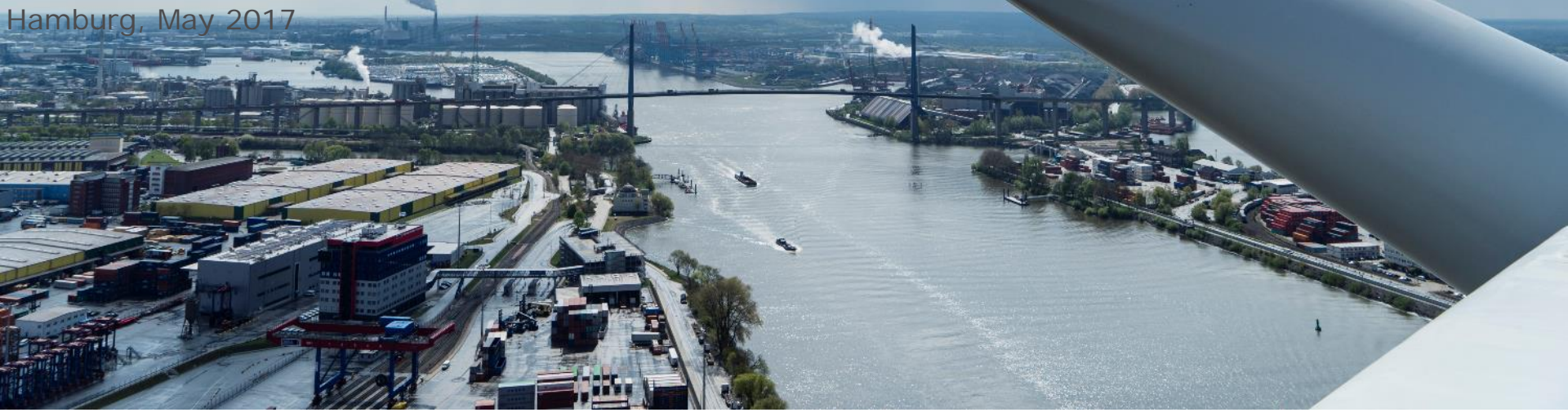


# Product services and IoT supporting Levelized Cost Of Energy (or how to stay competitive...)

Service & Logistics Summit 2017  
ISLA's 9th conference Aftersales Service and Spare Parts Logistics  
Hamburg, May 2017



## Defining the playing field

### “Customer Service vs. Service as a product”

- Customer service is focusing on the customer interaction before, during and after the sales of the main product “wind turbine generator -WTG” of Nordex – Acciona Wind Power (NX-AWP).
- Our product “WTG Service” support the proper (future) functioning of the wind turbine to ensure it will meet technical specifications & requirements and performance expectations. NX-AWP offers customized service products ranging from mechanical warranty to all inclusive contracts;
  - Consumables, Spare Parts, Main Components
  - Availability guarantees (time / production) and compensation for loss of production
  - Customized reporting, remote monitoring & troubleshooting, repair on defect
  - FOC –upgrades ensuring compliancy with latest safety and technology standards
  - Business case support and commercial upgrades to improve Annual Energy Production or reduce OPEX

Customers take it for granted having access to (real –time) remote monitoring. Ad-hoc status reports are expected to be standard. Both real –time information and reporting contribute significantly to a positive customer experience.

# I am a customer: my Personal Power Plant...

Home
My Site
Public Sites
Account

✔ **Elden Power Plant** 
[Overview](#)
[Real Time](#)
[History](#)
[Alert](#)
[Report](#)
[Settings](#)

☁️ 05/16 Light rain shower 16-26°C | ☀️ 05/17 Sunny 17-26°C | ☁️ 05/18 Light rain 12-17°C ⚠️ Alerts : 126 items

**Site Image**



**Trees Planted**  
41.22 trees

**Carbon Offset**  
15.04 ton

**Income**  
€2.26K

Power Now	Today's Energy	Monthly Energy	Yearly Energy	Total Energy
0.39 kW	0.24 kWh	429482.07 MWh	1717.93 GWh	1717.93 GWh

