



Real Time Monitoring, Analysis and Prediction for Wind Farms

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Business Model

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The Market Need

Imagine you have over 1 thousand wind turbines under your watch. Some of your O&M problems can appear time and time again, in two or more different regions.

Sometimes, and specially if your maintenance is made by the OEM or different ISP, the teams have to go through the same learning curve to solve the same problem.

That costs you time and energy!

The Solution

Delfos is an intelligent maintenance platform that uses machine learning, technical knowledge and the already available data from the wind turbine to foresee failures before they occur.

We create a database with prediction models and solutions related. Therefore, you only have to go through that learning curve once, and the knowledge learned in Portugal can be used in Brazil and in the UK.

Our platform is doing more than predictions, is scaling up knowledge!

Delfos Intelligent Maintenance

- Created in 2016 as a Spin-off from Energo
- Intelligent Maintenance Platform
 - Machine Learning - IBM Watson
 - SCADA data Analysis
 - Problem-Solution Database

Uses machine learning and technical knowledge to transform already available data from wind turbine into predictions and useful information

Our Background - Energo

- *Founded in 2007*

- *Main Activities:*

- *Development projects of Wind and Solar Farms*

- *Over 530 MW of projects developed*

- *Wind Turbine Inspections*

- *520 Wind Turbine Blades inspected*

- *350 MW Total Inspected from different manufacturers*

- *Distributed Generation*

- *Research, Development and Innovation*

- *Key Partners:*



Management Team



Samuel Lima - Executive Director

MSc. Renewable Energies at UFC, Brazil
B.Eng. Aeronautical Engineering at ITA, Brazil

Professional Background:
Wind Energy Maintenance, Market Analyst
and Airplane Maintenance

Areas of Expertise:
Mathematical Modeling, Wind Energy and
Maintenance

[LinkedIn](#)



Adão Muniz - The Industry Veteran

MSc. Nuclear Engineering at COPPE, Brazil
B.Eng. Mechanical Engineering at UFC, Brazil.

Professional Background:
Eletrobras Termonuclear; Siemens; First
president of Abeeólica - Brazilian
Association of Wind Energy

Areas of Expertise:
Performance Analysis and energy generation

[LinkedIn](#)



Guilherme Studart - Financial Director

MSc. International Management at ESADE-
CEMS, Spain.
B.B.A. Business Administration at UFC,
Brazil.

Professional Background:
Volkswagen; América Latina Logística

Areas of Expertise:
Supply Chain and Finance

[LinkedIn](#)

Our Supporting Team Profile



Electrical Engineer

MSc. Electrical and Renewable Energies at UFC, Brazil
B.Eng. Electrical Engineering at UFC, Brazil

Areas of Expertise:

Wind turbine Electrical System, WTG Inspections



Wind Energy Consultants

Professional Background:
15 years of experience in the Wind Energy Industry.

Areas of Expertise:

Wind Turbine Blades and Commissioning



Mechanical Engineer

B.Eng. Mechanical Engineering at ITA, Brazil

Areas of Expertise:

Performance Analysis and energy generation



Talent Acquisition Strategy

Scouting for talents from the top engineering school in Brazil, namely
ITA.

Summer Internship Programme

Our Platform

● *Characteristics:*

- *Increase of Energy Production*
- *Increase of Asset Lifetime*
- *Lower O&M Costs*
- *Predict Failures and Underperformance*
- *Security Focused*
- *WTG Technology Independent*
Subscription based platform

● *Modular Solution:*

- *Performance*
- *Reliability*
- *Predictive Maintenance*
- *Failure Database*
- *Asset Management*

NO HARDWARE INSTALLATION IS REQUIRED!

