Performance for Assets

Turning data into actionable intelligence

www.performanceforassets.com

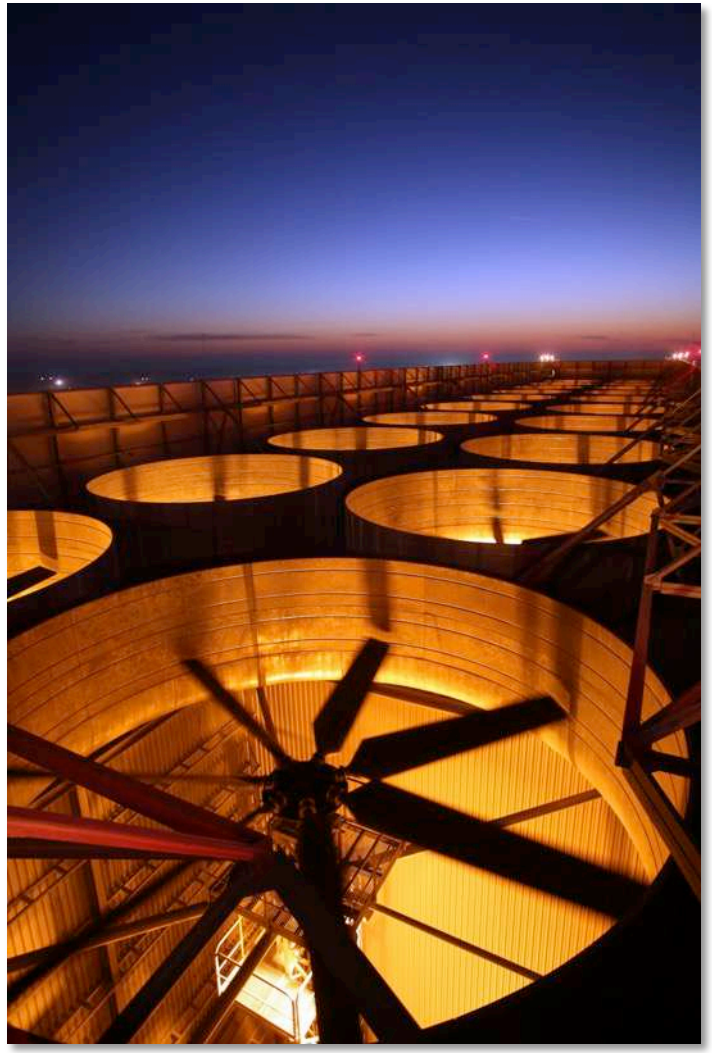

How to enhance the value of existing products & services?
Half of my expert-personnel will retire in the near future
Where can I save energy?
How do I ensure safe and reliable operation of aging equipment?
How can meantime between failures be extended?
Why does my machine not perform as expected?
Can processes be optimized and how?
Schelde
Schelde
Industriedok

Today's Industrial Challenges

Production processes
continuously generate
massive amounts of data

but...

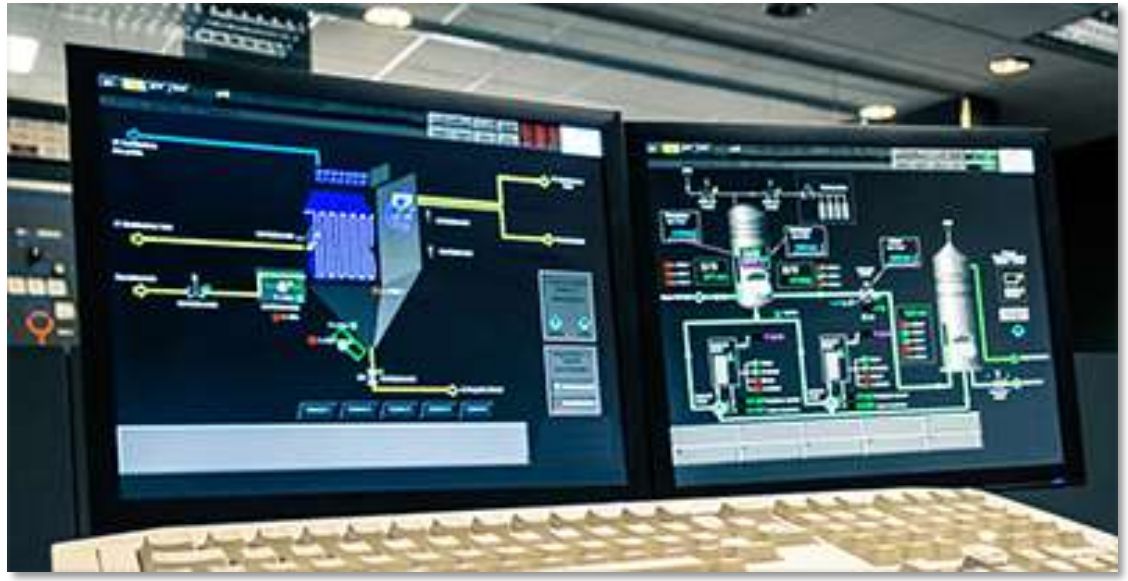
"On average, between
60% and 73% of all data
within an enterprise
***goes unused** for analytics"*
- Forrester



Today's Industrial Challenges

Moreover, traditional condition monitoring systems give a **narrow view on process behaviour**

CMS



PLC

To broaden the view, we correlate the condition monitoring measurements with the operational data and **centralize, filter and synchronize all available information**

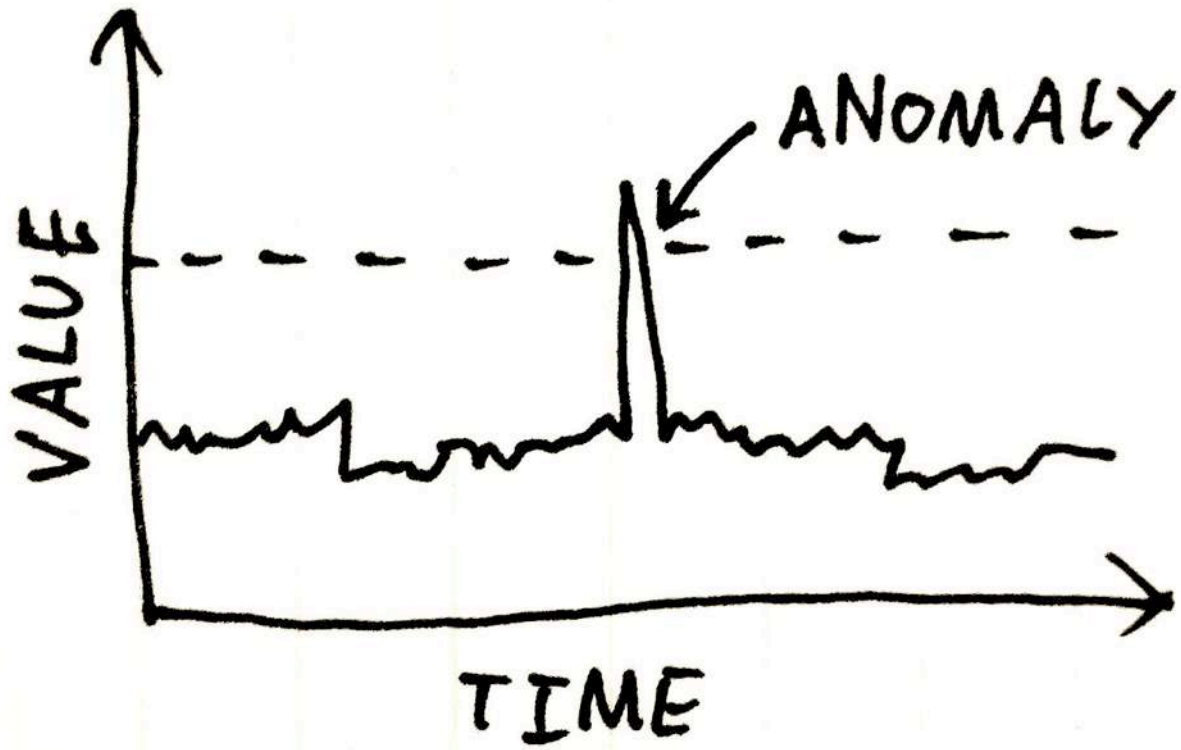
Today's Industrial Challenges

Furthermore we evaluate and integrate

the **other unstructured data sources**

that can potentially be relevant

Our approach: Methodology



- **Detect** anomaly
- **Diagnose:** Where does the anomaly come from?
- **Prognose**: How does anomaly evolve and when to take action?