**Location**



**Site Profile**

System Size: 4.00 kW

Installer: ATAMA

Peak Power: 4.03 kW

Efficiency: 2550777.86 kWh/kW/day

Commission Date: 2013-08-12

Last Update Time: 2017-05-16 08:15:44,GMT +1

**Power** | Energy

Elden Power Plant



From  Day Week charts.com

# Current level of digitalization in wind turbine service

## “More or less meeting Customer expectations”

Past; Service is perceived as a cost; scheduled maintenance with pre -defined intervals; trouble shooting 'on defect' and inventory management based on historical consumption;

Present; change towards prevention through prediction / condition based maintenance; Service has become a product and regarded as adding value;

- Collecting data via eg. condition monitoring systems (CMS) and apply statistical / mathematical models to define condition based maintenance intervals, determine failure rates and trying to forecast the 'just in time - exchange of components' before break down.
- Direct impact on spare parts management due to more accurate forecast thus avoiding unexpected failures.
  - Specifically of interest when products represent high value (assets) or potential high costs related to downtime (typically within a B2B –environment) and Production or Revenue Based Production (predicting cash flow)
- Apply existing IT and communication technologies to increase efficiency regarding the physical deployment of a service technician / service engineer
- Last but not least; share real time status information & reporting via a Customer portal

So where is the game changer? Because so far we have 'just' automated data collection and become a little bit faster / more efficient in identifying (future) issues and executing work?

## Time = Money = Cost Of Energy (COE); where it starts

### “Shift focus from parts & revenue to costs”

Classic availability of wind turbines is time based; it should be available for production. For a WTG this would mean 365 days minus 6 days of maintenance = 359 days. One would measure the % of time actually available.

Many of our customers have understood it is even more important to have the WTG available for production when there actually is wind, i.e. when power can be produced. Theoretically this would mean the WTG can be 'not available' for 40 days per year without any negative impact on production. One would measure the Loss of Production compared to the theoretical production that could have been produced.

Customers are now looking at revenue –based availability; When energy prices are too low compared to operating costs, remote technology could support curtailment of WTG's or even stop them completely. Typically this would happen during high winds where supply is high and prices are low. By less loads on the equipment, OPEX might reduce and e.g. life time extension will be possible.

So far, it is focus on revenue. The other challenge is to manage costs that have not occurred yet and to include them in the present business case of customers. Meaning to reduce Cost of Energy not by increase of Annual Energy Production (AEP) but reducing costs (CAPEX / OPEX)

## Cost of Energy

“Taking care of products sold, but actually before they are sold...”

$$\text{COE} = \left( \text{CAPEX} + \text{OPEX}_{\text{lifetime}} \right) / \text{AEP}_{\text{lifetime}}$$

- Market price developments within renewable energy sector (especially solar) is forcing the wind energy industry to take future CAPEX & OPEX reduction as well as AEP over the lifetime of the WTG into consideration when handing in bids ‘today’ for future projects
- → Cost of Energy mindset (increase output, reduce CAPEX / OPEX) to support forward selling, meaning define CAPEX up to 2 years ahead and OPEX life time!
- Future technology (eg. IoT, artificial intelligence...) will have to be embedded in our (future) product design to reduce future expected costs. Changes and new technologies come fast and therefore customers expectations are regularly exceeding the speed of design, realization and implementation.

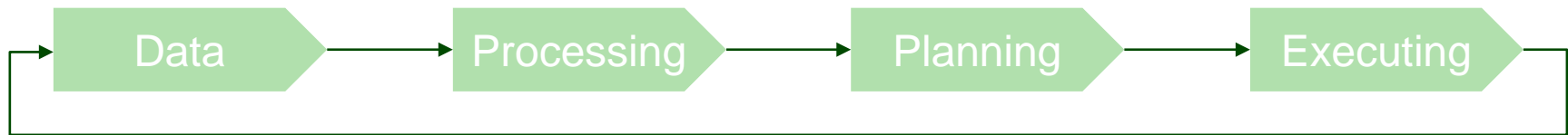
So where does this leave us in terms of improving our product ‘WTG service’ by adding “IoT”?

# SITE: Service IT Environment at Nordex – Acciona Windpower

## The next step(s)

### “The Internet of Things...?”

The **Internet of Things (IoT)** has been defined by the ITU (United Nations specialized agency for information and communication technologies) as “a global infrastructure for the information society, enabling advanced services by interconnecting (physical and virtual) things based on existing and evolving interoperable information and communication technologies.”