Underlying Magic

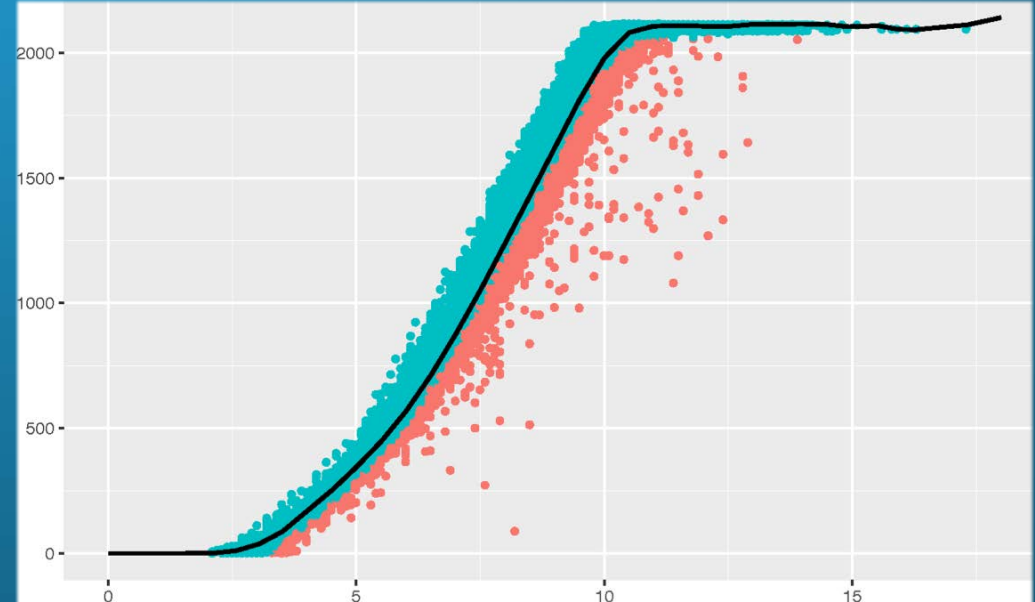
- Uses already available data:
 - SCADA Measurements (10 min data) and Alarms
 - Maintenance Logs and Reports
 - Inspection Reports and Data
- *Data is parameterized, therefore the analysis can be applied for every wind turbine model*
- *Failure model and solution database is created*
- *IBM Watson*

NO HARDWARE INSTALLATION REQUIRED: No CAPEX needed!

Performance Module

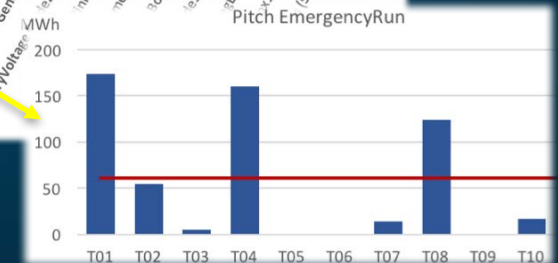
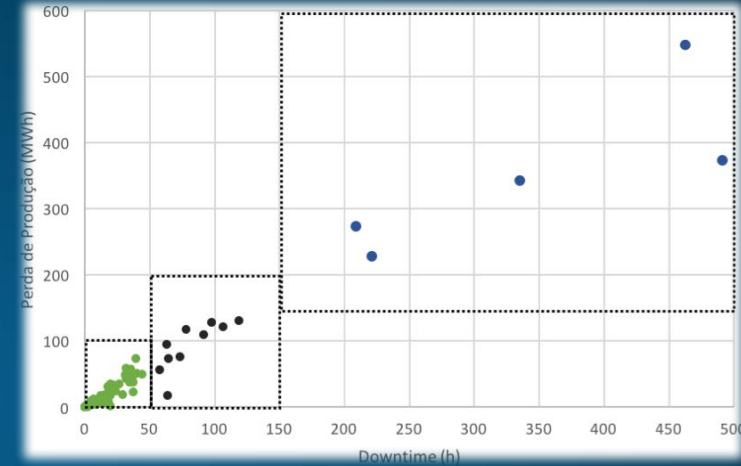
- *Power Performance Analysis*
 - *Operational Power Curve*
 - *Power Generation Efficiency*
 - *Power Limitations*
 - *Active vs Reactive Power*
- *Operational Efficiency Analysis*
 - *Expected vs Operational Parameters*

- *Wind Turbine Misalignment*
- *Production Analysis*



Reliability Module

- *Availability Auditing*
 - *Time based*
 - *Power based*
- *Downtime Analysis*
 - *Type, Frequency, Impact, Origin*
 - *Classification*
 - *Production Loss*
 - *Evolution*
- *Reliability Parameters*
- *Benchmarking*



Predictive Maintenance Module

- Machine Learning to find the best model or combination of prediction models
- Standard Working Model
- Alarms based in deviations from models
- Health Score for each subsystem
- Prediction models from available data:
 - *SCADA measurements*
 - *SCADA alarms*
 - *O&M Report*
- Identify abnormalities before they become failures
- Avoid Underperformance and big Correctives

NO ADDITIONAL HARDWARE IS REQUIRED!