Actionable intelligence

for performance optimization & predictive maintenance

Our approach: Actionable Intelligence

Immediate / online actions

Safety, reliability & continuity

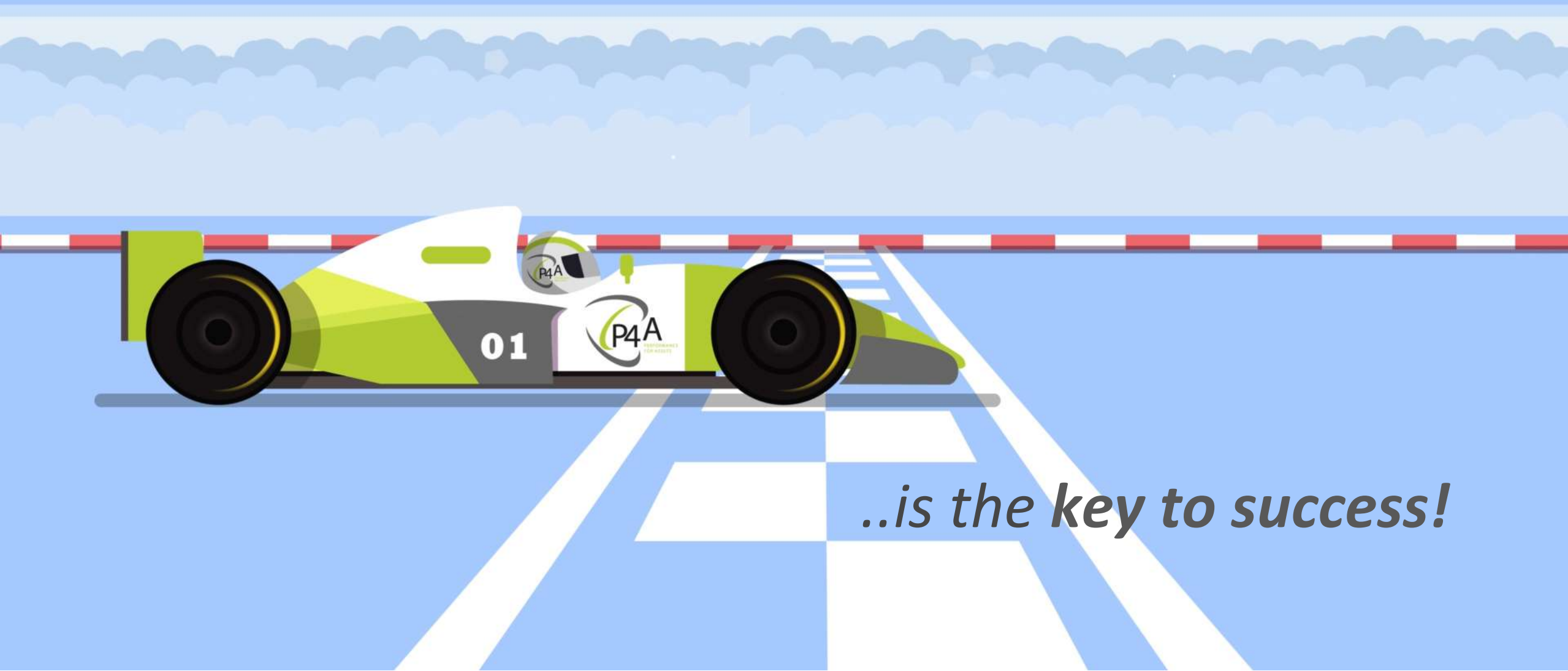
Mid-term actions

Planning, savings & performance

Long term actions

Procedures, strategy & investments

*Combining **process / asset** knowledge with **data analytics**..*



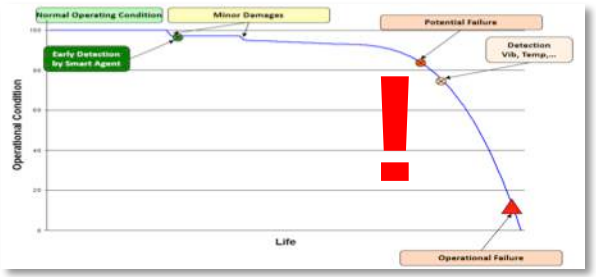
*..is the **key to success!***

Machine learning: 3 approaches

Online condition monitoring

Online identification of anomaly

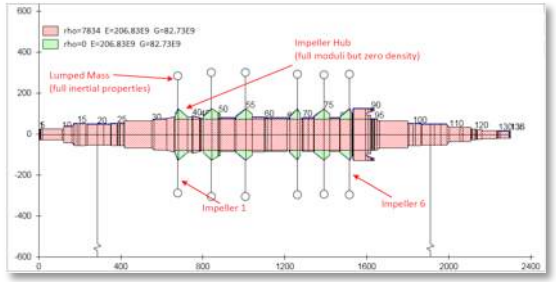
Offline human diagnosis



Physical models

Theoretical optimum condition

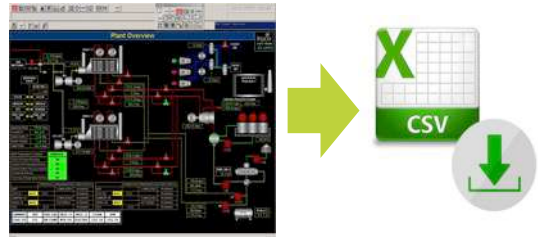
Impossible to include all hypothesis



Data driven models

Historical process data

Relative view on equipment status



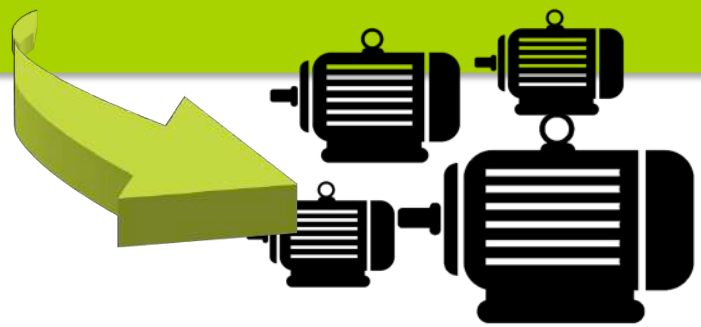
Our approach: Hybrid model

Online condition monitoring

Physical models

Data driven models

Hybrid models

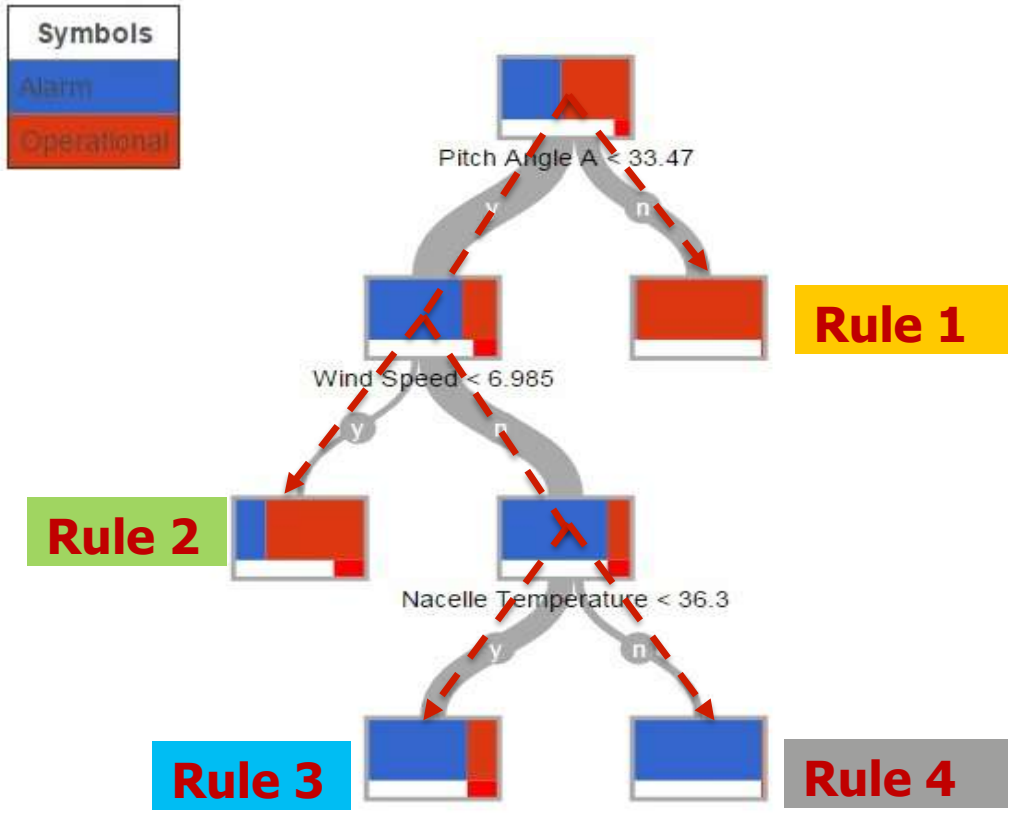


Robust models and optimized machine-learning

by **centralizing, synchronizing and analysing** all asset data!

Our approach: Analytic tools

We use **+30 proven analytic tools** such as the **decision tree** to:



1. Analyse the historical data
2. Automatically select the key parameters that related to a drift/deviation
3. Create rules by combining different parameters
4. Test the robustness

After validation, the rules can easily be copied to all same type equipment and are **automatically adapted** (auto-learning) to the different operating conditions of each unique equipment

Our goal: Providing actionable intelligence for…

PERFORMANCE OPTIMIZATION

PREDICTIVE MAINTENANCE

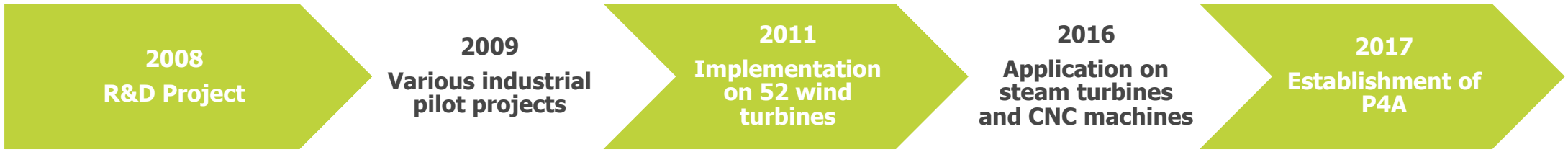
ENERGY SAVINGS

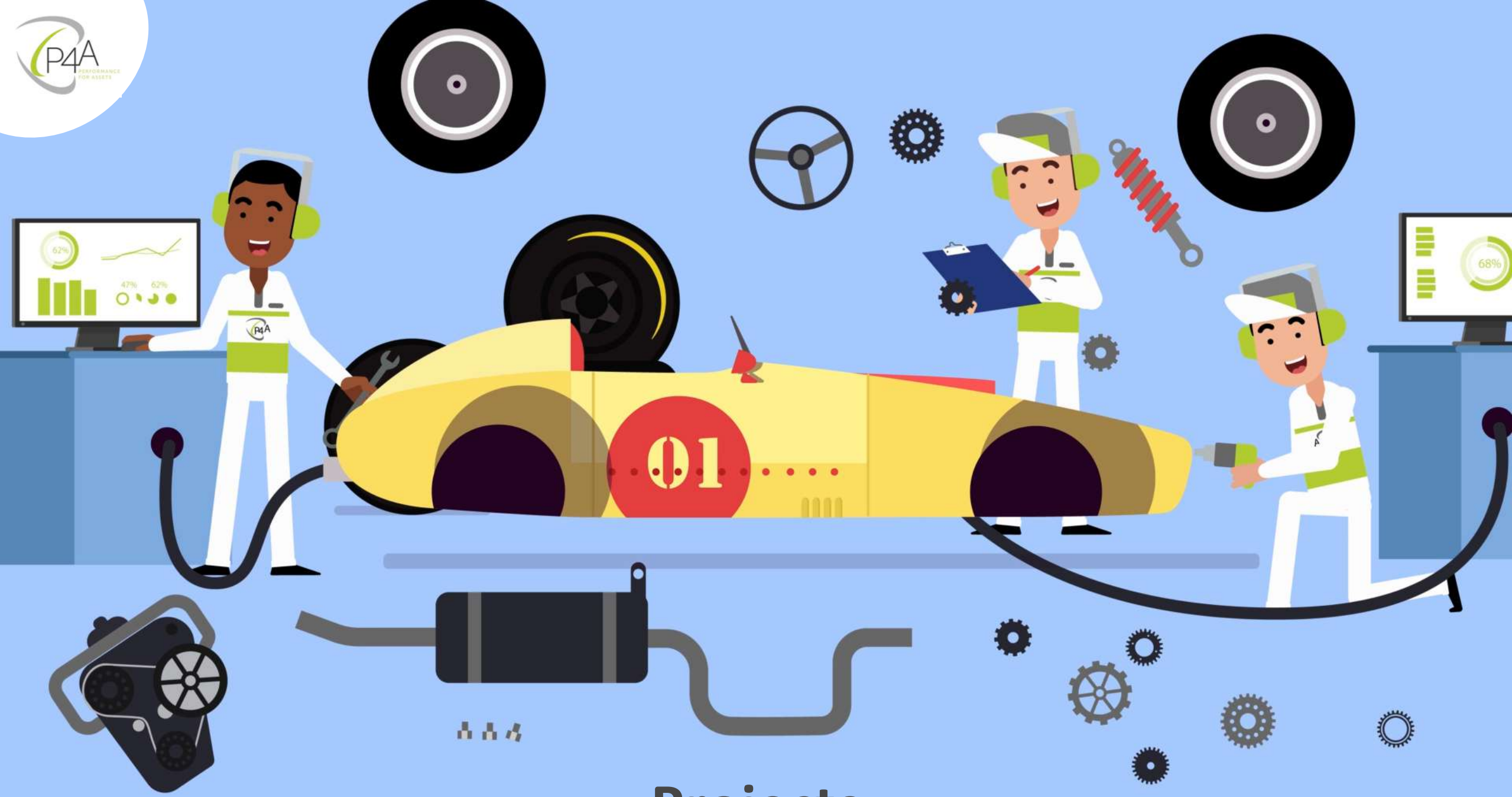
COMPENSATION OF LOSS OF KNOWLEDGE

COST REDUCTION & REVENUE INCREASE

Track Record

- Started in **2008** as an **R&D project** focusing on the development of a remote asset management platform for rotating equipment in industry – need of intelligent monitoring tool for our O&M production based contracts in the conventional industry
- **Health monitoring platform**, modeling based using the latest of data mining tools
- Since 2008 ~**6 million €** was invested to develop robust, reliable monitoring and management tool for rotating equipment
- In 2017, **Performance for Assets** was established to market this collaborative platform to a larger audience





