RWE

Internet of Wind 4.0

NextGen SCADA

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Team Lead Application Development

RWE Renewables International GmbH

Agenda

1 The new RWE
Who we are, what we do in the renewables world

2 How a flexible infrastructure is helping us to operate a global renewable portfolio
Potential of digitalization in the wind industry
Global data backbone

3 More sensors = more data = higher performance ?
From data to actions

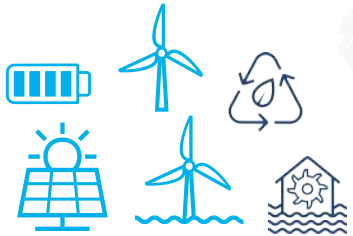
4 IoT and retrofitting –some real use cases
Ice detection
Foundation monitoring

The new RWE

Internet of Wind 4.0, RWE Renewables, Gregor Biering

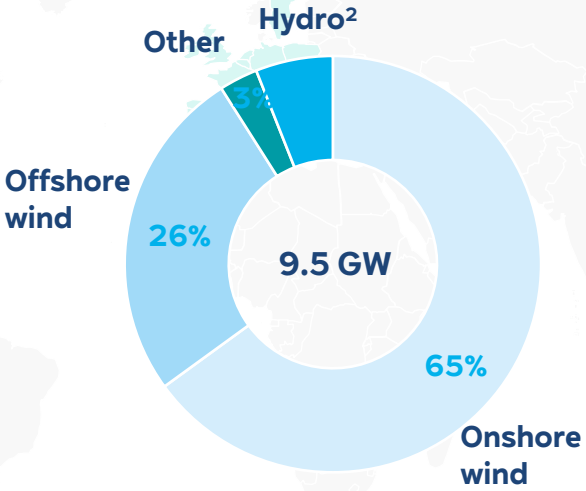
A global player with a well diversified renewables portfolio

Continents...

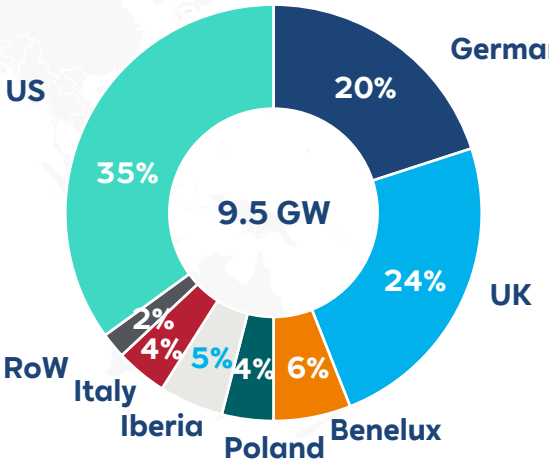


...broad technology mix

Renewables capacity by technology[1]



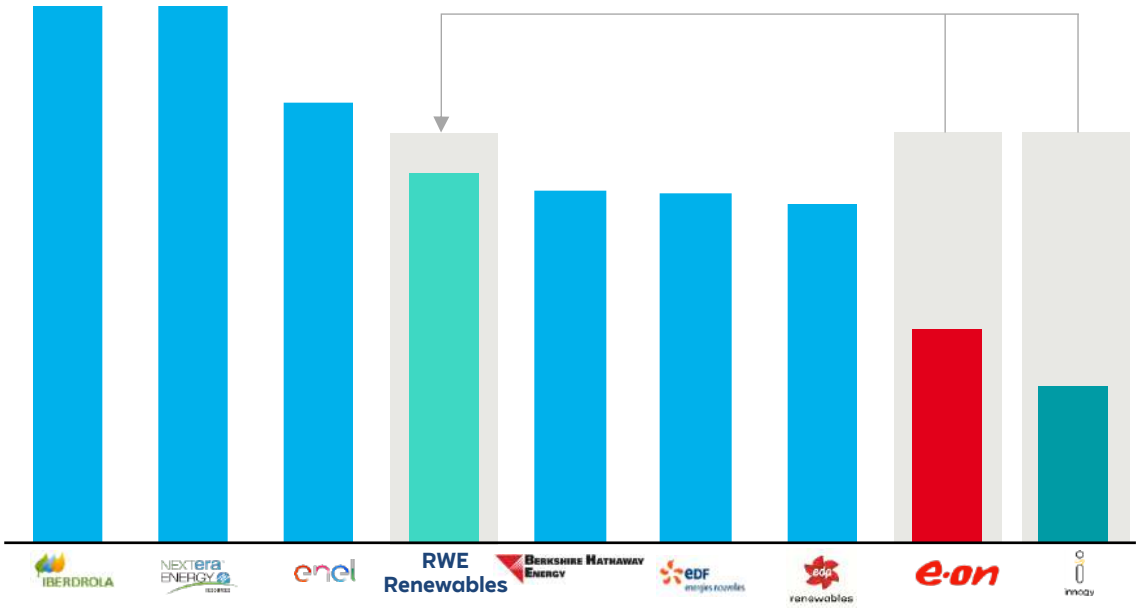
Renewables capacity by country[1]



[1] Pro forma combined renewables capacity; E.ON and innogy portfolio as of 31 August 2019; RWE portfolio as of 1 January 2019. Pro rata view. | [2] Hydro and biomass assets to be transferred to European Power segment.