Predictive Maintenance Module

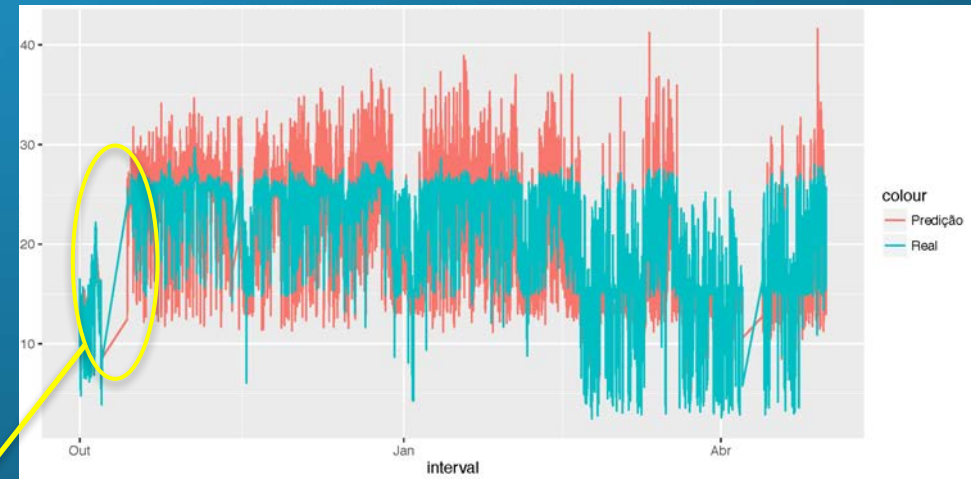
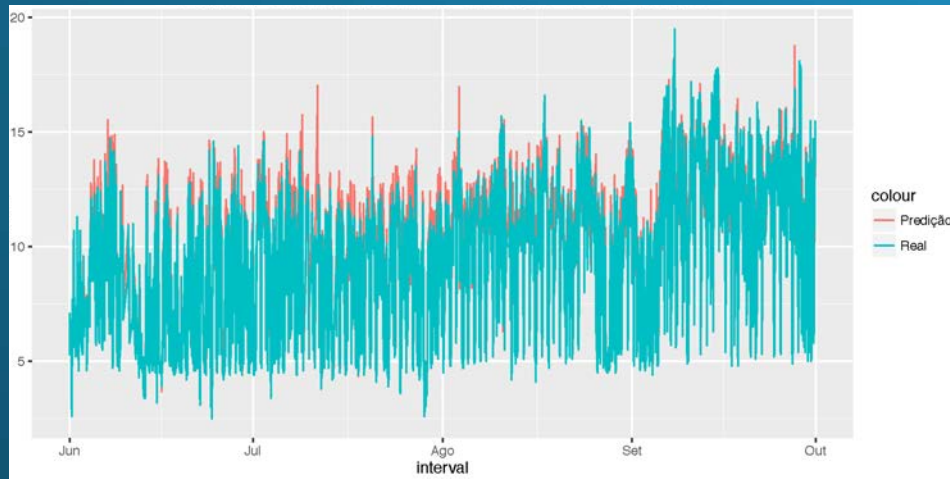
- Failure model creation
 - Uses data from O&M
 - Structured and Unstructured data
- Machine learning
 - Prediction Model creation
 - Variable, subsystem and component associated
 - Downtime and energy lost associated
 - Most effective action
- Parameterized Analysis
 - Reinforce security and anonymity
 - Enables interchange of models created for similar technologies

NO ADDITIONAL HARDWARE IS REQUIRED!