Projects

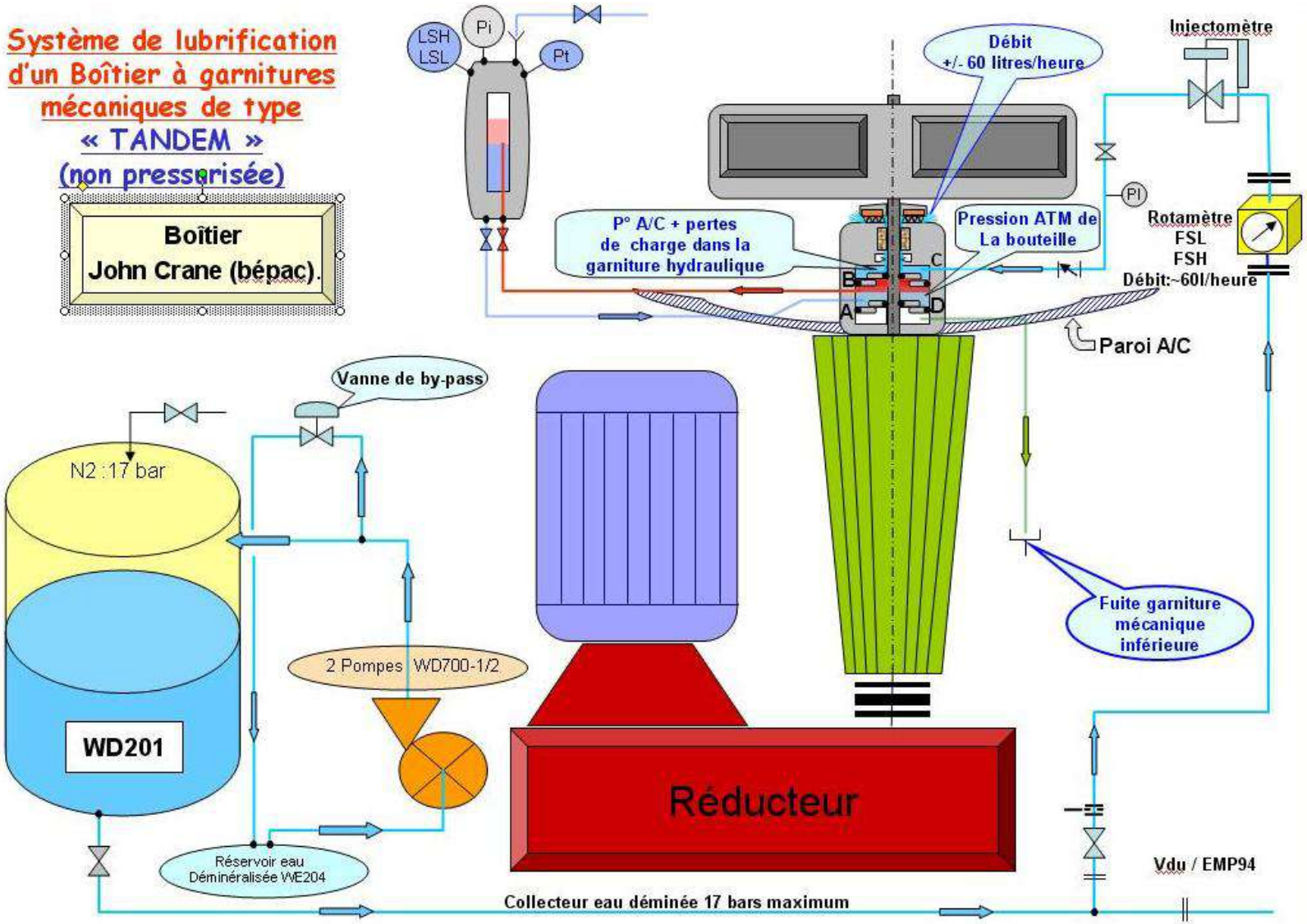
Case 1: Improved production uptime & safety

*How to avoid **returning failures***

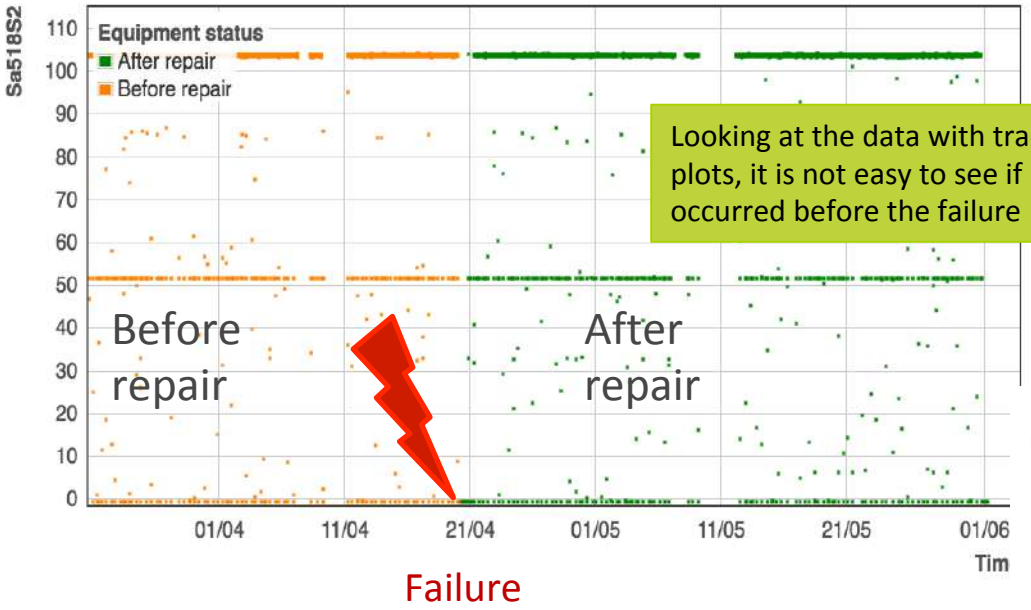
*on a **critical mixer** in a **chemical plant***

*causing **long downtime** and **safety risks**?*

Case 1: Improved production uptime & safety



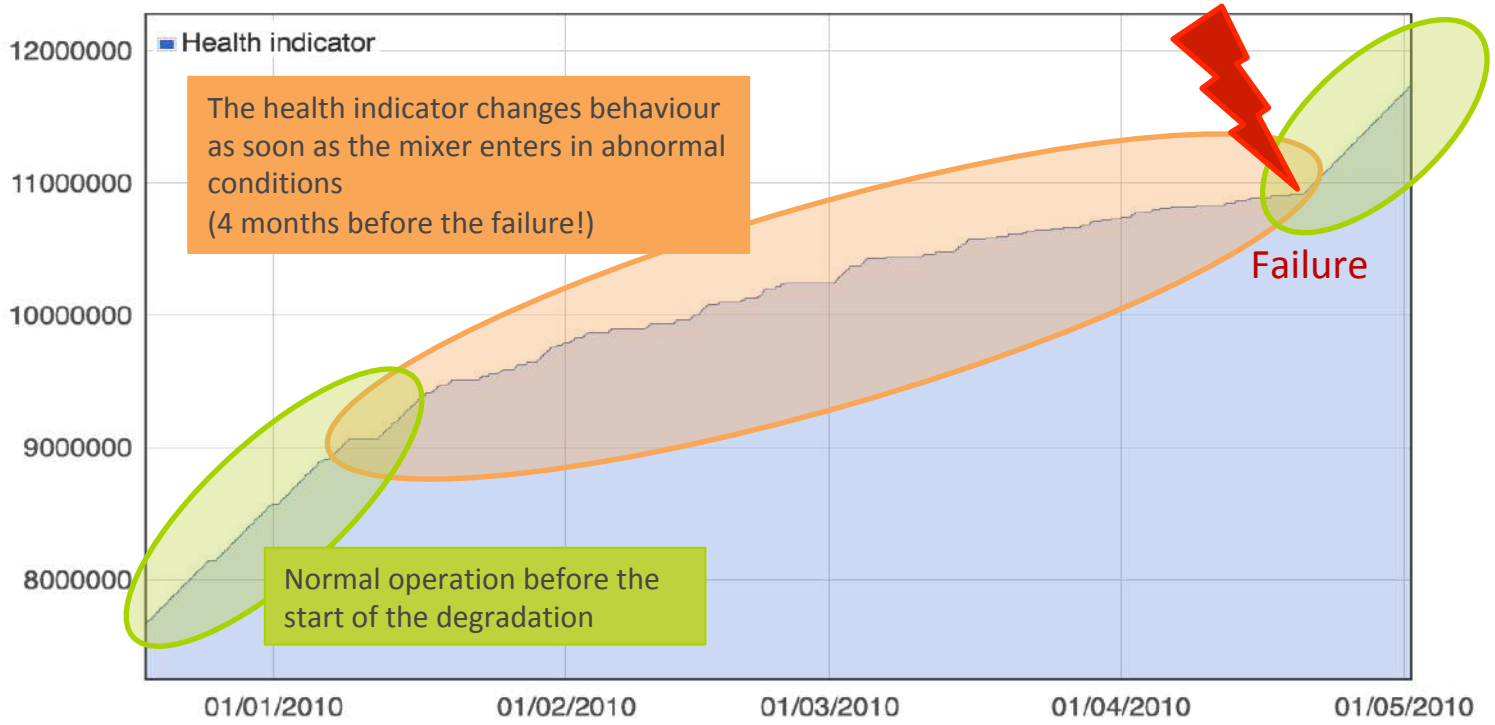
Case 1: Improved production uptime & safety



Failure

Looking at the data with traditional charts and plots, it is not easy to see if patterns have occurred before the failure

Machine learning helps to identify which conditions on data define a healthy situation or an upcoming failure



Case 1: Improved production uptime & safety

Step 1: **Detection of anomaly**

- Use of historical data to analyse conditions before/after a failure and identify key factors to establish a health indicator
- Unhealthy conditions can be detected 4 months before the failure

Step 2: **Diagnosis**

- Root cause analysis based on data and our new health indicator

Step 3: **Prognosis**

- Prediction of remaining life time based on new health indicator

Step 4: **Intelligence - Predictive Maintenance**

- Implementation of a predictive maintenance tool with alarm thresholds to protect the equipment from upcoming failures

Case 1: Improved production uptime & safety

The benefits

- **Improved production reliability and safety** through predictive maintenance
- Automated **alarms to protect** equipment
- **Easy** implementation
- **Self-learning** big data model