RWE Renewables well positioned from the start

Globally owned renewables capacity[1]



No. 4 worldwide

No. 3 in Europe

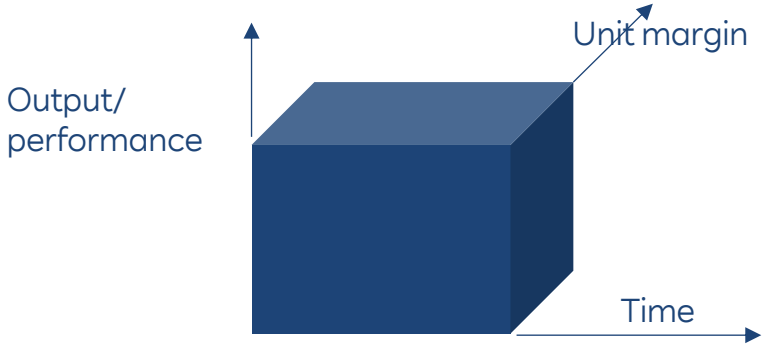
No. 2 in offshore wind

[1] Excluding Chinese players. Includes onshore wind, offshore wind, solar, small hydro, marine, geothermal and biomass. | Source: BNEF, as of 31 Aug 2019.





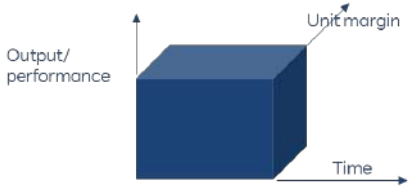

Three women, three men, different nationalities - one board



We are “operating in a box” – bound in three dimensions:

Unit margin (Price – cost)/ unit
Time to produce
Output performance

Business performance
Optimization



Increase Output / performance

Identify underperforming assets

Optimize turbine performance

Reduce losses inside the wind farm

Optimize control algorithm

Increase the time we can operate

Increase energetic availability

Increase lifetime of windfarm

Decrease maintenance times

Avoid unplanned outages

Reduce return to service times

Dynamic maintenance schemes

Optimize costs and revenues

Reduce O&M costs

Reactive to predictive maintenance

Optimize revenues

Insource margins – self-perform as economic

Risk & opportunity management

Utilizing the central data pools in different Apps is creating benefits for the business

Self service reporting portal as a key interface to data and pre defined reports.

How a flexible infrastructure is helping us to operate a global renewable portfolio

Potential of Digitalization

Manufacturing

Documentation
CAD / CAF
3D printing
Simulations

Project origination / development

Project portfolio management
Business case tracker
Modelling

Wind farm planning

3D/ 4D Simulations
Array layout design
Project optimization
Tendering / E-Auction

Construction

Logistic tracking
Training, simulations
Digital twins,
Quality management

Operations

RT / CMS monitoring
Advanced Analytics
Machine learning
Augmented Reality
Spare part management

Field force management
Forecasting
Smart repairs
System integrations and connected services
Mobility

Decomisioning

Project management
Logistic tracking
Waste management
Documentation

Big unknown

New business models
New revenue streams

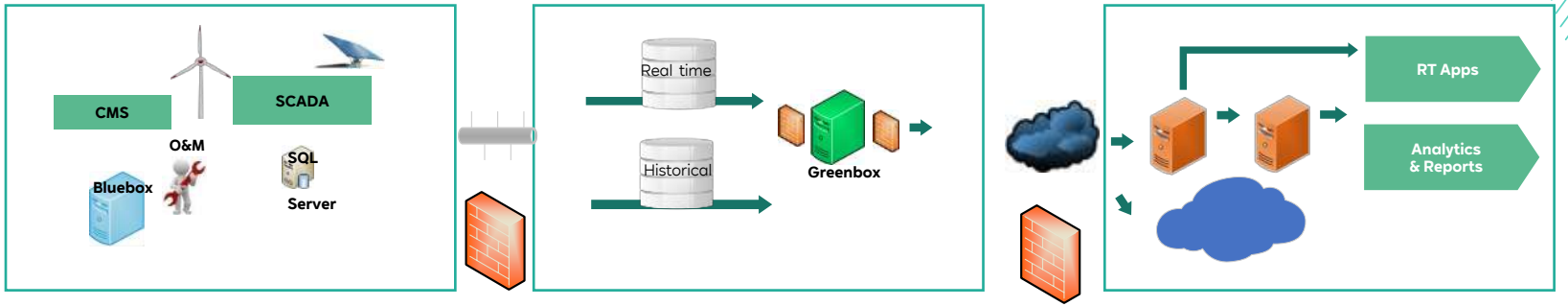
Internet of Wind 4.0, RWE Renewables, Gregor Biering

How to connect to the assets and manage the data?