Case Study – Proof of Concept (1/3)

- **Generator NDE Bearings were constantly failing and being replaced**
- *Applying Delfos, it was discovered that the failure was associated with Current Asymmetry, which caused an eddy current that damaged the bearing*

Current Asymmetry over time

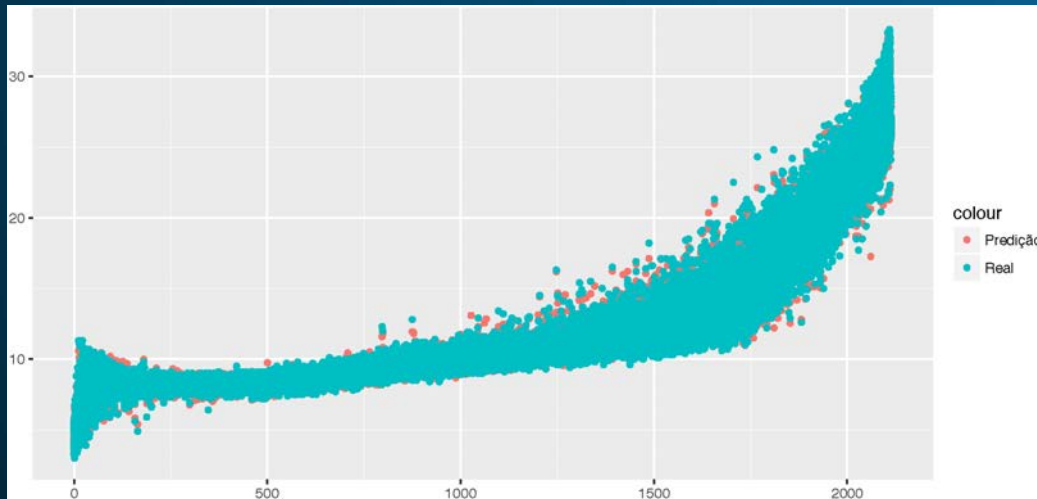


Action that caused the current asymmetry

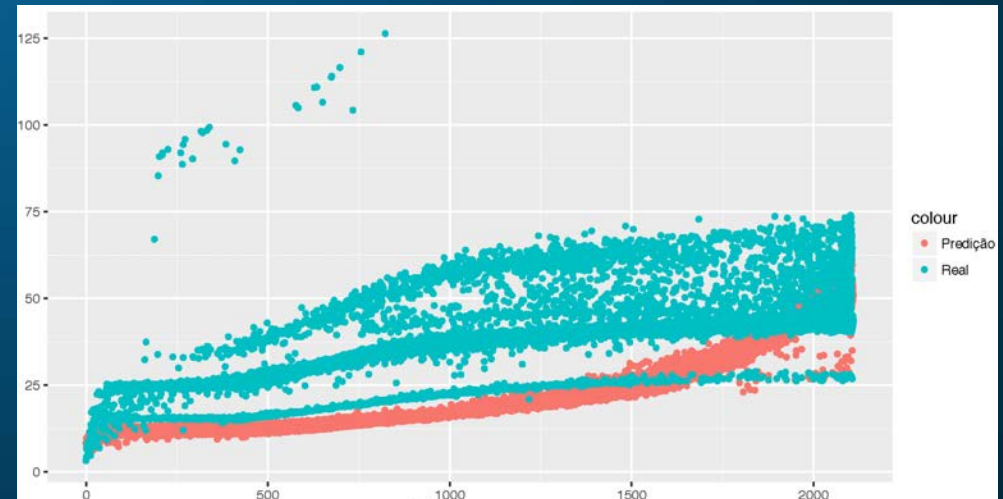
Case Study - Proof of Concept (2/3)