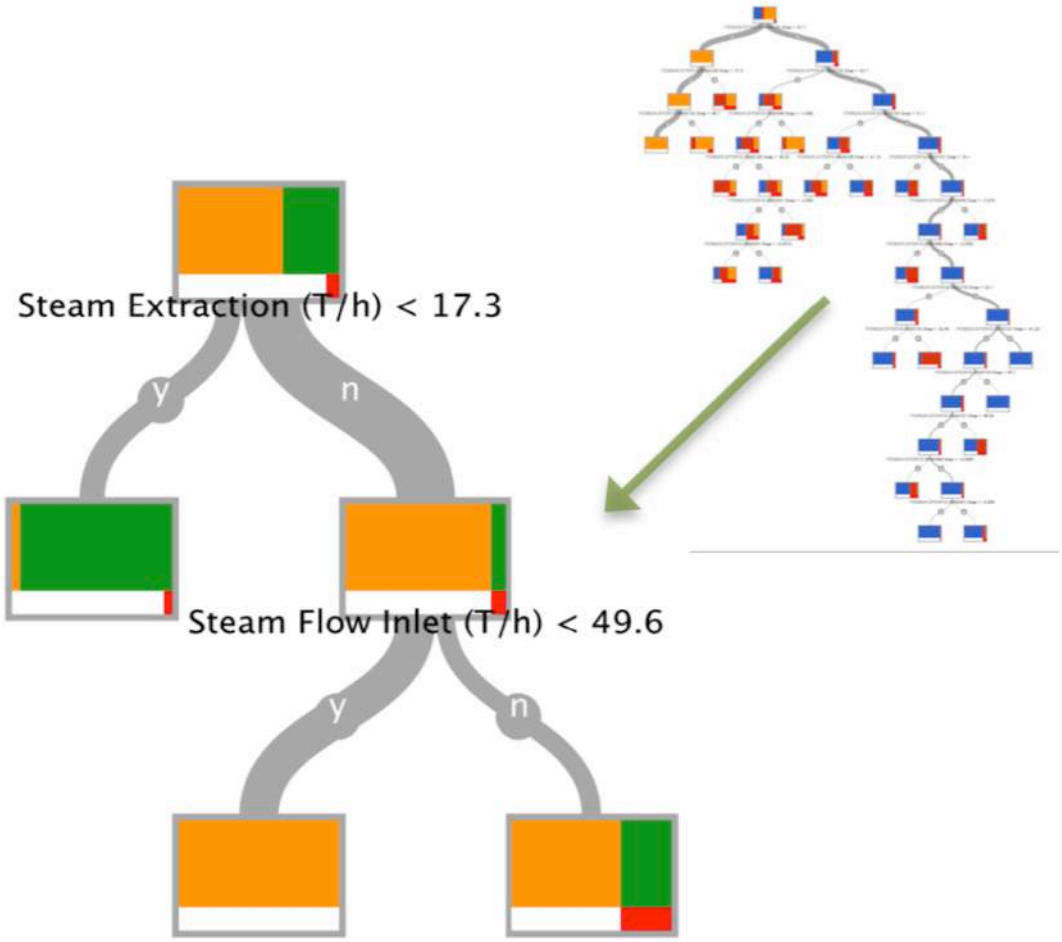
Case 2: € 500.000/year energy savings

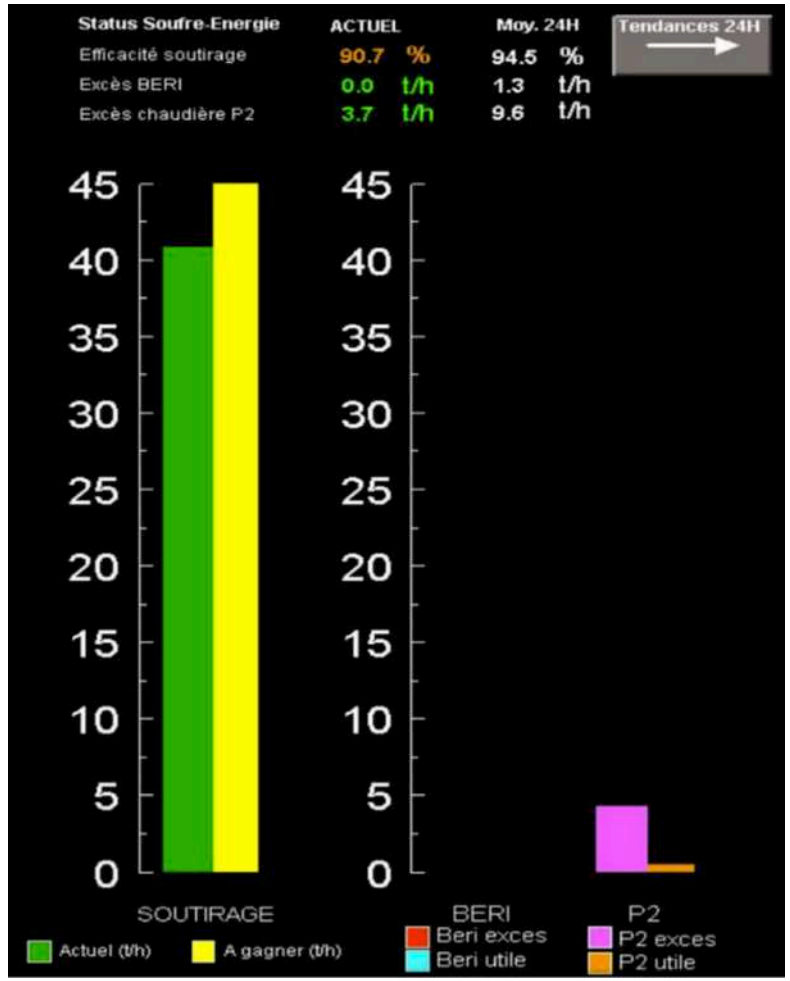
*How to **optimize the steam extraction***

*of the steam network in our **phosphate plant***

*and thereby **minimise the energy bill?***

Case 2: € 500.000/year energy savings





Extract from the decision tree (model) created by P4A to indicate the best way to operate the steam network

Operator dashboard for optimized steam extraction

Case 2: € 500.000/year energy savings

Step 1: **Detection of inefficiencies**

- A + 100.000 tons of steam / year gap in energy efficiency was revealed through our process analysis and data mining approach

Step 2: **Diagnosis**

- Root cause analysis through variability exploration of historical data and process thanks to our analytics tool

Step 3: **Prognosis**

- Waste of steam extraction of 5 tons/hour, resulting in a € 60/hour financial loss

Step 4: **Intelligence – Performance Optimization**

- Install dashboard to monitor extraction flow (actual vs optimum), improve communication between various departments and enhance reporting practices

Case 2: € 500.000/year energy savings

The benefits

- Increased steam extraction of 5 tons / hour
- Significant cost reduction
- Better management and monitoring
- More sustainable operations
- Implemented in < 3 months

The ROI

- Recurrent savings of € 500.000 / year on energy equivalent to 7.000 tons of CO2 per year in gas consumption, or a 15% reduction

Case 2: Advanced turbomachinery monitoring

*How to get an **absolute view***

*on the **condition** and **behaviour***

*of my **turbomachinery**?*

Case 2: Advanced turbomachinery monitoring

Elaboration of a **mechanical dynamic model** based on **reverse engineering**

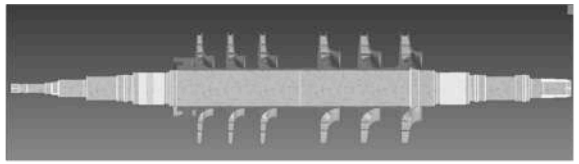
Results & Tests

1 Creating and testing rotormodel in high speed balancing machine

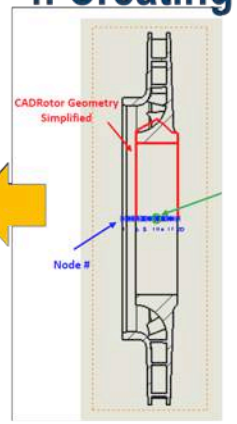
1. Disassembling rotor

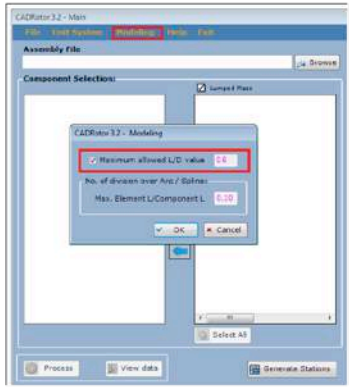
2. Scanning Parts

3. Reverse engineering rotor

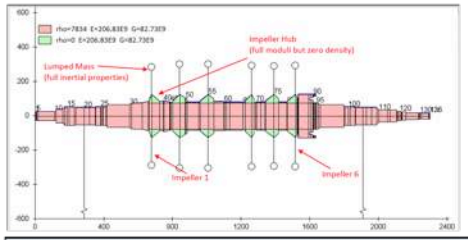


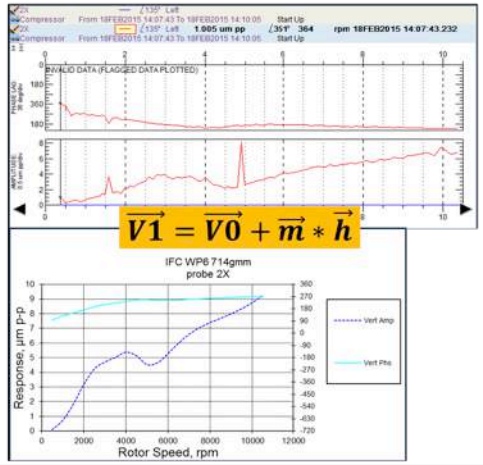
4. Creating rotor dynamic model





5. Testing rotor dynamic model in high speed balancing installation





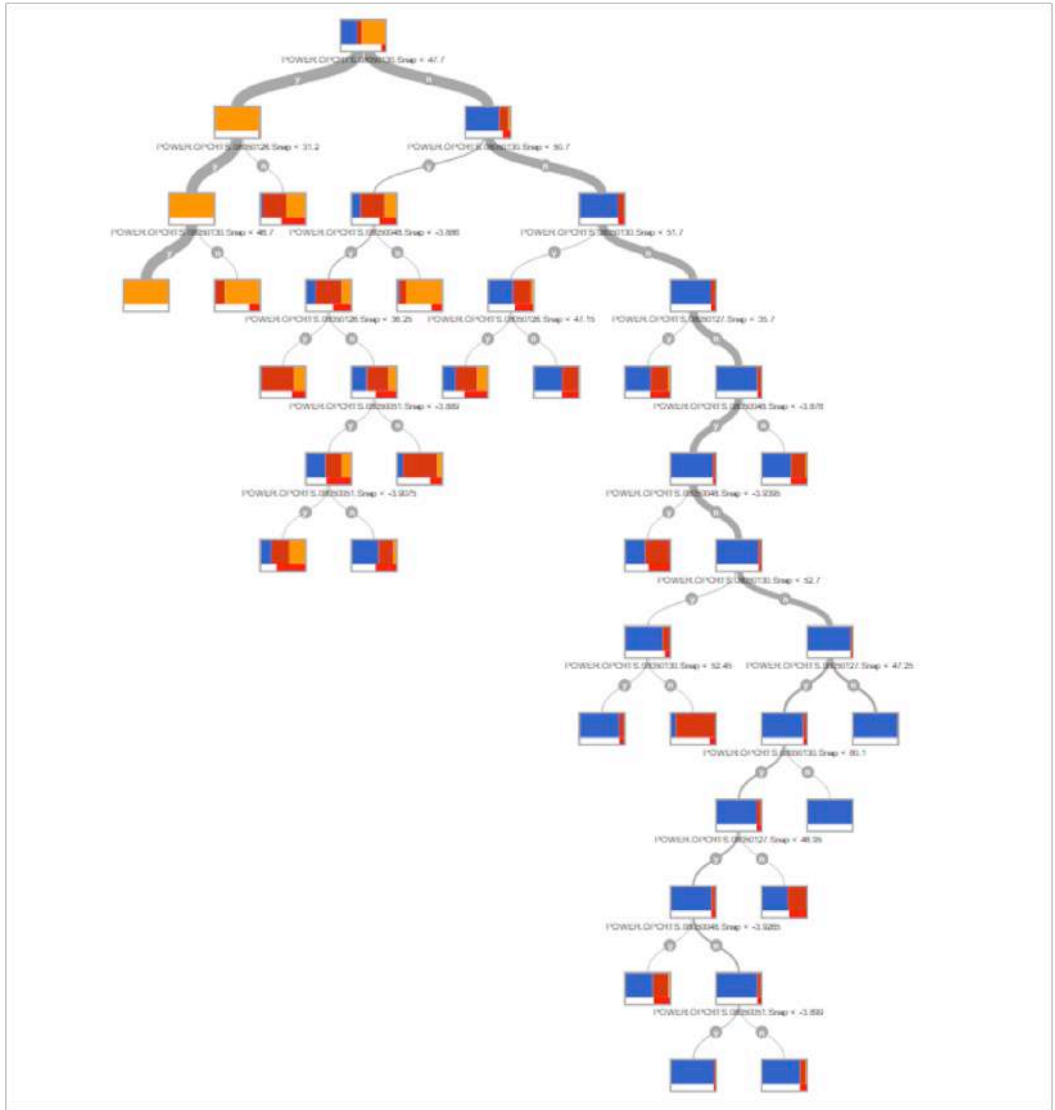
Quality of XL rotor model was controlled by comparing the results with the vibrations measured during the trial runs of the high speed balancing process

Case 2: Advanced turbomachinery monitoring

Fine-tuning of the **dynamic model** using the **balancing machine**

Influences due to;

1. bearing design
2. labyrinth seals
3. impeller & turbine blades



Using this input we configure

up to 50 auto-learning models/asset

which we then follow online!