Infrastructure at the Wind- and PV farm

Connecting Infrastructure at the assets

Central Infrastructure and applications



Majority of components are not standardized but related to a dedicated supplier or technology

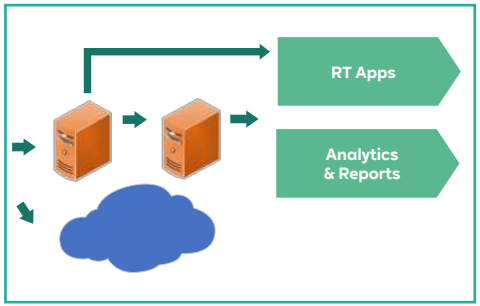
Bridging layer to transport and standardize towards a central infrastructure

Processing layer

Strong separation between the different layers

Where to store and process the data?

Central Infrastructure and applications



Processing layer

On premise

Pros	Predictable hardware costs Full control on security, data, updates and version Greater ability to customize
Con	Not flexible on short term and peak resource demands (slow deployment on hardware) Ongoing maintenance efforts

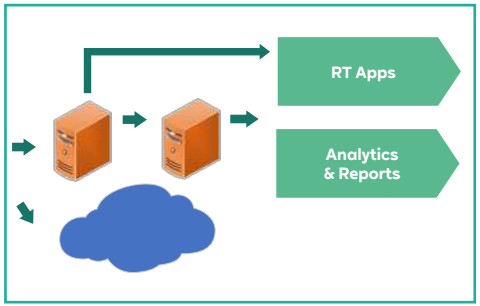
vs

Cloud

Pros	Flexible on short term and peak resource demands (faster deployment on „hardware“) Just cost effective if deployed cloud native
Con	Subscription / license cost increased by business growth Training required Less control on security, data, updates and version

How to enable cloud / on premise best-of-breed?

Central Infrastructure and applications



Processing layer

On premise

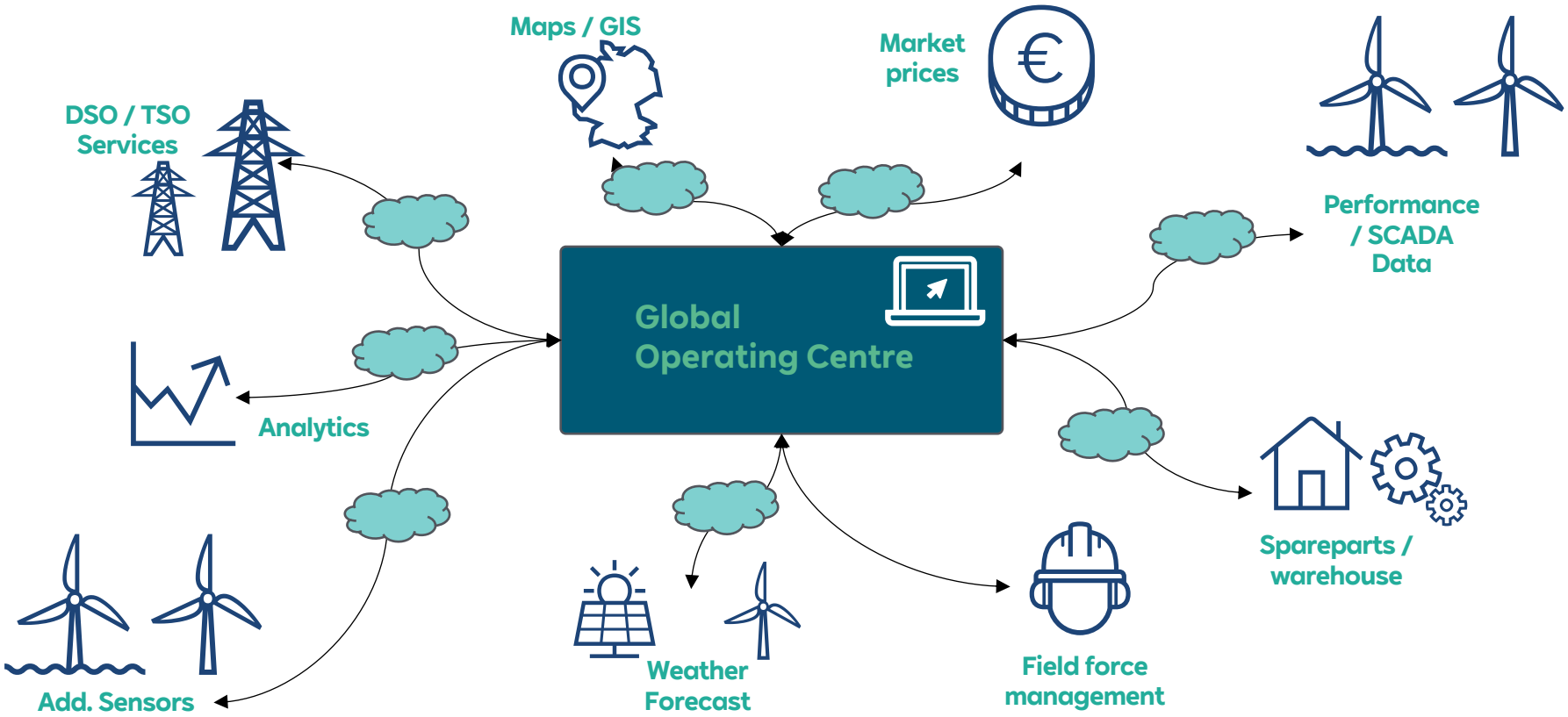
- RT / CMS monitoring with predicable growth
- Proprietary system without cloud native options
- Simulations
- Gateway / management layer

vs

Cloud

- Advanced Analytics
- Machine learning
- Process automation related to reporting
- Datalake

