Leveraging smart data for predictive maintenance in wind industry

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Head of asset management center China

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Agenda

• Big data to smart data
• Vestas way to smart data
• Smart data for predictive maintenance in Vestas
• Vestas turbine monitor — a predictive tool for maintenance
Big data to Smart data

Vestas today

Vestas facts

59000 wind turbines in 70 countries
**Big data to Smart data**

Modern wind power plants produce more data than ever.

<table>
<thead>
<tr>
<th>Wind Turbine</th>
<th>SCADA</th>
<th>Power Plant Controller</th>
<th>Substation Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind Turbine</td>
<td>Condition Monitor</td>
<td>Meteorological Mast</td>
<td></td>
</tr>
</tbody>
</table>

### Equipment:
- Vibration
- Temperatures
- Status signals

### Performance:
- Production
- Reactive power
- Availability
- Error logs

### Environmental:
- Wind speed
- Ambient temperatures
- Wind direction
- etc.
Big data to Smart data
Transfer big data to smart data

Big data ≠ smart data
+ Analytic

Leveraging smart data for predictive maintenance in wind industry
Big data to Smart data
From Big Data to Smart Data

<table>
<thead>
<tr>
<th>Big Data from wind farm</th>
<th>Optimal Product Development</th>
</tr>
</thead>
<tbody>
<tr>
<td>Machines &amp; Sensors</td>
<td>Optimal Siting &amp; Development</td>
</tr>
<tr>
<td>Meteorological</td>
<td>Optimal Maintenance</td>
</tr>
<tr>
<td>Spatial layout</td>
<td>Optimal Parts</td>
</tr>
<tr>
<td>Laboratory</td>
<td>Optimal Asset Management</td>
</tr>
<tr>
<td>Unstructured Logs Reports</td>
<td>Improve Business Performance</td>
</tr>
</tbody>
</table>

Vestas Data Centre

Analytical Platform

Internal

Analytical Apps

External

Optimal Siting & Development
Optimal Maintenance
Optimal Parts
Optimal Asset Management
Improve Business Performance
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Summary
Vestas way to smart data
Vestas Data history at a glance (1/2)

- Surveillance Centre in Balle in DK established
- V52 850kW
- V80 1.8MW
- V80 2MW
- V82 1.65MW
- V90 2MW

- First SCADA system developed by Vestas installed
- Global Vestas Performance & Diagnostics Center established

- Number of monitored turbines rose with more than 25% in 2007
- Lost Production factor reduced to 1.7% (from +6% in 2009)
- Failure predictions improved by more than 33%

- Vestas Data Center warehouse established
- Vestas Turbine Monitor is introduced
- World Class weather and power forecasting introduced
- Firestorm Supercomputer installed
- Vestas Online Dispatch introduced
- Upgraded Enterprise Data Architecture


1,500 1,000 500 0

Vestas Online

Leveraging smart data for predictive maintenance in wind industry
# Vestas way to smart data

## Vestas Data history at a glance (2/2)

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>CMS Vibration Monitoring Analysis taken in-house</td>
</tr>
<tr>
<td>2015</td>
<td>Vestas turbine Monitor is fully integrated with SAP Service order system for turbine technicians</td>
</tr>
<tr>
<td>2015</td>
<td>Asset Management Centre formed</td>
</tr>
<tr>
<td>2015</td>
<td>Mindstorm Supercomputer installed</td>
</tr>
<tr>
<td>2015</td>
<td>Vestas Data Science Community is founded</td>
</tr>
<tr>
<td>2015</td>
<td>3rd party integration - Gamesa</td>
</tr>
<tr>
<td>2016</td>
<td>3rd Party Integration - GE &amp; Suzlon</td>
</tr>
<tr>
<td>2016</td>
<td>Analytical Enablement What-if scenarios</td>
</tr>
<tr>
<td>2016</td>
<td>+500 Predictive Monitors now watching 60 GW</td>
</tr>
<tr>
<td>2016</td>
<td>Truly global setup, 4 remote operations centers, operational analytics and a global advanced analytics department</td>
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</table>

In past years:
- 1,600,000,000 Analytics Run
- 88,000 Service Notifications

+500 Predictive Monitors now watching 60 GW

Mindstorm Supercomputer installed

Vestas Data Science Community is founded

Truly global setup, 4 remote operations centers, operational analytics and a global advanced analytics department.

Vestas way to smart data
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Smart data for predictive maintenance in Vestas
From reactive to proactive

Prevention Through Prediction

Damage detected

Inspection

Order spare parts

Repair work

Production loss start No detection

Prevention Reoccurrence

Production loss start No detection

Reactive

Production loss start No detection
A combination of different methodologies

TECHNOLOGY

An effective combination of methodologies to detect abnormal behaviors and potential risks in the turbines

<table>
<thead>
<tr>
<th>Online data</th>
<th>Ad-hoc data</th>
<th>Fully integrated with business</th>
</tr>
</thead>
<tbody>
<tr>
<td>vibrations</td>
<td>endoscopies</td>
<td>ERP integration</td>
</tr>
<tr>
<td>scalar data</td>
<td>motor tester</td>
<td></td>
</tr>
<tr>
<td>oil analysis</td>
<td>Blade care</td>
<td></td>
</tr>
<tr>
<td>Any other data automatically collected</td>
<td>Any other data</td>
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TRADITIONAL APPROACH

- We used VOB to connect to a park
- We selected one turbine
- Checking temperatures, pressures, etc.
- In this case the pitch oil system temperature is 47°C
Concept of Vestas Turbine Monitor (VTM)

Readings

- **REACTIVE**
  - Alarm level
  - Turbine Stopped

- **PREDICTIVE**
  - Alert level
  - Notification
  - Service
Leveraging smart data for predictive maintenance in wind industry
A part of full business optimization

- **Vestas Turbine Monitoring Applications**
- **Vestas Global Applications**
- **Work Order (ERP)**

**Automatic Notification To Service Before Failure**

- Mitigation & work instructions
- Improve Mitigation Action, Monitor Accuracy

**Plan Service using Vestas weather Forecasting™ to Minimize Production Losses, Maximize Safety**
**Case: Controller temperature**

**Case History**
High controller temperature

**Possible Consequences**
Damaged component and turbine stopped

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**Reactive Maintenance**
Problem not detected until a major issue causes a stop and an expensive replacement: 1,000 € and a long stop

**Proactive Maintenance**
Service takes advantage of the next scheduled inspection, they identify the root cause, the replacement part costs 15 € and we optimize the maintenance!
Case : Bearing Temperature

**CASE HISTORY**
High bearing temperature

**POSSIBLE CONSEQUENCES**
Damaged Gen bearing and turbine stopped

**REACTIVE MAINTENANCE**
Problem not detected until a major issue causes a stop and an expensive replacement: 7,000 € and a 3 days minimum stop

**PROACTIVE MAINTENANCE**
Service takes in advantage the next scheduled inspection, they identify the root cause, the consumed material costs 100 € and we optimize the maintenance
Performance before and after VTM

2 first years using Turbine Monitor and consequences of terminating the VTM contact
Summary

• Big data needs to be transferred to smart data to bring value

• Vestas never stops the steps of improving the smart data capabilities

• The wind farm maintenance is transforming from reactive to proactive

• Predictive tool increases the turbine reliability
Thank you for your attention