Large-scale integration of wind energy

The unstoppable growth of wind parks on land and sea presents all European stakeholders with new challenges. Among the most important of these is the connection to the electricity grid, particularly if the power is to be transported over long distances.

Text **Marjolein Roggen**

Following a period in recent years during which the European countries mostly invested in wind parks on land to achieve their ambitions for sustainable energy, the past several years have seen a marked increase in the interest of governments, project developers and electricity companies for offshore wind parks. This is due, in part, to the stimulating role of the European Union and advancing technological progress.

High power

The European Wind Energy Association estimates that in 2020 around 180 GW of wind energy capacity will be operational, of which 35 GW will be offshore. This is enough to meet 12 to 14 percent of the total European electricity demand. This contribution will increase to no less than 300 GW in 2030, with 120 GW from offshore wind parks. “To achieve this growth, the character of the wind parks will also change,” explains Hans Cleijne, consultant at KEMA. “The first offshore wind parks in the North Sea had a power output of less than 100 MW, stood in water no more than 20 meters deep and were no farther than 25 kilometers off the coast. The capacity of the wind parks currently under development ranges from 250 to 1000 MW, while the depth is as great as 35 meters and the distance from the coast increases to between 40 and 80 kilometers. The conditions to which offshore turbines are exposed are therefore increasingly extreme. This places specific requirements on the design of the wind turbines. In 2009, a special IEC standard (IEC 61400-3) was developed for this application that builds upon the standard for onshore turbines.”

Photo: Fotostudio Alain Baars

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Connection to high-voltage network

One of the biggest questions that must be resolved is how all this onshore and offshore wind power should be tied into the high-voltage network and who is responsible for doing so. The current situation in Europe is that every offshore wind park is connected to land by a single cable, thus without redundancy, for the most part to the 150 kV high-voltage network. The additional load is not too great at present, but some areas are suffering congestion problems. “The challenge we face in our efforts to achieve large-scale integration is that the current grid is not designed to facilitate large volumes of wind generated electricity. Especially building wind farms at remote locations is exacerbating the challenges faced by grid operators,” stresses KEMA’s consultant Frits Verheij.

Selection

“To determine how we will meet the demand for large-scale connection to the network, we must first select the transport technology,” says Hans Cleijne. “At what voltage level will the electricity be transported, and will it be direct current or alternating current? Extensive static and dynamic analyses are also necessary. Furthermore, offshore connections place high demands on equipment, the connections to the mainland en tendering processes. And last but not least, the environmental impact will also have to be considered.”

Responsibility

In the Netherlands it has until now been mainly the project developers of offshore wind parks that have also had the responsibility for constructing and maintaining the connection to land. “We expect that in the near future it will no longer be the project developer that establishes and controls the inter-connection but rather the manager of the transmission grid who assumes this task,” says Hans Cleijne. “The wind parks are becoming increasingly larger and they are being built ever farther from the coast. When you also consider that the investments and risks are too great for a single project developer, it seems logical that the grid operator will have to assume this responsibility. This will also allow transport connections for multiple wind parks to be clustered.”

Photo: David Bouman

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Model study

Together with a number of partners including project leader EWEA, KEMA has conducted the first European study into wind integration: TradeWind. Several scenarios have been computed, for a number of years up to 2030, based on the EWEA figures. “The most important conclusion of this European study is that the integration of 300 GW of wind power, or even more, is achievable,” according to Frits Verheij. “This means that the system must become more flexible and that for instance greater capacity needs to be available for cross-border interconnections. Certainly where large quantities of offshore wind power are being produced, the transmission network on land must be reinforced, which to a large extent is necessary anyway. Another finding is that large-scale integration of wind energy leads to less extreme variations in the network, better predictability of production and a higher capacitance value of the installed capacity.” **<<**

More information:
consulting.emea@kema.com
T +31 26 356 20 25
www.kema.com/wind-energy