Harmonized global concept – To serve different demands



Harmonized global concept – Based on a hybrid infrastructure

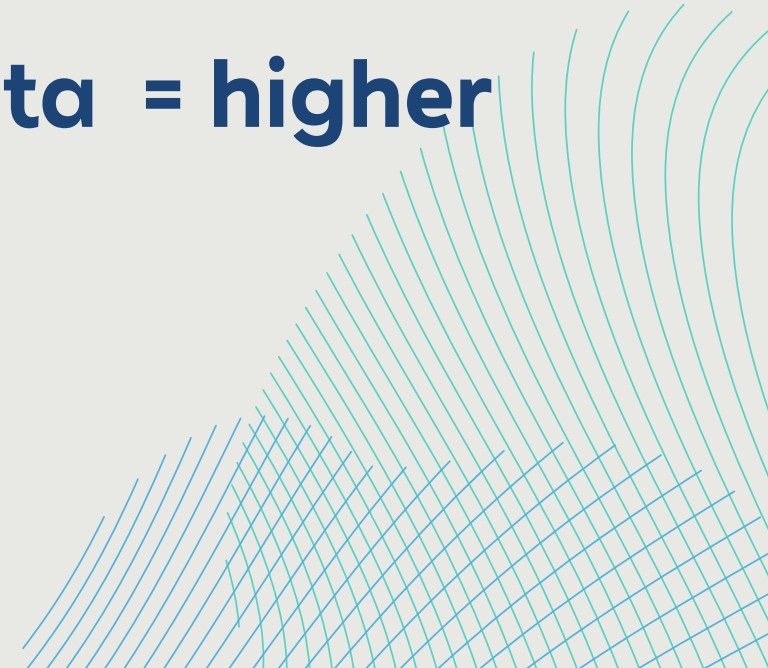
Local devices are require to gather data. Amount of devices increases

New solutions are developed cloud native if possible. Existing solutions are migrated.

Cloud enables more flexibility in regards to analytics and process automation

Solutiondeployment has changed over time

More sensors = more data = higher performance ?



From data to action – ensuring an efficient alarm classification approach

Triggers

Ensure All major OEM technologies are covered

Check all alarm codes

Standardisation

Event-based downtime detection of all events based on SCADA alarms/events

Relevant technical standards taken into account (IEC 61400-26-1 and RDS-PP)

Classification

High degree of automation

Except for ambiguous SCADA events
What actions to take for which Alarms

Notification

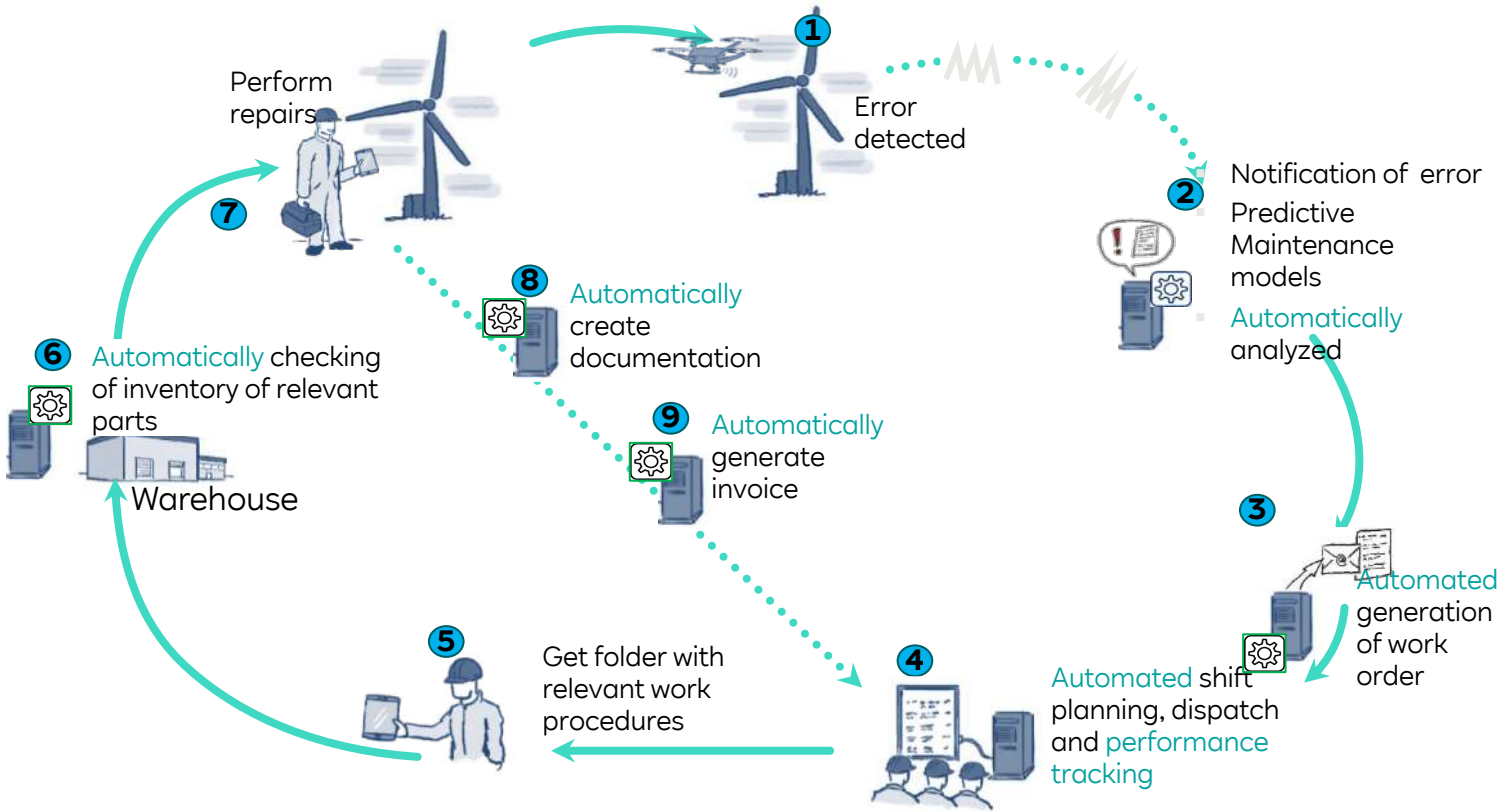
Predictive maintenance
Downtime notifications
Reoccurring events
Daily summaries
Dashboards
Performance
Warnings
Alerts