- Model created was enable to:
 - Identify WTG with problems with up to 150 days

Current Asymmetry over Active Power



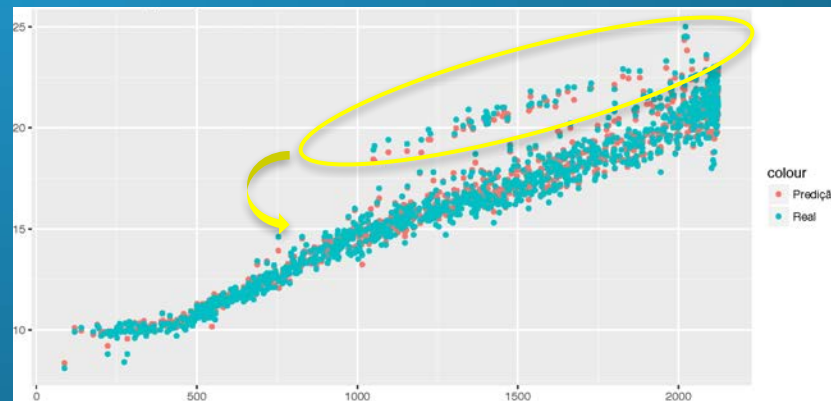
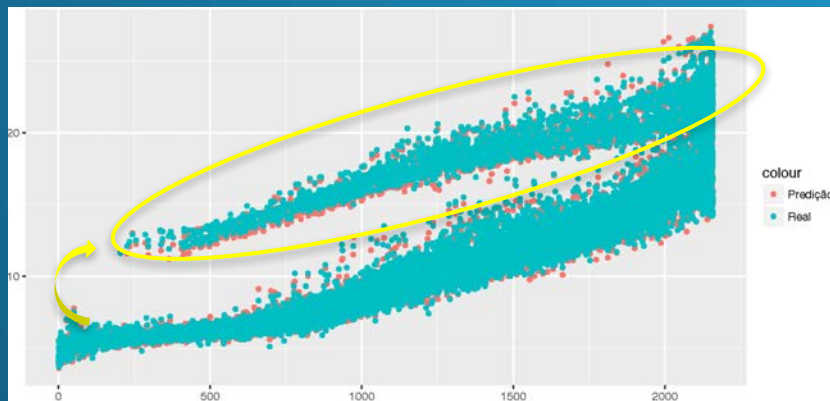
WTG with no current asymmetry problem



WTG with current asymmetry problem – same Wind Farm

Case Study - Proof of Concept (3/3)

- *Model created was able to:*
 - *Notice that the root cause was properly corrected once*
- *Applying that correction can treat the root cause and avoid future problems*



In the same wind farm a WTG started to deviate from the functioning envelope, but a correction was applied making the WTG return to the working envelop. WTG that didn't receive this correction had the bearing replaced up to 4 times in the same time frame. As the root cause wasn't solved by the OEM, the bearing kept failling.

Asset Management Module

● Unstructured Database with all maintenance related data

● Special attention on Wind Blades

○ Damage and repair evolution

○ Reports

○ Photographies

○ Logs

○ Inspection data

● Complete WTG history

CHECK LIST			
INSPEÇÃO EXTERNA			
ITEM		SO	CO
01	Identificação do número de série (legível)	☐	☐
02	Inspeção visual de toda a extensão do BORDO DE ATAQUE	☐	☒
03	Inspeção visual de toda a extensão do BORDO DE FUGA	☐	☐
04	Inspeção visual de toda a extensão do INTRADORSO	☐	☒
05	Inspeção visual de toda a extensão do EXTRADORSO	☐	☒
06	Inspeção visual da Ponta da Pá (para-raio e dreno)	☐	☒
07	Inspeção visual da Raiz da Pá	☐	☒
INSPEÇÃO INTERNA			
ITEM		SO	CO
08	Placa de Identificação da Pá (legível)	☐	☐
09	Teste de continuidade e resistência ôhmica do flange de aterramento da raiz da Pá ao barramento de aterramento do HUB	☐	☐
10	Inspeção visual da escotilha de acesso à Pá	☐	☒
11	Inspeção visual da fixação do close-out	☐	☒
12	Inspeção visual da estrutura da raiz da Pá	☐	☒
13	Inspeção visual do bordo de ataque (Intradorso, Extradorso e Alma)	☐	☒
14	Inspeção visual entre as almas (Intradorso, Extradorso e Almas)	☐	☒
15	Inspeção visual do bordo de fuga (Intradorso, Extradorso e Alma)	☐	☒
16	Cartão de Identificação	☐	☒
17	Inspeção visual da fixação da pá ao hub	☐	☒

