Growing on Smart Data
Siemens Gamesa Renewable Energy Today

- **87 GW** Installed Global Capacity
- **25k** Employees
- **11 €B** Annual Revenue
- **11.5 GW** Order Entry
- **23.2 €B** Order Book
- True global, modern and scalable footprint
- Advanced digital capabilities
- Portfolio covering all requirements

1. End of June 2018 (Q3 FY18)
2. End of FY'17
Siemens Gamesa Renewable Energy Today
Three business units with strong market position

**Onshore**
- **74 GW** installed in 75 countries.
- **9.7 GW** promoted in 14 countries.
- The technology partner of choice for onshore wind power projects.

**Offshore**
- **11.4 GW** installed all over the world since 1991.
- The most experienced offshore wind company with the most reliable product portfolio in the market.

**Service**
- **55.4 GW** under service and maintenance.
- Helping customers achieve their business objectives by ensuring that turbines work at peak efficiency throughout their life cycle.
fGamesa WindOne® Project - 2011

Company Challenges
- Reduce costs
- Increase benefits
- Keep customers in focus
- Unique repository for all the company
- Extracting more value from existing assets
- Knowledge tools for managing underperformance

Project Challenges
- Huge amount of information
- Change the way maintenance was done
- Thousands of assets in remote locations
- Personnel in many different countries & cultures
fGamesa WindOne® Project

- Thousands of Wind Turbines in remote locations
- Billions of data generated

- Real Time
  - Monitor & Operate

- SGRE Providing O&M Services

- Analysis
  - Continuous improvement
Milestones

2012
- WINDONE® DEPLOYED
  Assets RT Monitoring Tool
- PI SYSTEM DEPLOYED
  Starts archiving data

2012
- NATIVE TOOLS
  Process Book & Datalink

2013
- WINDONE® REPORTS
  Ad-Hoc Application

2013
- AUTOMATED ANALYSIS
  Matlab, R & Python scripts
- WEATHER FORECASTING
  Site ad-hoc models

2014
- ROC CONTROL
  Alerts for Specific Conditions
- WINDONE® AVAILABILITY
  EBA calculation

2015
- AF ANALYSIS
  Complex Analysis in Real Time
- ALARMS TO WINDONE®
  Bidirectional integration

2015
- 2015
- Expand Use

2016
- ADDING CONTEXT
  Refining & clustering

2017
- 2017
- Real Time Analysis

2017
- MODELS GROWTH
  Today

2018
- Store & Report

Real Time Analysis

Milestones

Older DDBB

Real Time Analysis

Expand Use

06
Facts about our PI System

>900
Wind Farms connected to WindOne®

>19k
Wind Turbines Integrated

3.2 MM
Active Tags with Real Time Acquisition

90k
Running Analysis

400
Direct Users

>2000
Indirect Users

Data from wind turbines, wind farms, SCADAs, regulators, met masts & substations

6 Different applications using PI Data

* Figures as of September 2018.
General Architecture

- **Multi-OEM**
  - Gamesa
  - oOEM

- **Collector & Gateway**
  - Windone®

- **Central Systems**
  - Asset Framework Database
  - Time Series Database
  - Alarms Database

- **Enterprise Applications**
  - PI Analytics
  - Windone® Reports
  - Windone® Customers
  - Windone® Availability
  - ...

- **Users**
  - Remote Operation Center
  - Field Technicians
  - Support teams
  - General Users
Use Cases

Success Stories
Particular use cases
Several examples on how the PI System has helped the company

Same system, different solutions for different use cases:
- WindOne® Reports
- Remote operation center solutions
- Advanced analytics
WindOne® Reports Example

**Challenge**

- Predefined, easy-to-get and quick reports for all stake-holders within the company.
- Integrated with other company tools.

**Solution**

- Combine PI System data with other data sources to provide standard reports executed under the same assumptions.
- PI SDK, PI AF SDK.

**Details**

- > 30 reports and subreports.
- Assets health, behaviour and configuration, fleet analysis, wind farm reports.

**Outputs**

- Used by Support Teams, Field Technicians and many others.
- O&M personnel able to execute reports at “design engineers” level.
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Remote Operation Center Example

**Challenge**

- Grid Operator requirements.
- Operate & maintain Wind Farms, apply setpoints.
- Internal requirements.

**Solution**

- Wind Farms, Wind Turbines, Scadas & Regulators modelled in PI AF.
- Expression analysis & Event Frames used.

**Details**

- ROC operators get a notification either if there is near gets out of range (+security margin) or the quality indicator gets too low.