Action

Acknowledge
Remote reset
Onsite maintenance
Onsite Assistance

Global Operating Centre

Connecting tools and data to automate processes in one integrated platform



Systematic data analysis – increase efficiency and reduce costs with PredATur® (Predictive Analytics of Turbines)

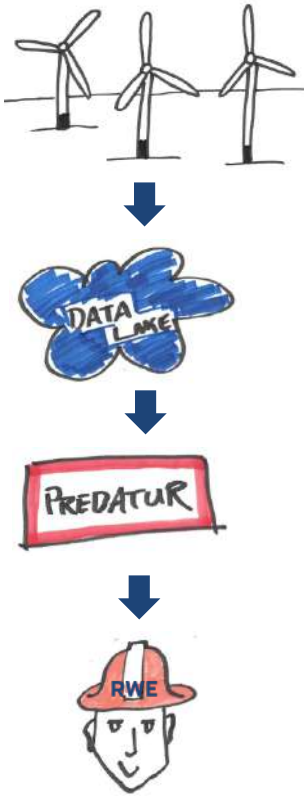
With common installed hardware significant amounts of 10min SCADA data are collected that can be used for predictive maintenance (PM)

SCADA data usually include mechanical, electrical and hydraulic data plus event codes

RWE Renewables developed the PredATur® tool to:

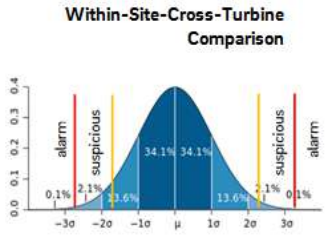
- Utilize machine learning methods to identify turbines with deviating signals
- Provide a user interface for analysts and technicians to check the turbines signals and alerts
- Automatically categorize downtimes and provide a user friendly way to re-categorize
- Connect SAP to link maintenance with downtime information and PM detections
- Analyze vibration measurements, if available

Motivation



Detect issues with different methods - Identify critical turbine signals before a serious defect occurs

A “within-site cross-turbine comparison” is used as first step and backup solution for PredATur®

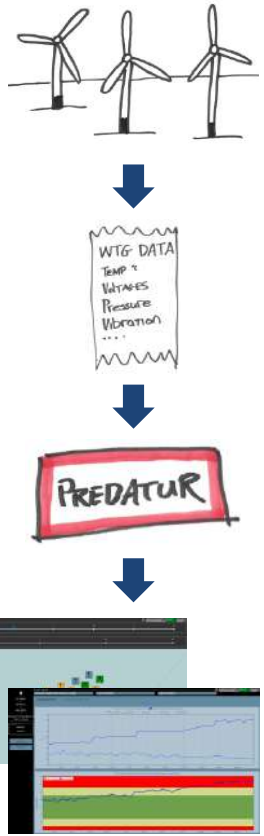


The site averages (or the averages for neighbouring turbines) are calculated
The averages are compared to the measured values
Different methods for comparison are available

The backbone of PredATur® is a machine learning approach

Machine learning algorithm is used to analyze the correlations between the different signals within a turbine and with surrounding turbines

