Case Study: Structural Health Monitoring
Offshore Wind Farm Arkona

Initial situation

Arkona is the most efficient wind farm to date in the Baltic Sea: off the coast of the island of Rügen, 60 wind turbines are located on an area of 39 square kilometers and have a total output of 385 megawatts. With this output, up to 400,000 households can be supplied with electricity. The offshore wind farm is a joint project of E.ON and the Norwegian energy company Equinor. The individual wind turbines are higher than the Cologne Cathedral and stand on steel foundations at water depths of up to 37 meters. Thus, they are exposed to environmental influences and dynamic stresses. In order to ensure safe wind farm operation and adequate load-bearing capacity, the German Federal Maritime and Hydrographic Agency (BSH) stipulates condition monitoring of foundation structures. An individual structural health monitoring concept developed by Wölfel is designed to ensure that the wind turbines feed into the grid as continuously and efficiently as possible, incur the lowest possible costs for operation and maintenance and meet the requirements of the authorities.

Approach

With our tried and tested SHM.Foundation® monitoring system, the structural behavior of wind turbines can be digitally recorded, tracked and evaluated. Due to the modular design of the system, an individual „Structural Intelligence Concept“ tailored to the project requirements could be developed for Arkona. The robust electronic components were installed by a team that is specially trained for offshore operations. In order to enable data exchange with the wind turbine control and SCADA systems, appropriate interfaces were additionally set up. Intelligent algorithms are used for signal analysis. Thus, the really relevant information can be extracted from the flood of recorded data. Not only structural-mechanical parameters as well as maximum and fatigue loads are taken into account, but also operating and environmental conditions such as wind and wave loads. This is the only way to evaluate the overall condition of the wind turbines. On this basis, diagnoses are then made and specific recommendations for action are derived for the project.

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With permanent monitoring, structural changes can be detected at an early stage. If defined threshold values are exceeded, the control center is alerted and can react immediately. The costs for repair measures are usually much lower at this early stage. Based on the collected data, a „service life file“ is created for each individual wind turbine. At the end of the design service life, a well-founded decision can be made about possible further operation on the basis of the actual lifetime consumption. The knowledge gained can even be used to identify and apply life cycle extending operating practices. The results of the analysis and all important indicators are available to the project team from E.ON and Equinor at any time in our Monitoring Intelligence Center MIC.Foundation. The person responsible can see at a glance whether limit values are being adhered to, whether and where a problem is occurring, what may be the cause and what measures need to be taken to solve the problem or prevent it from progressing. In addition, event-controlled notifications and automatic reporting are configured. For authorities, the documentation required to prove the load-bearing capacity is thus created.

**Result**

Wölfel is responsible for the entire structural health monitoring of the Arkona wind farm, from the design to the installation of the hardware up to signal analysis with intelligent algorithms and the formulation of specific recommendations for action. Thanks to the successfully implemented „Structural Intelligence System“, E.ON and Equinor have an overview of the current condition of the wind turbine at any time, can react at an early stage in the event of deviations and can optimize the operation. We are proud to be a part of this offshore wind farm project with our SHM.Foundation® monitoring system.

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