Siemens Wind Power A/S

Denmark

SIEMENS

Minimized risk through predictive maintenance

The challenge for offshore wind farm operation & maintenance: High productivity at low costs

Cost of energy is the key measure for a sustainable power generation industry. Consequently, the major value drivers for offshore wind are optimizing power production, operating costs and resource productivity.

Value drivers

1. Optimize power generation
2. Optimize operating costs
3. Optimize productivity of resources

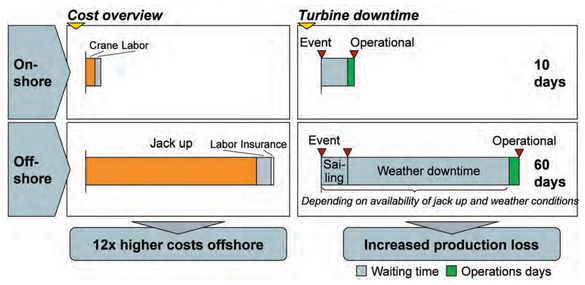
Main offshore challenges

1. Sea and wind conditions leading to weather downtime
2. Transport of personnel
3. Availability and cost of sea vessels

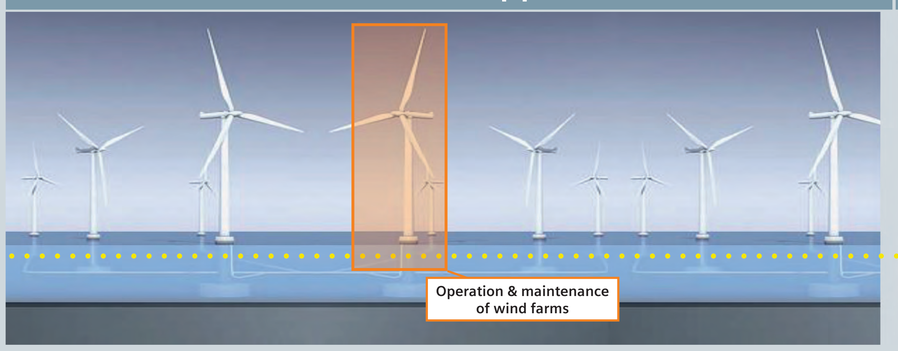
Key success criteria

- ☑ Turbine reliability
- ☑ Maintainability and maintenance strategy
- ☑ Accessibility and transportation strategy
- ☑ Local site operations and maintenance planning

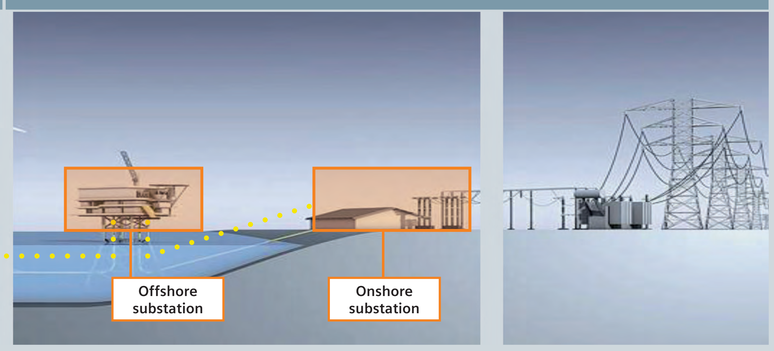
Example: Exchange of gearbox



Turbine supplier

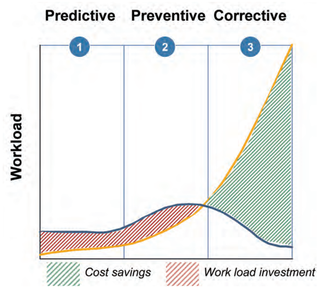


Transmission and Distribution



Tackling the challenge with a strong maintenance strategy and planning

Focus lies on reducing time spent offshore



1. Maintenance carried out following a forecast derived from analysis and evaluation of significant parameters of the degradation of the system or component.
2. Maintenance carried out at predetermined intervals or according to prescribed criteria, intended to reduce the probability of failure or the degradation of the system or component.
3. Maintenance carried out after fault recognition to bring the system or specific component into original operating condition.

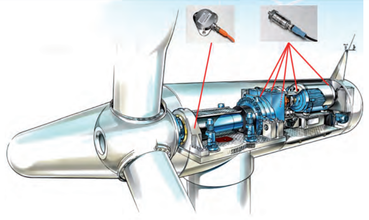
Predictive maintenance enables defect detection prior to turbine breakdown

Predictive maintenance relies on Turbine Condition Monitoring (TCM)

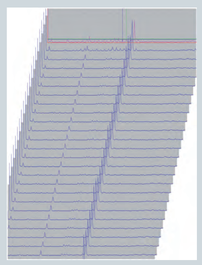
Turbine Condition Monitoring (TCM)

The TCM system continuously checks the external and internal state of the wind turbine to detect significant deviations from its normal operating condition.

The system conducts precise online vibration measurement on the gearbox, the generator and the main shaft bearings and provides a real-time condition status based on comparison between measured vibration data and reference masks.



Example: Hairline fracture in tooth.
If the tooth section breaks off it could damage other components, causing turbine stop and costly repairs.



- The figure shows a waterfall plot from a frequency monitoring system.
- The peek on the plot shows a frequency change deviating from the base line.
- The frequency of this development is loaded in to a database, and all turbines/customers globally, will benefit from the findings.
- When collecting all data possible, the manufactures can predict failures prior to a defect.

A diagnostic centre: Key to minimized risk and reduced cost of energy

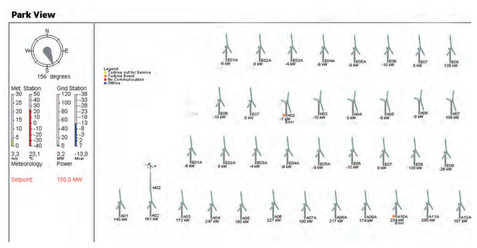
The Diagnostic Centre

The marked trend shows that the manufactures develop diagnostic centers to predict failures and increase reliability and customer value.
The diagnostic centre is based on a complex operational database system and uses model based monitoring, Turbine Condition Monitoring and Remote Data Analysis.

Data from the TCM system is analyzed in the diagnostic centre performing live frequency monitoring 24/7 all year round on all moveable parts of the turbine and wings.

Another monitoring system is the Supervisory Control And Data Acquisition system (SCADA), which provides customers with a detailed analysis of the output of their turbines.

Data is continuously collected from each turbine



Wind turbine data: Wind speed, active and reactive power, yaw angle, etc.
Electrical and mechanical data: 3 phases and current voltage, frequency, rotational speeds
(generator and rotor RPM), temperatures of gear oil, etc.
Statistical data: Total and subtotal turbine statistics such as availability, external error codes,
calendar hours, etc.
Meteorological data: Wind speed and direction, air pressure, temperature, etc.
Grid data: 3 phases and current voltage, active and reactive power, etc.

With a diagnostic centre performing live frequency monitoring 24/7 all year round, the historical data and learning increases every day. The Service provider is thus constantly getting closer to the target of a 'zero visit hit rate' outside of scheduled services, allowing for a significant reduction of operation costs and increased power generation.

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