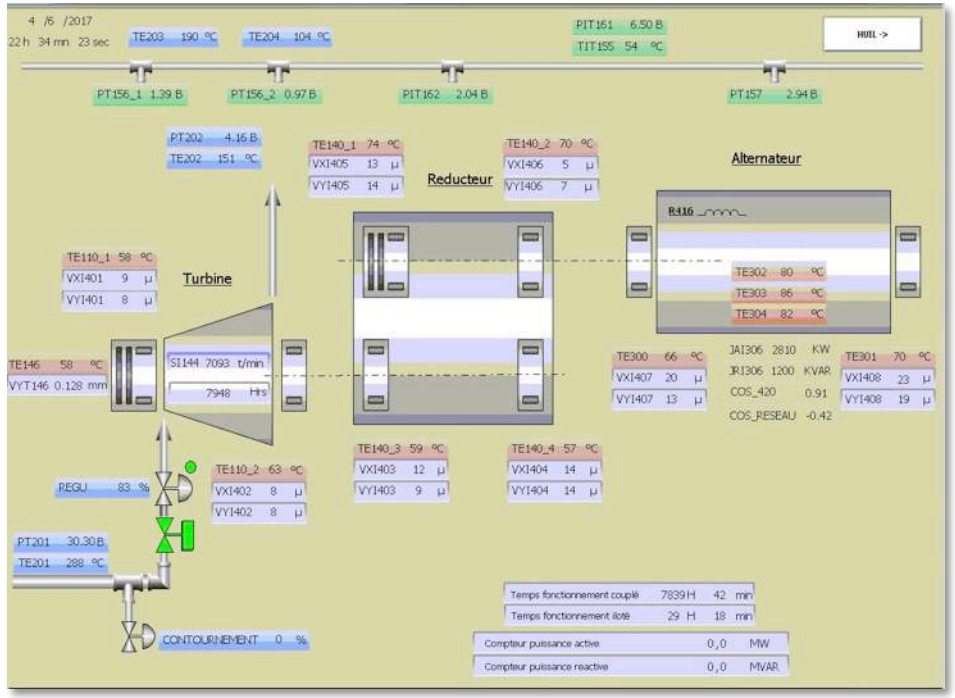
Case 2: Advanced turbomachinery monitoring

The benefits of our hybrid model?

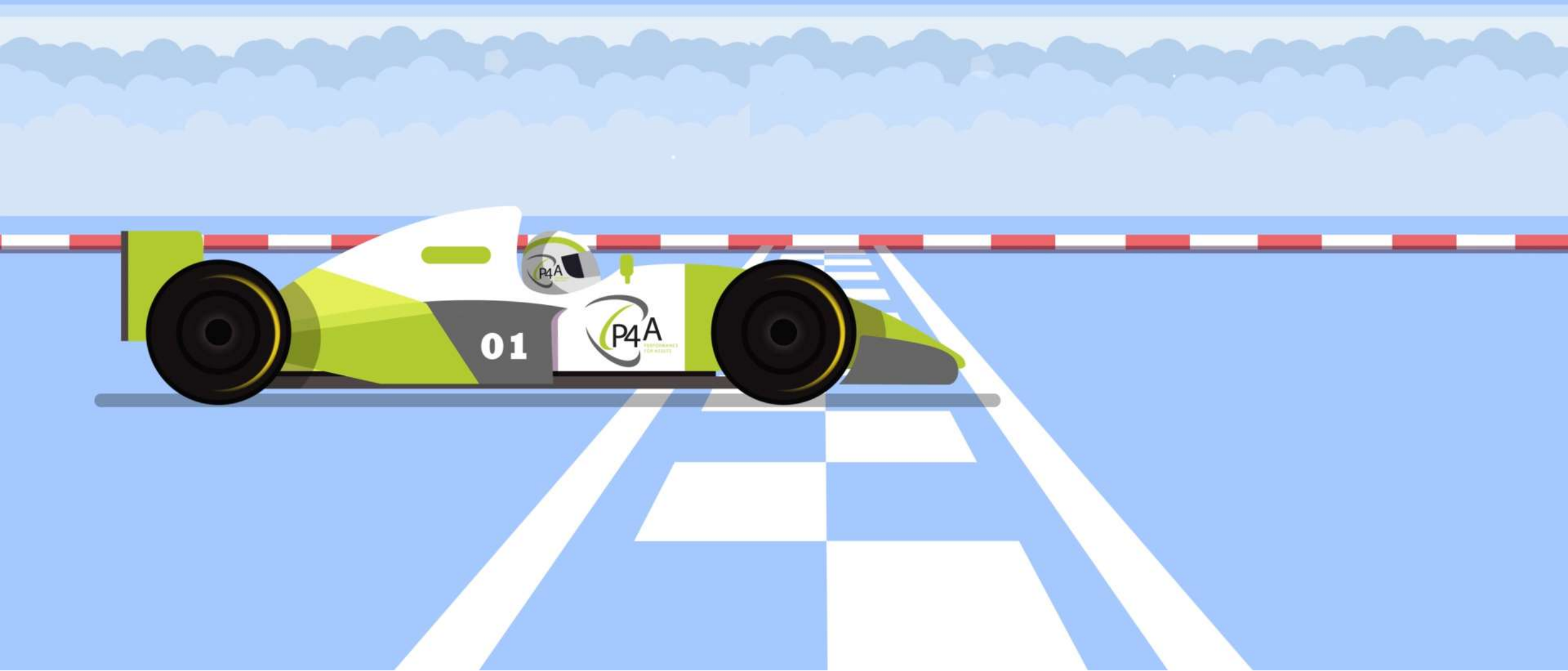
- Using physical models only gives a narrow view on the asset behaviour

- By correlating the physical model with historical and real-time condition data we are **monitoring the asset from all angles**

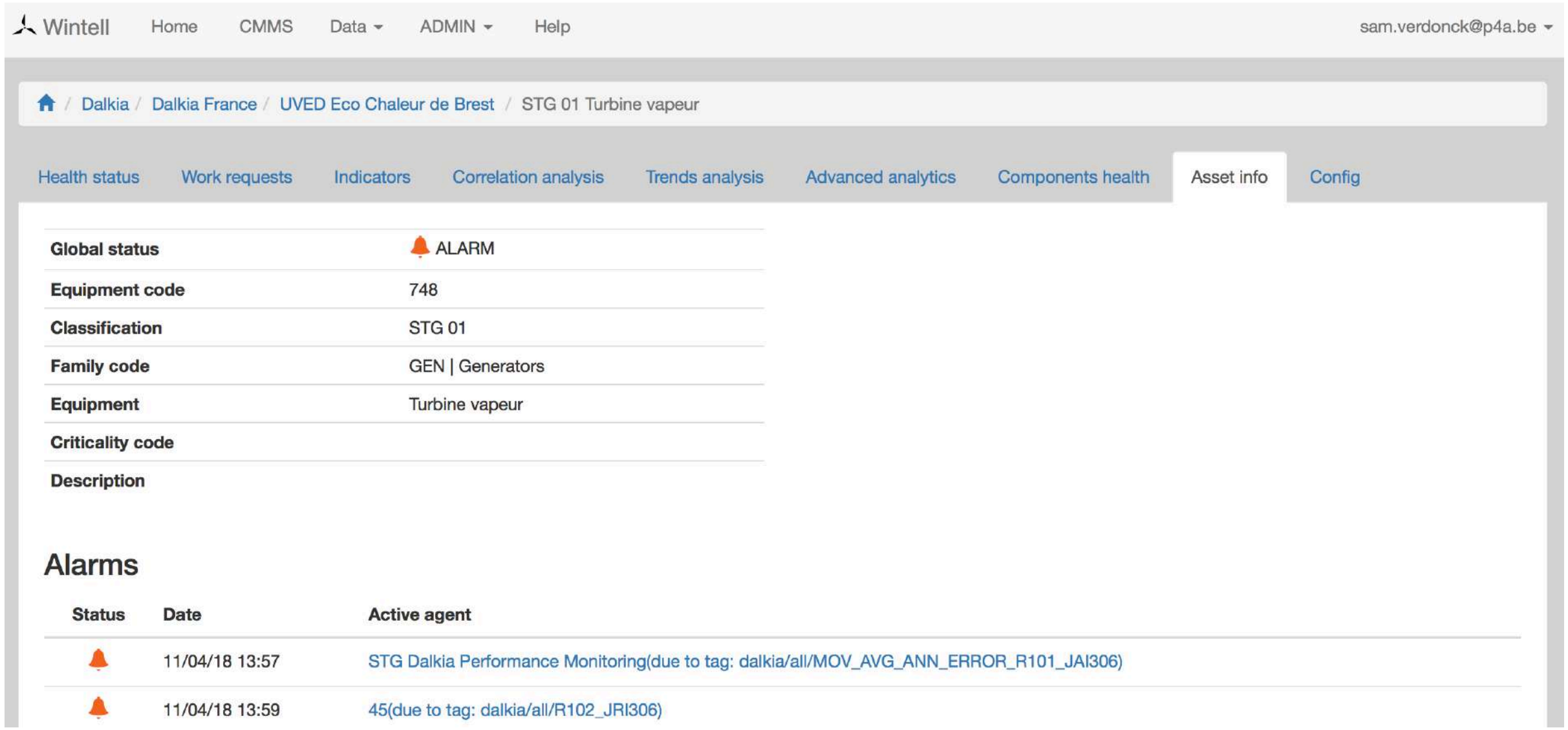
- Our robust auto-learning models allow **reliable, continuous condition monitoring**



