farm, suitable for certification tests on a complex, hilly terrain with high wind levels. We also developed specific tools and methodologies for an accurate and computationally-efficient simulation of wind turbines.

What did your tests consist of?

Harsh environments – variable wind conditions and the complex dynamics of large wind turbines, especially on offshore sites – lead to a significant increase in loads and loss of reliability. To overcome this problem, the Windtrust partners develop and test new technologies and applications such as blade flaps. This way, they try to decrease the costs of energy production.

Cener disposes of the advanced software and experience in wind tunnel and water tank tests, necessary to perform computer simulations and experiments that show the impact of those technologies and application. Previous to the integration in a real wind turbine, we did simulations and tests to evaluate different configurations and working conditions for a proper assessment of the technologies, reducing as much as possible the uncertainties.

What were the main challenges?

Obviously, we needed to decrease the loads while maintaining or even increasing the power production and decreasing the costs of exploitation. Another way to lower the exploitation costs is to extend the life time of the moving components. The complex wind conditions they are exposed to and the wind turbine dynamics result in abrupt load changes. We need to reduce or to avoid damage in the systems and components.

Without suitable control methods, this can cause fatigue and other damage to the blades and the other wind turbine components. This is especially a problem for the largest turbines, because they experience more complex conditions and the situation near the ground can be very different from the situation at the highest blade tip. Therefore the modelling software has to be able to properly manage all the operating conditions.

Also, the experimental testing has to be representative of the real problem. We needed to develop new aero-elastic modelling tools and demonstration tests, for instance to find out the influence dynamic flaps have.

What result have you obtained?

Some of the most loaded components are the blades. Our work showed that, by applying a specific configuration of flaps, it is possible to decrease the load on the blade root by at least 10%. This approach uses one flap in each blade, centred in the 90% core of the blade, with an extension of 7% in both blade span-wise directions (from 83% to 97% of the blade radius). Depending on the selected configuration and the control strategy, load reduction can be improved significantly.

This opens two possibilities. The first is a reduction of the blade cost, due to a decrease of weight or a longer lifetime. The second is the use of longer blades, resulting in more power generation. Side benefits are a reduced overspeed and fewer pitch activity.

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