CONSIDERAÇÕES DAS OCORRÊNCIAS EXTERNAS:
 Item 02 - Evidência de dano na pintura e sujidade no bordo ataque entre o R-7400 e o R- 40000;
 Item 04 - Evidência de superfície irregular lado do intra dorso próximo ao R- 47700;
 Item 06 - Evidência do SPDA se soltando no lado do intra dorso R- 41700;
 Item 06 - Evidência de má instalação de receptor do SPDA lado do extra dorso no R- 41700;

CONSIDERAÇÕES DAS OCORRÊNCIAS INTERNAS:
 Item 12 - Evidência de luminosidade irregular na raiz lado do intra dorso no bordo de fuga;
 Item 13 - Evidência de luminosidade irregular no bordo de ataque;

LEGENDA: SO - Sem Ocorrência CO - Com Ocorrência



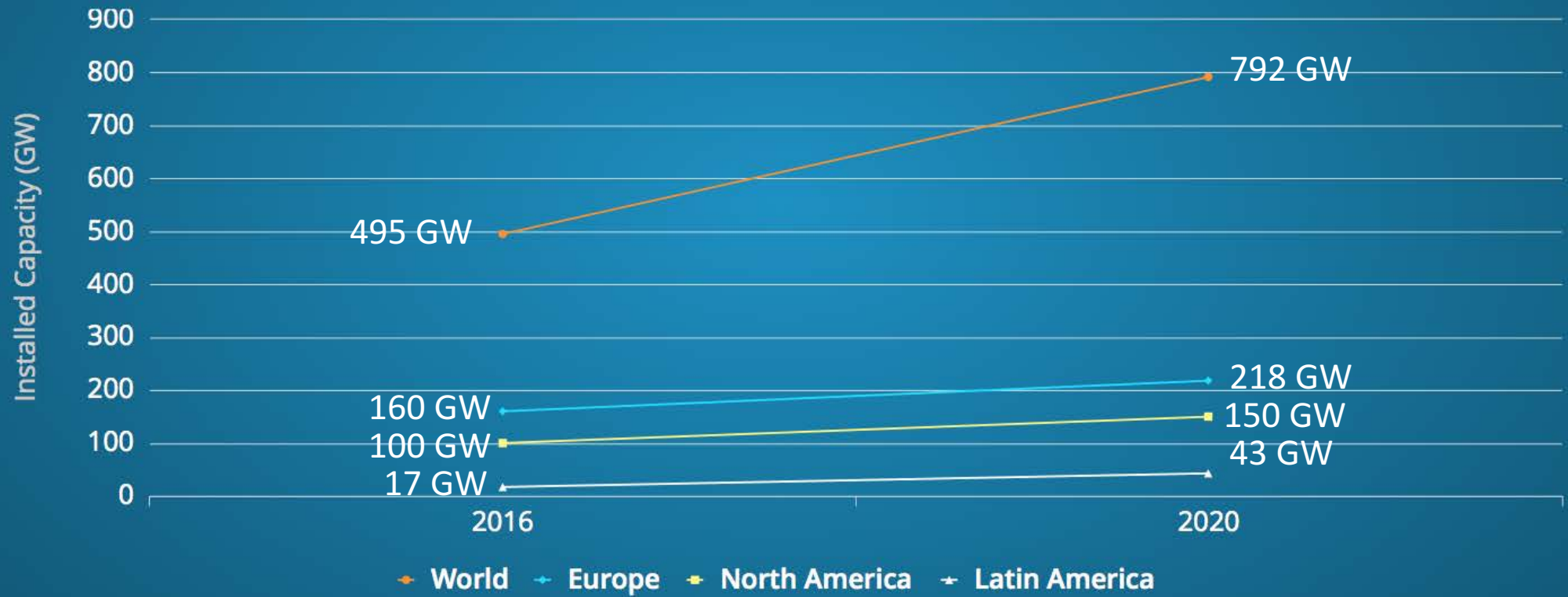
Customer Segment

- Wind Farm Owners
- Wind Farm Operators
- Wind Energy Investors
- M&A Consultants

Revenue Streams

- Modular Solution
- Reliability Engineering
- Performance Analysis
- Intelligent Maintenance Platform
- Subscription Based
- One-time Analysis