**Outputs**

- ROC operators check the situation at the Wind farm and then decide the best course of action.
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Regulator Power Factor Control

Notification is closed

Power Factor Error detected in Regulator XXXX RV1

Windfarm Name: Wind Farm YYYY
Client Name: Client AAA
Grid Node: Grid Node 1
SCADA: SCADA XXXX

Alarm Type: COSPHERRORALLZONES
Start Time: 15/07/2018 16:00:00
End Time: 15/07/2018 17:00:00

* Alarm Note:
-cosphierror:Power factor of measured cos phi differs more than X% with cos phi setpoint when active power is over 50% of nominal power.

https://cosphierroralert.org/alarms?

Target Cos Phi: 0.966
Measured Cos Phi: 0.985

Cos Phi Error: 1 %
Active Power: 1024.883 kW
Reactive Power: -1780.579 kVar
Voltage: 20.855 V
Regulator Status: 100
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Regulator Power Factor Control

**Reactive Regulator State**

- Coa PHI read by regulator at SET or at n 0.05 TEB
- Cos PHI target endpoint of reactive regulator
- Regulation objective 0.055 TEB

**Regulation Quality**

- 57.143 %

**ROC Z1 MIN ACTIVE PWR**

- 6.300 kW

**ROC Z2 MIN ACTIVE PWR**

- 3.100 kW

**Active power read by regulator at SET**

- 74.967 TEB

**Voltage read by regulator at SET or at f**

- 30.4 TEB

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Advanced Analytics Example

**Challenge**
- Assets health & performance monitoring.
- Detect / Predict hidden faults.
- Improve maintenance.
- Avoid major incidents.

**Solution**
- Expression analysis & event frames analyzing RT WTG signals.
- Raising alarms if conditions trigger model thresholds.

**Details**
- Definition & Parametrization.
- Check asset condition vs model.
- Alarm included in Alarms DDBB

**Outputs**
- O&M People & site supervisors to carry out tasks depending on alarm code.
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Wind Farm’s 3σ quality check

<table>
<thead>
<tr>
<th>Event Code</th>
<th>Description</th>
<th>Status</th>
<th>Windfarm</th>
<th>Device Code</th>
<th>Date On</th>
<th>Date Off</th>
</tr>
</thead>
<tbody>
<tr>
<td>83035</td>
<td>GAAS - Gearbox oil temp: high difference with Wind Farm avg.</td>
<td></td>
<td>WF012</td>
<td>WTG P</td>
<td>20-08-</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2018</td>
<td>01:00:00</td>
</tr>
</tbody>
</table>

List of Variables

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>83033</td>
<td>GAAS - Generator slippings temp: high difference with Wind Farm avg.</td>
</tr>
<tr>
<td>83035</td>
<td>GAAS - Gearbox oil temp: high difference with Wind Farm avg.</td>
</tr>
<tr>
<td>83036</td>
<td>GAAS - Generator NDE bearing temp: high difference with Wind Farm avg.</td>
</tr>
<tr>
<td>83037</td>
<td>GAAS - Generator DE bearing temp: high difference with Wind Farm avg.</td>
</tr>
</tbody>
</table>

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## Particular use cases
Several examples on how the PI System has helped the company

<table>
<thead>
<tr>
<th>Challenge</th>
<th>Solution</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improve O&amp;M services</td>
<td>Use PI System capabilities jointly with other enterprise systems.</td>
<td>What benefits were achieved/measured?</td>
</tr>
<tr>
<td></td>
<td>• WindOne Reports: web application.</td>
<td>• Anticipation to problems.</td>
</tr>
<tr>
<td></td>
<td>• PI EF + Notifications + Coresight for Remote Operation Center</td>
<td>• Standard reporting.</td>
</tr>
<tr>
<td></td>
<td>• PI Analysis + Alarm generation + Enterprise Systems</td>
<td>• Effective operation &amp; maintenance of a huge fleet of WTGs.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Reduce cost of O&amp;M.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Increased performance of support teams, better time-to-solution ratio.</td>
</tr>
</tbody>
</table>

- • WindOne Reports: web application.
- • PI EF + Notifications + Coresight for Remote Operation Center
- • PI Analysis + Alarm generation + Enterprise Systems
The Future

- **CONTROL YOUR COST**
  - Business Knowledge
  - Digitalization
  - Protection

- **MITIGATE YOUR RISKS**
  - Maintenance
  - Multibrand
  - Upgrades

- **MAXIMIZE YOUR REVENUE**
  - New Reports
  - Assets No. Growth
  - oOEM

- **BI Tools**
- **Smart Fleet®**
- **Cyber-security**
- **PI System**

The Future

MITIGATE YOUR RISKS
We are

Cortaire, Juan Miguel
Chief Engineer
Siemens Gamesa Renewable Energy
Juan.Cortaire@siemensgamesa.com

Suescun, Edurne
Service Product Manager
Siemens Gamesa Renewable Energy
Maria.Suescun@siemensgamesa.com
Questions?

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