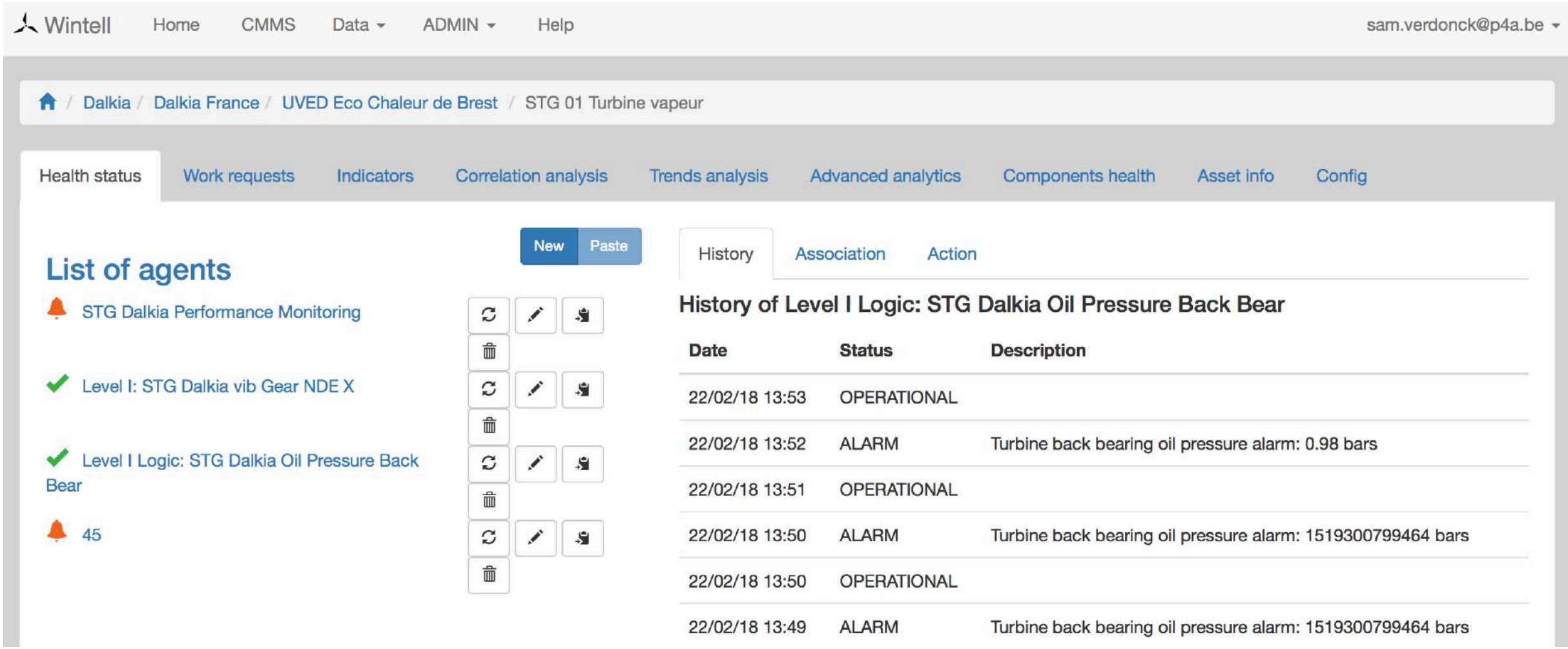
Dashboard



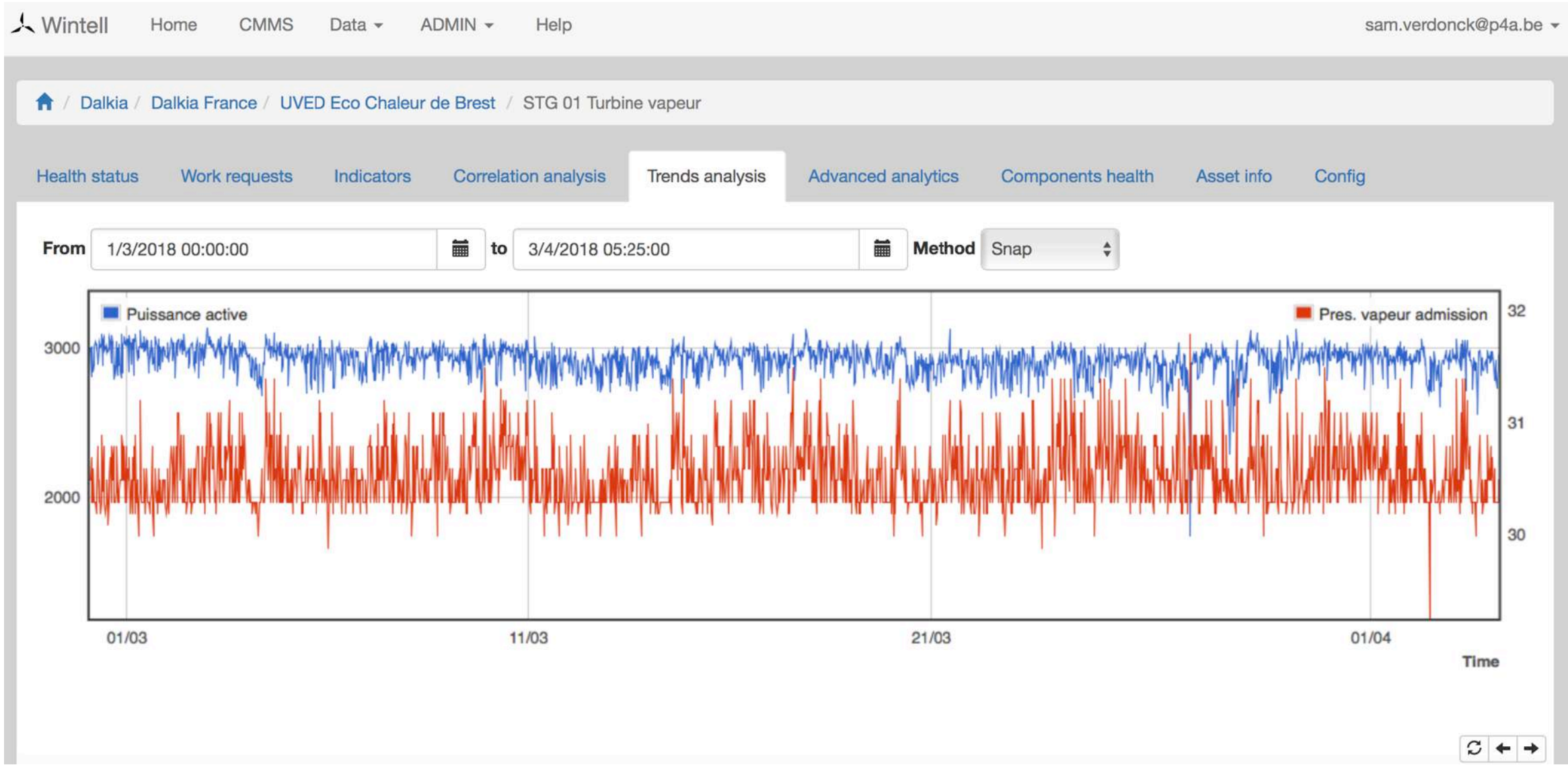
Asset info with alarms



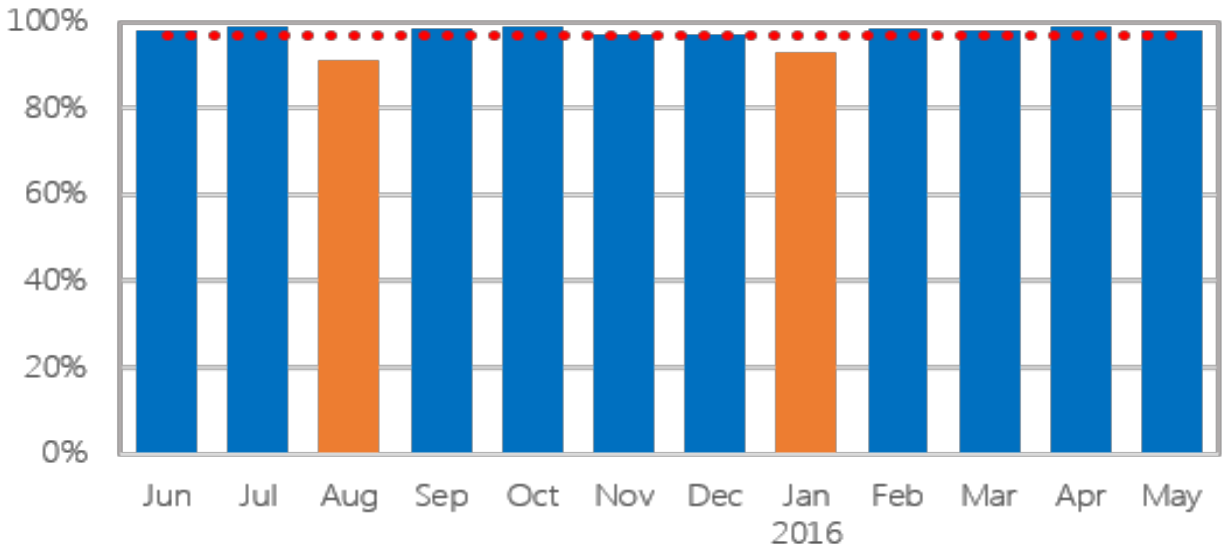
Asset health status

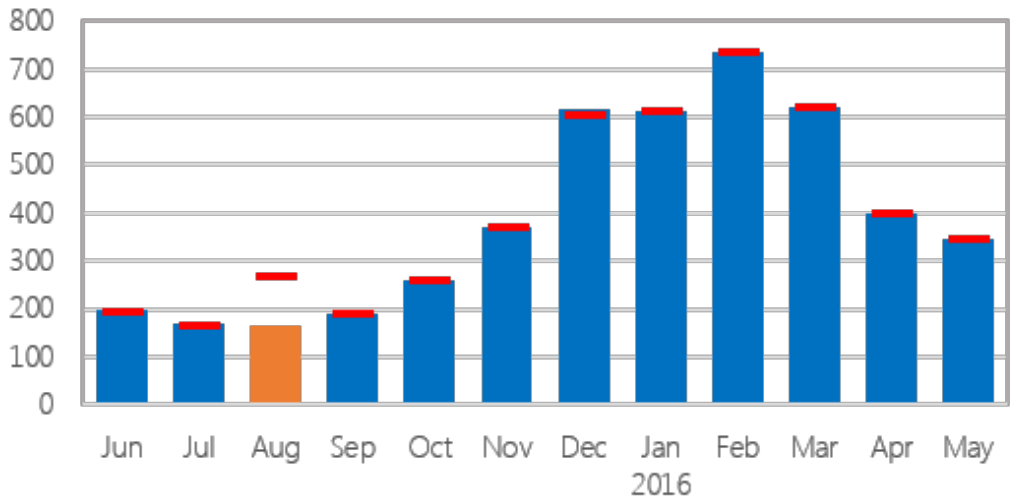


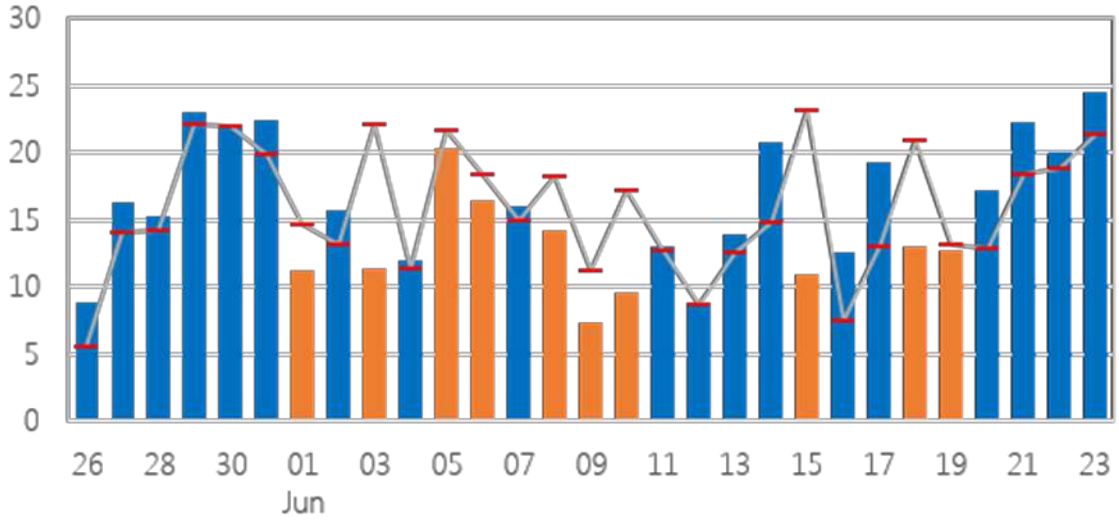
Various trend analysis options



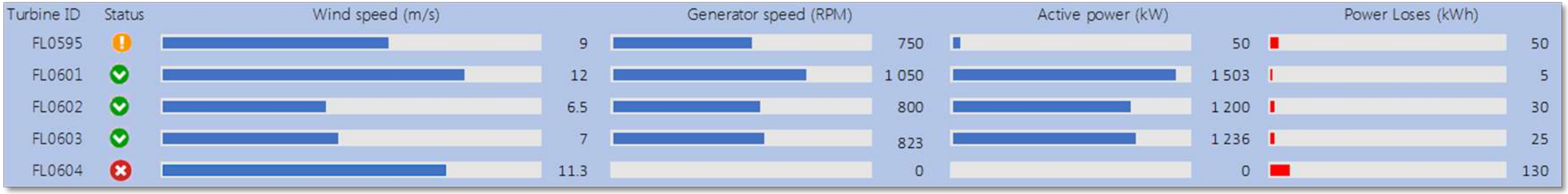
ASSET MANAGER: Production analysis