Approach



Connect systems and improve turbine knowledge

SAP Connection

Work-orders can be connected to PredATur® detections

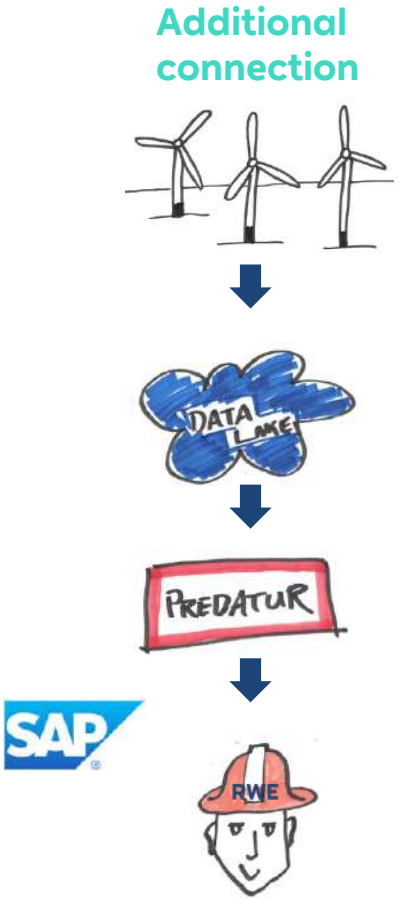
If a similar detection occurs old work-orders and functional locations can be referenced to help with the resolution of the issue

Notifications can be triggered from PredATur® to streamline the process

Downtime categorization

High quality downtime categorization is the basis to identify availability drivers

PredATur® automatically identifies and categorizes downtimes based on SCADA and SAP



PredATur® detections reduced operating costs and production losses

Several over-temperatures related to coolers that needed cleaning

Clogged filters

Generator over-temperatures

Failing sensors of different kinds

Voltage imbalances

Nacelle direction miscalibrations

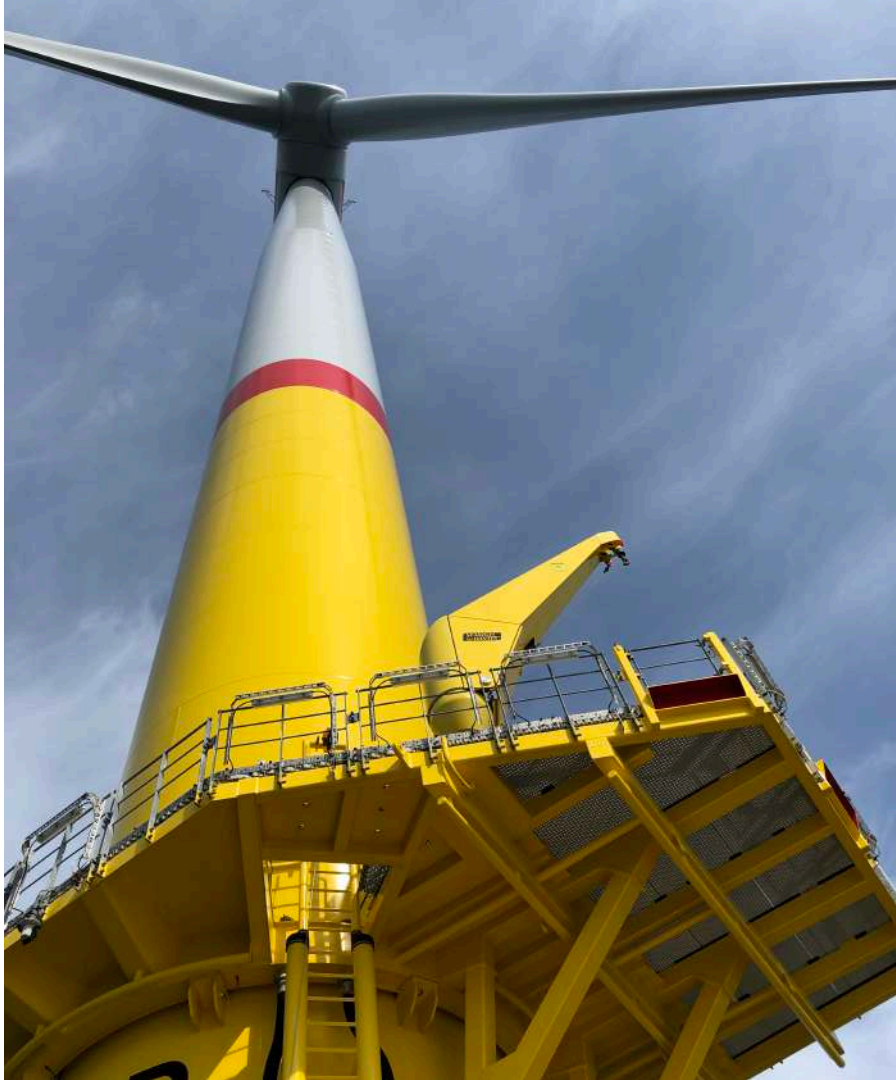
Pitch miscalibrations

(Generator-/ Gear-/ Main-) bearing over-temperatures

Brake pressure deviations

Cooling water pressure and level deviations

Converter over-temperatures and malfunctions



IoT and retrofitting –some real use cases

Applying additional sensors to improve asset performance and asset integrity

„With our retro fit solutions for

- Condition Monitoring,
- Ice detection,
- Foundation monitoring

we have improved the performance of our windfarm drastically.