- NX-AWP Wind turbines are connected to the internet and creating huge amounts of data: energy production, condition monitoring of components, exterior parameters (temperature, wind), etc. etc.
- Human resources are processing this data (remote monitoring, technical support center, data analytics team) and eventually make decisions based on the outcome of processing data
- Actions are initiated; service orders planned, materials ordered and teams scheduled
- Service activities are executed and everything is being logged in the same 'environment' which we could define as being the NX-AWP IoT



## > The next step(s)

### “IoT: the first step to get to Industry 4.0!?”

---

Wikipedia:

The term "Industrie 4.0" originates from a project in the high-tech strategy of the German government. The Working Group on Industry 4.0 presented a set of Industry 4.0 implementation recommendations;

- **Interoperability:** The ability of machines, devices, sensors, and people to connect and communicate with each other via the Internet of Things (IoT) or the Internet of People (IoP)
- **Information transparency:** The ability of information systems to create a virtual copy of the physical world by enriching digital plant models with sensor data (CMS) (=simulation models, analytics, forecasting)
- **Technical assistance:**
  - First, the ability of assistance systems to support humans by aggregating and visualizing information comprehensibly for making informed decisions and solving urgent problems on short notice
  - Second, the ability of cyber physical systems to physically support humans by conducting a range of tasks that are unpleasant, too exhausting, or unsafe for their human co-workers (= robotics)
- **Decentralized decisions:** The ability of cyber physical systems to make decisions on their own and to perform their tasks as autonomously as possible. (=Artificial Intelligence)

# Case study towards Industry 4.0 at NX-AWP

## “Cost of Energy at NX-AWP”

---

- Connect SCADA & CMS systems and expand with advanced data analytics
  - Combine Big Data and pattern recognition with our Risk Priority Number ( $6\sigma$ ) across entire fleet under service
  - Add machine learning to remote monitoring and create algorithms to support decentralized decisions
  - Enable remote monitoring of machines by machines and allow automated intervention

and:

- Link Remote Monitoring as well as Field Service Reporting tool to Back –end ERP
  - Combine Big Data and pattern recognition with our Risk Priority Number ( $6\sigma$ ) across entire fleet under service
  - Auto –creation of Service Orders including material and tools based on suggested solution
  - Scheduling of resources based on templates but still requiring

**First steps towards Industry 4.0 at Nordex – AWP; simplified case study**

# Example applying Market Basket Analysis

The screenshot shows the Amazon product page for a Seagate Backup Plus 4TB Portable External Hard Drive. The page includes the Amazon logo, navigation menus, and product details. A blue box highlights the 'Frequently bought together' section, which shows the hard drive and a Lacdo EVA Shockproof Carrying Travel Case for 2.5-Inch Portable External Hard Drive, GPS Camera and... for a total price of \$126.99. An arrow points from this section to a text box on the right.

**Frequently bought together**

Total price: \$126.99

[Add both to Cart](#)

[Add both to List](#)

These items are shipped from and sold by different sellers. Show details

- This Item: Seagate Backup Plus 4TB Portable External Hard Drive USB 3.0, Black (STDR4000100) \$119.00
- Lacdo EVA Shockproof Carrying Travel Case for 2.5-Inch Portable External Hard Drive, GPS Camera and... \$7.99

Amazon recommends you to buy complementary products by analyzing purchasing behavior of past customers.

## Shopping baskets

- Basket 1: Beer, Diapers, Pretzels, Chips, Aspirin
- Basket 2: Diapers, Beer, Chips, Lotion, Juice, Baby food, Milk
- Basket 3: Soda, Chips, Milk
- Basket 4: Soup, Beer, Diaper, Milk, Ice Cream
- Basket 5: Sofa, Coffee, Milk, Break
- Basket 6: Beer, Chips