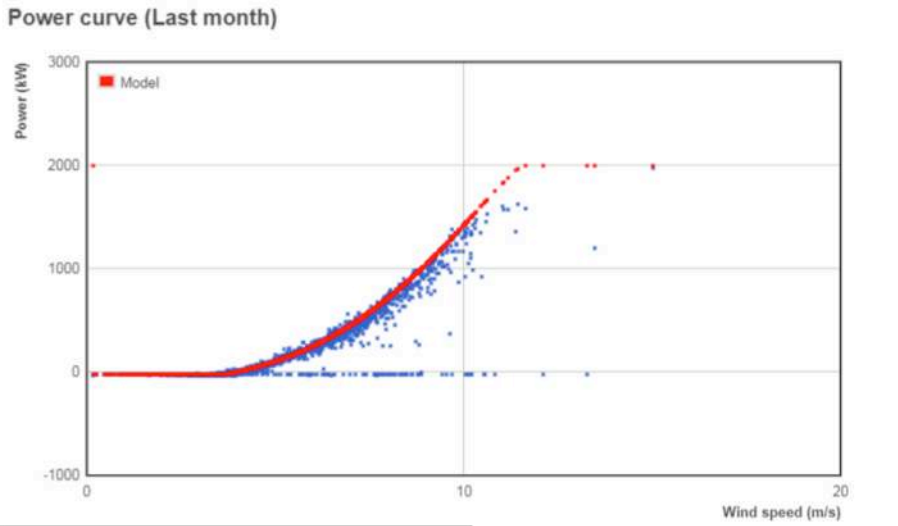


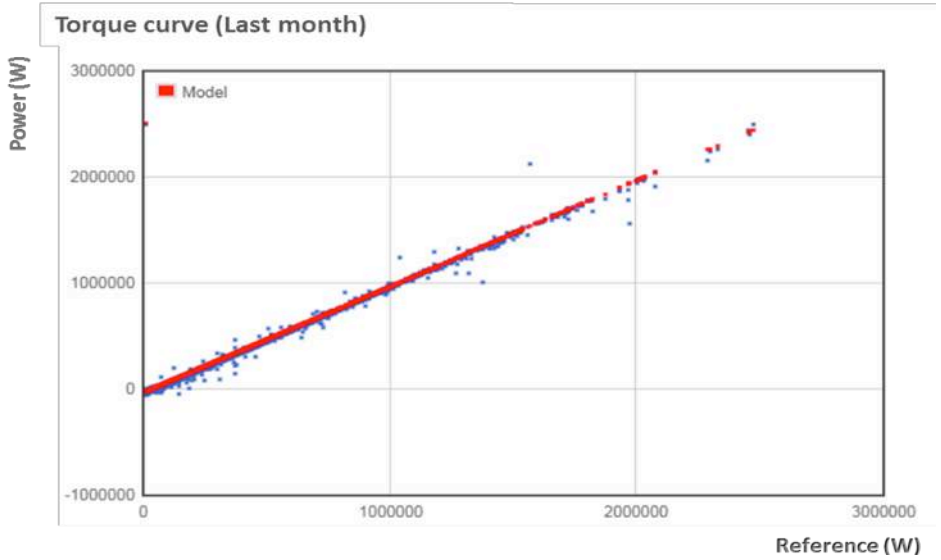
ASSET MANAGER: Gap analysis

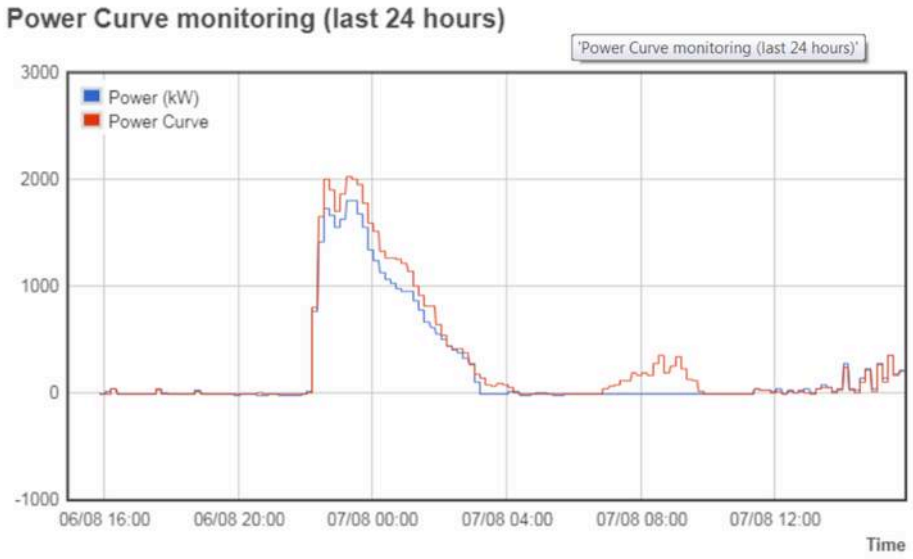


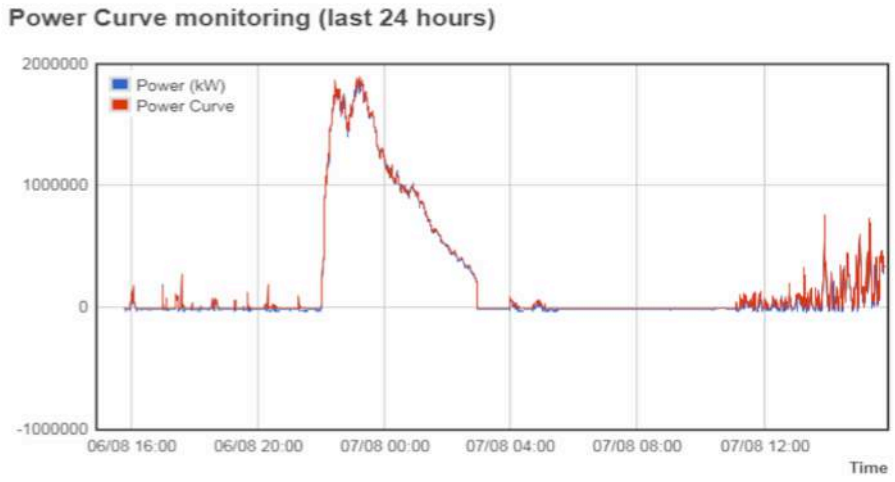
Turbine ID	Status	Wind speed (m/s)	Generator speed (RPM)	Active power (kW)	Power Loses (kWh)
FL0595	!	9	750	50	50
FL0601	✓	12	1 050	1 503	5
FL0602	✓	6.5	800	1 200	30
FL0603	✓	7	823	1 236	25
FL0604	✗	11.3	0	0	130