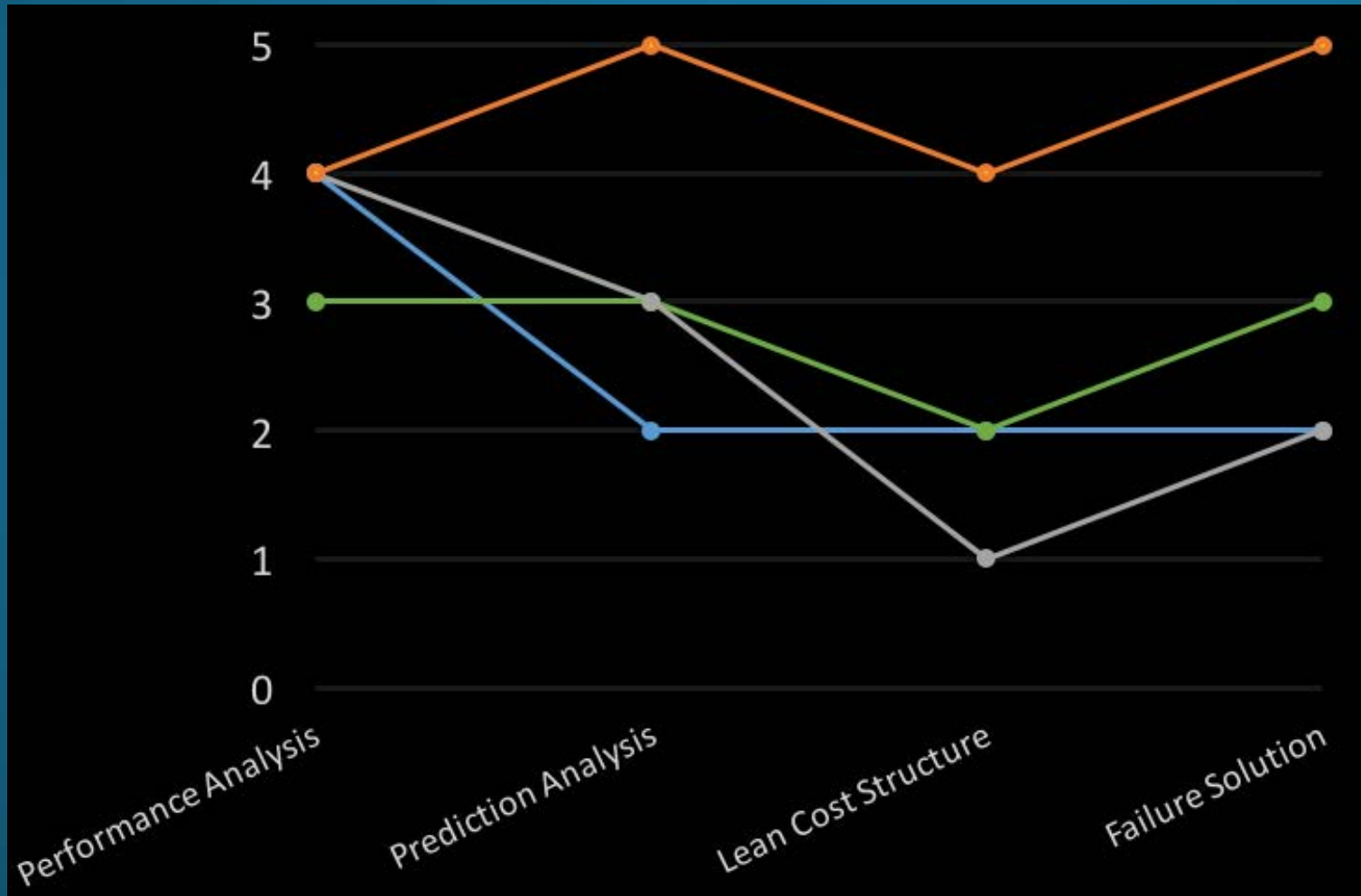
Market Size



Timing

- Market Timing:
 - Consolidation of Onshore and Offshore Technologies
 - Focus in Optimization
- Development timing:
 - Development cost decreased considerably
 - Prediction Tools
 - Machine Learning Tools - IBM Watson

Competition



• **Delfos**
Intelligent Maintenance



● In-house Development



Delfos

Intelligent Maintenance

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