Set of transactions

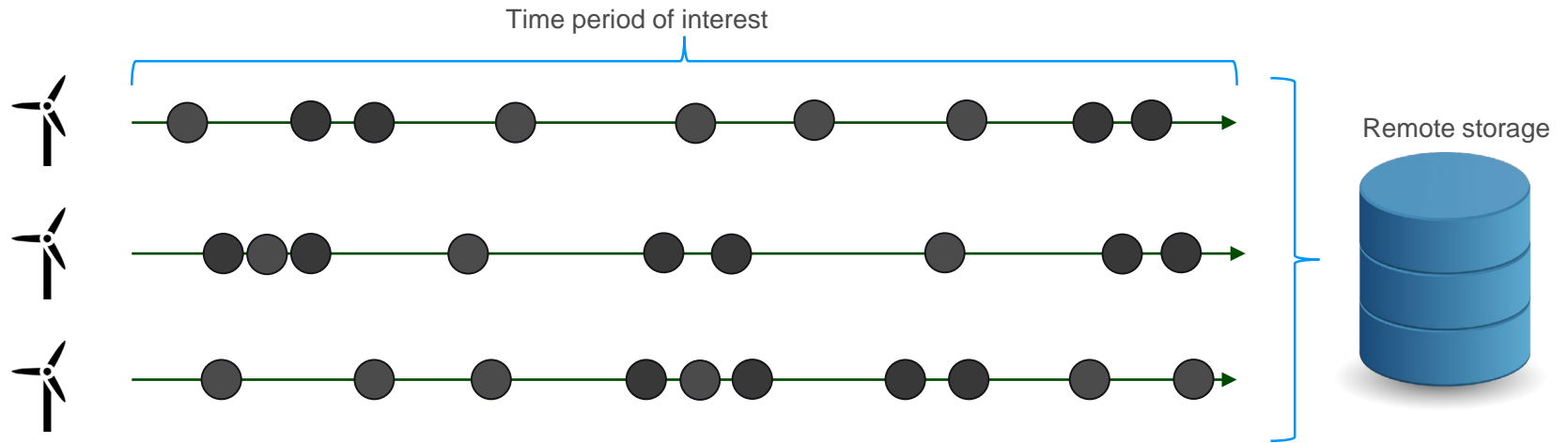
## Shopping baskets

- Basket 1: Beer, Diapers, Pretzels, Chips, Aspirin
- Basket 2: Diapers, Beer, Chips, Lotion, Juice, Baby food, Milk
- Basket 3: Soda, Chips, Milk
- Basket 4: Soup, Beer, Diaper, Milk, Ice Cream
- Basket 5: Sofa, Coffee, Milk, Break
- Basket 6: Beer, Chips



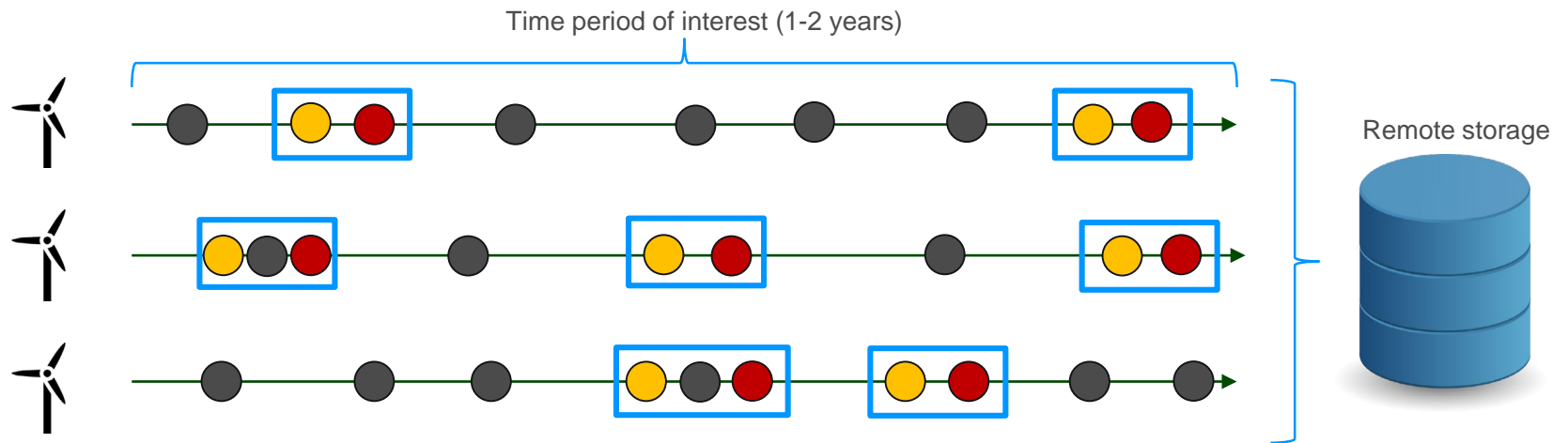
Set of transactions

# ► Technical assistance



● Event in turbine (warning or alarm)