Tower and foundation monitoring provide the data basis for any life time extensions of existing windfarms.“

´Danielle Jarski: Director Asset & Innovation Management , RWE Renewables


Icing

Our Windfarm Bowbeat

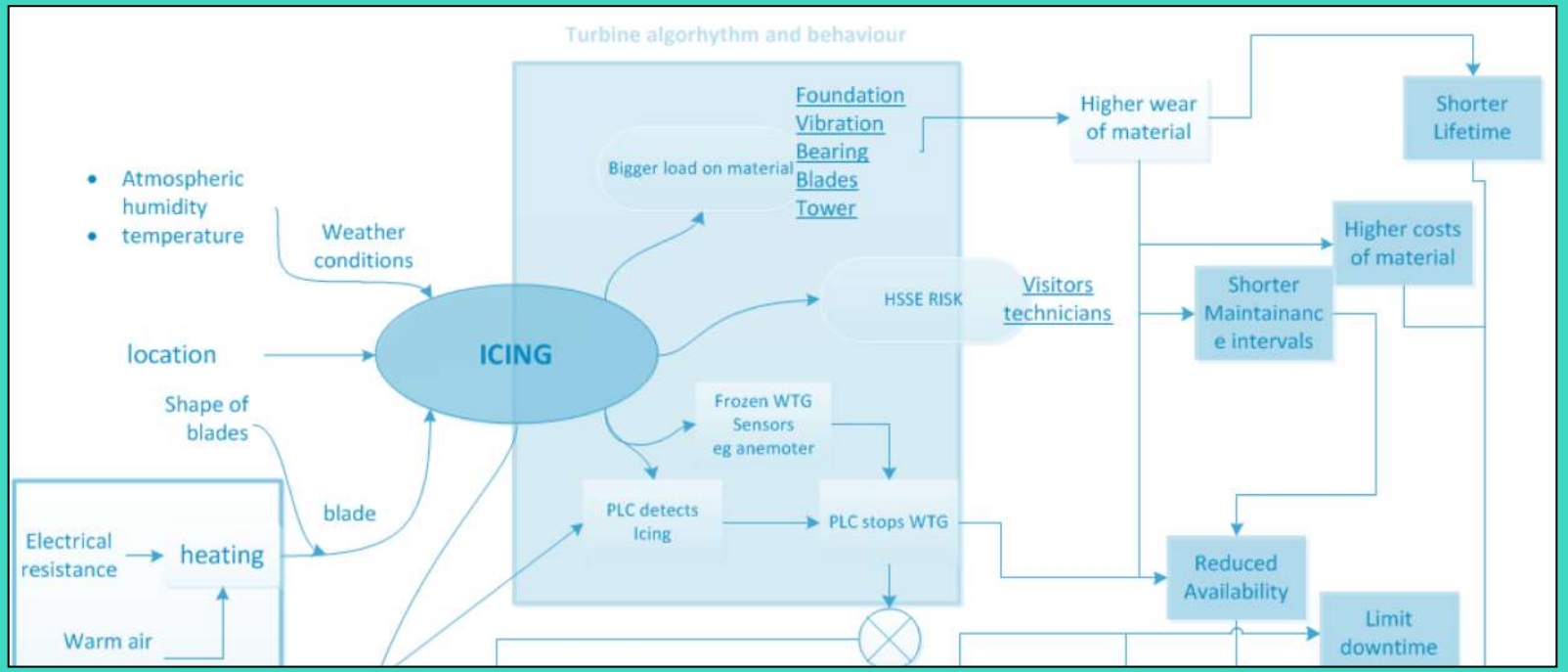
Challenge:

Ice detection and how to react

Impact:

HSE - health and safety of people

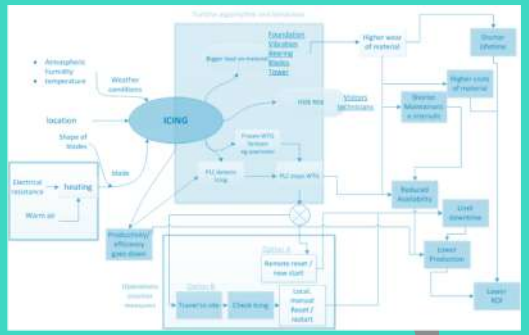
Production - how to minimize production losses



We need to understand how the „System Windturbine“ interacts with Icing

Apply and test sensors

Re evaluate the model



Decision based on business case

Test the technic, revaluate the model and decide on business case / investment

Tower and foundation monitoring create the basis for lifetime extension

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Foundation Prognosis & Diagnosis

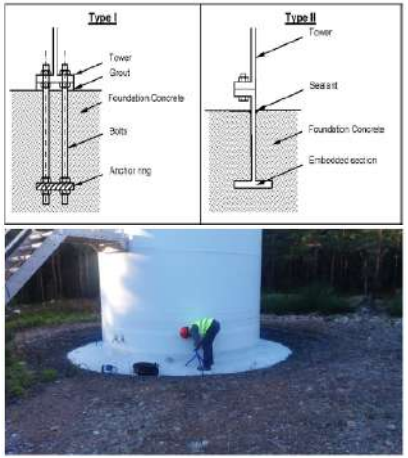
The project started in 2015 from systematic findings on tower foundation interface on WTG in our fleet spread around the world.