# Technical assistance



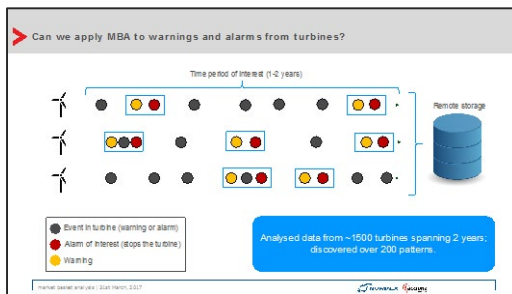
- Event in turbine (warning or alarm)
- Alarm of interest (stops the turbine)
- Warning

Analysed data from ~1500 turbines spanning 2 years; discovered over 200 patterns.

# Decentralized decisions

MBA analysis supports timely intervene and preventing downtime; Validation of selected reoccurring alarms showed cost reduction of 500kEUR/YR

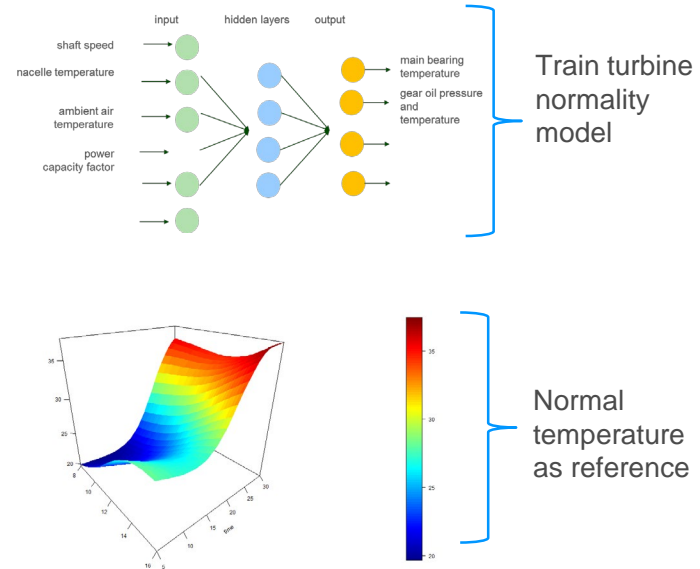
## Alarm log data



## Add SCADA data to the mix

- oil temperature
- pressure
- energy produced
- generator speed
- outside temperature
- and more...

## Model normal behavior





## Conclusion

**“Making customer service even better in an always-connected world”**

If we would now link forecasted failure rates & condition monitoring with weather forecast, energy prices, and machine learning applications supporting decentralized automated decisions in back –end systems, we create an almost self –operating environment where human intervention would be limited to actual visits to WTG’s to replace parts and carry out preventive maintenance...

**IoT is supporting Levelized Cost Of Energy and in parallel making customer service even better in an always-connected world**

**But IoT is just one of the building blocks...**

**> Thanks for  
your attention**

# > Together on the same course

## **Nordex SE**

Langenhorner Chaussee 600  
22419 Hamburg  
Germany

Tel: +49-40-30030-1000  
Fax: +49-40-30030-1333  
Email: [info@nordex-online.com](mailto:info@nordex-online.com)  
Web: [www.nordex-online.com](http://www.nordex-online.com)

## **Acciona Windpower**

Polígono Industrial  
Barásoain, parcela 2  
31395 Barásoain  
Navarra, Spain

Tel: +34-948-720535  
Fax: +34-948-720531  
Email: [infowindpower@acciona.com](mailto:infowindpower@acciona.com)  
Web: [www.acciona-windpower.com](http://www.acciona-windpower.com)