The aim of the project was to define a standard approach to support site in operation experiencing such problems.

The outcome of the project was the definition of different level of mitigation and repairing procedures for damaged tower foundation interfaces.

A standard approach

Best practice for onshore Foundation monitoring



Measurement work instruction

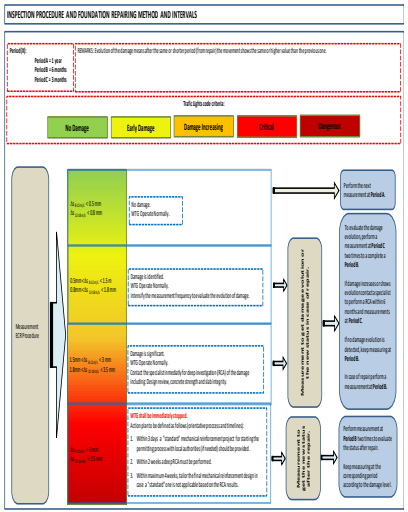

e. Do adjust the small holding piece at the end of the stand to align the sensor, meaning alignment vertical and horizontal. (The head end of the stand will allow to a fine adjustment of the sensor by using the water level). It is possible to easy adjust in all directions and lock it on the final position.

f. Install the sensor and adjust it in a way the pin is able to follow upwards and downwards movements, as half of the way. So after reset the sensor, it will be able to register positive and negative values. When the sensor is in its final position, it must be tightened so it is fixed.

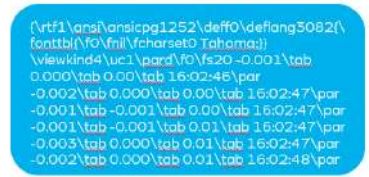
! Adjust the sensor and fix it

Remark: Adjustment of the sensor pin to allow it dials up and down registers. It means to place the sensor with the pin pulled up by the reference plate, installed on the tower, so the scale is half positive and half negative.

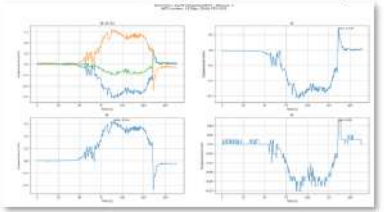
Measurement results, damage classification & mitigation measure



Measurement limitations



Measurement output format sample



Post processing sample

Measurement process improvement

In the long term these improvements may lead to define a kind of “foundation passport” that will support the full lifecycle of the component.

Did I cover everything – let's recap

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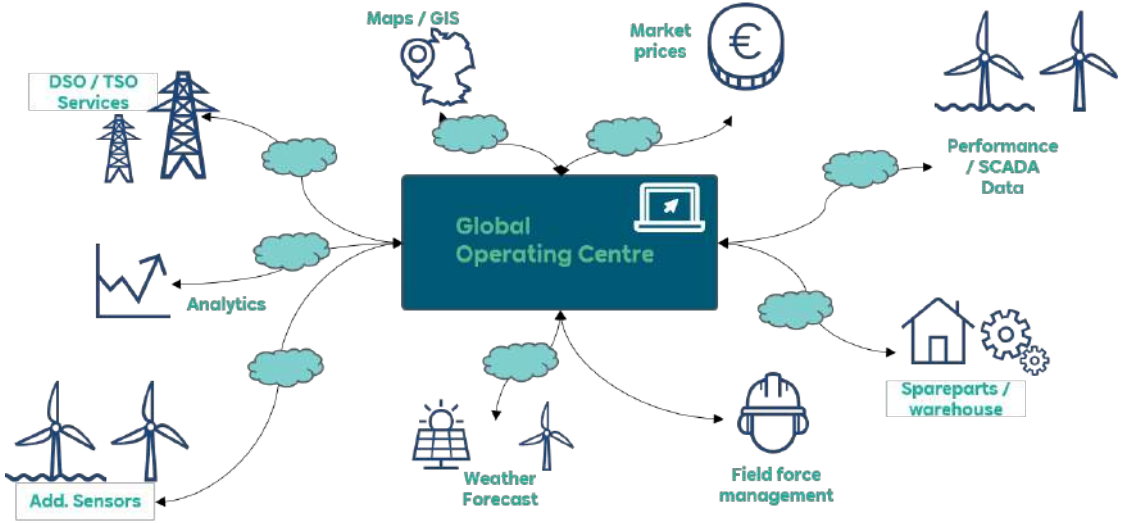

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All figures regarding the renewables business are based on pro forma combined innogy and E.ON publicly available data.

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Thank you