ASSET MANAGER: Power VS. Torque

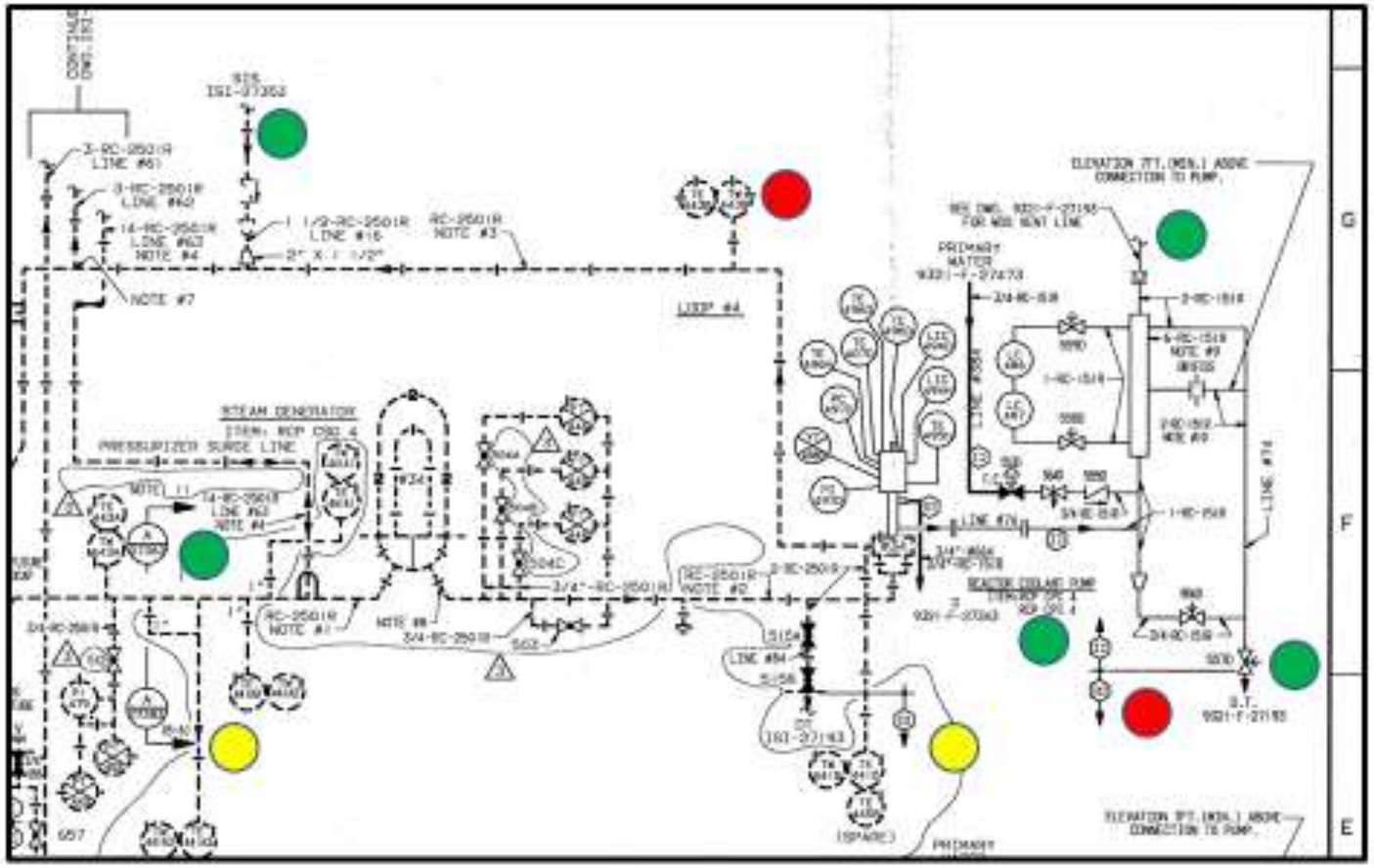








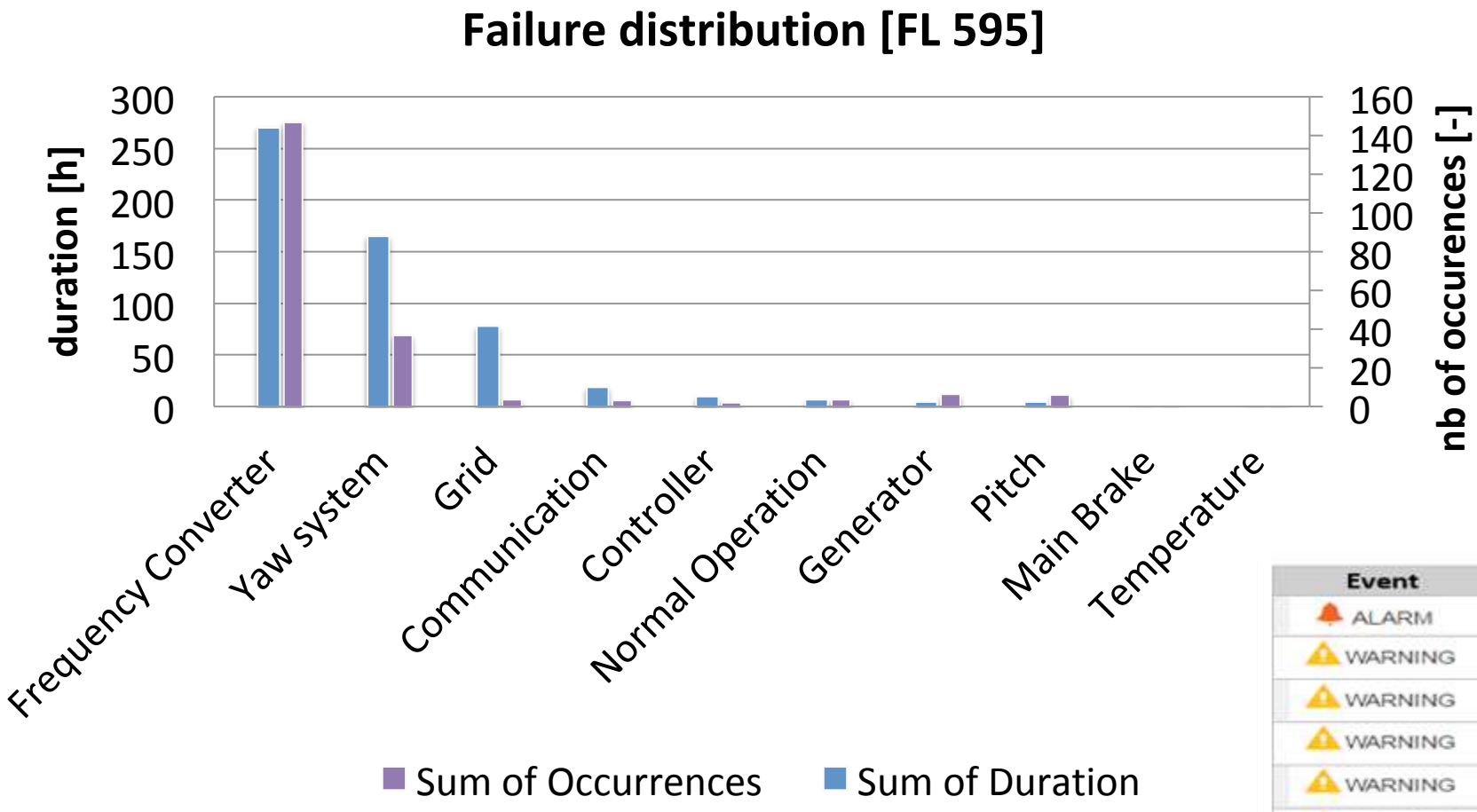
MAINTENANCE MANAGER: Alarm overview



KPI	MTTF	MTBA	Kpi 1	Kpi 2
Plant X	36 months	8.2 weeks	11	25.3

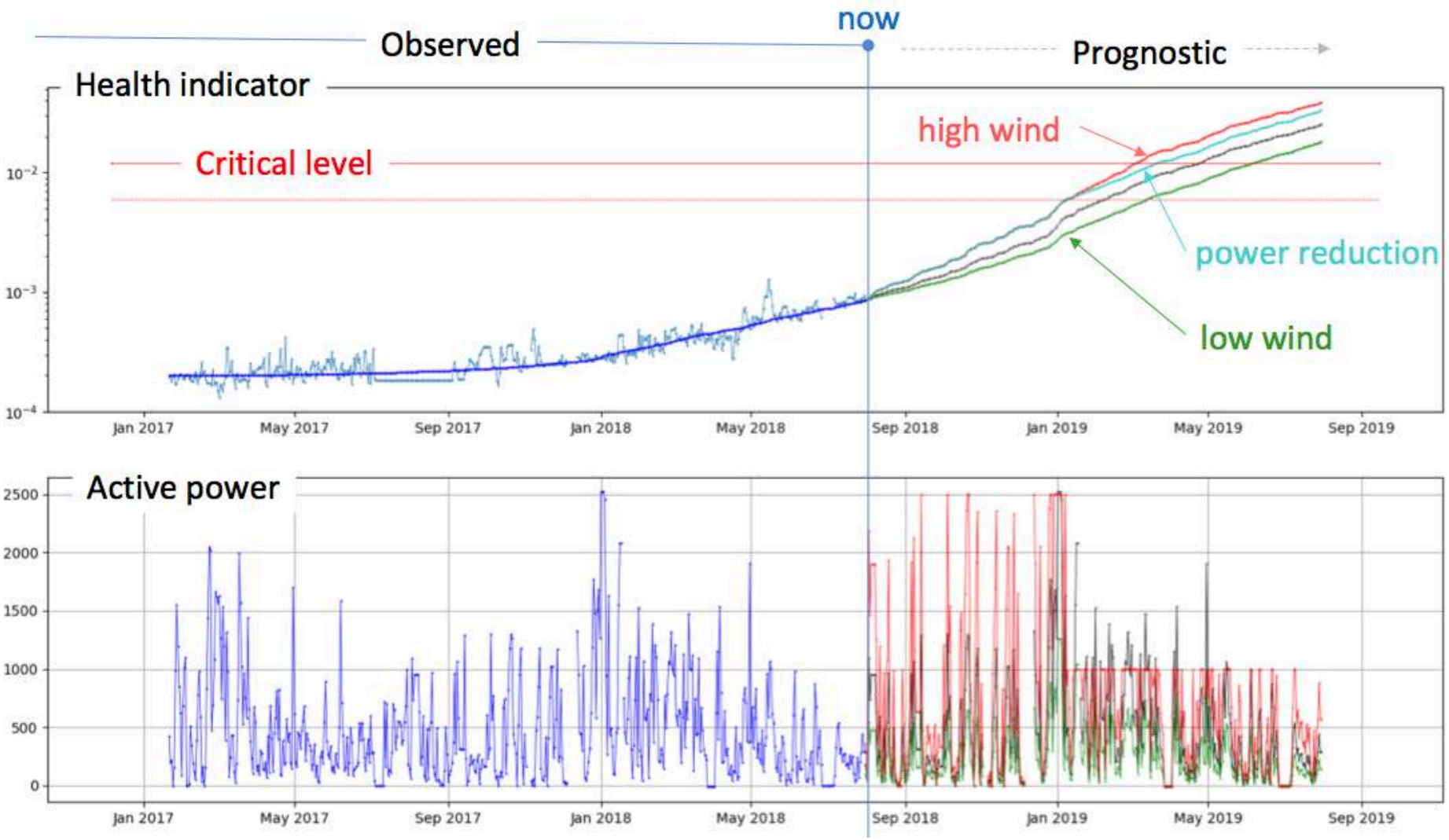
Status	Date	Asset
🔴	30/10/2017 14:48	Steam Trap 40
🔴	8/11/2017 07:41	Steam Trap 22
🔴	30/10/2017 14:48	Steam Trap 38
🔴	30/10/2017 14:48	Steam Trap 9
🔴	6/11/2017 18:04	Steam Trap 33
🔴	2/11/2017 08:58	Steam Trap 36
🔴	9/11/2017 05:56	Steam Trap 14
🟡	2/11/2017 08:58	Steam Trap 10
🟡	2/11/2017 03:28	Steam Trap 28
🟡	2/11/2017 03:28	Steam Trap 10
🟡	7/11/2017 17:42	Steam Trap 40
🟡	2/11/2017 03:28	Steam Trap 43
🟡	7/11/2017 21:20	Steam Trap 13

MAINTENANCE MANAGER: Failure analysis



Event	Date	Code	Components
ALARM	5/06/2015 15:52	734	Yaw system
WARNING	5/06/2015 18:56	128	Controller
WARNING	5/06/2015 19:32	128	Controller
WARNING	11/06/2015 11:21	734	Yaw system
WARNING	11/06/2015 21:41	1017	Communication
WARNING	17/06/2015 09:00	734	Yaw system
ALARM	18/06/2015 10:07	5706	Generator
WARNING	18/06/2015 10:14	110	Grid
ALARM	18/06/2015 10:32	1668	Freq Converter

MAINTENANCE MANAGER: Prognostic



Conditions	Prognostic
high wind	6 months
Low wind	12 months
High wind under power reduction	8 month

Services

Data value chain

Wintell + IBM

Data acquisition	Data stream	Storage	Analytics	Visualization
PLC/DCS	Quality	On premise	P4A Models	Dashboards
CMS	Relevancy	Private cloud	Data Maestro (Analytics)	Trending
Images	Cyber security	Big data	Open Source	Chatbot
Text	Governance		Physical	Open source
Videos	Gemalto		Clustering	
Sound				

Service packages

PLATFORM

Hosting, data governance, cyber security

- Data Connectivity
- Scalable storage system and data processing
- Data governance
- Data integrity and security
- Access to analytic tools

MODULES

Online hybrid models designed to enhance productivity and business gains

- Online Monitoring & Analysis
- Hybrid models built on physical & data driven models, tuned for machine specifications
- Multiple synchronized data sources
- Data Analytics
- Reporting Canvas
- Support from data scientists & process experts

BUSINESS DATA

Extract relevant KPI's

- Business Advices
- Anonymus Benchmarking

How to get started?

FLASH ANALYSIS

Approach: Process and business understanding

1. Identify needs and concerns
2. Identify data/information already available
3. Define KPI's

Targets: Present potential improvements and associated savings

1. Offline analysis of historical data and reporting
2. Online implementation
3. Additional quick wins models using on the same data into different areas

Deliverable: Report with opportunities for process optimization / PDM

Project flow

Step 1: **Process & Business Understanding**

- Interview with process engineers to define main Kpi(s)
- Evaluation of P&IDs / PFDs
- Evaluation of data availability / Key data identification

Step 2: **Flash Analysis**

- Definition of key performance indicators (KPIs)
- Performance & maintenance benchmarking
- Assessment of potential improvements opportunities (cost savings, performance, maintenance)
- Evaluation of constraints or road blocks

Project flow

Step 3: **Workshops**

- Workshops with operators and plant staff for
- Brainstorming root causes of variability and process improvement ideas
- Objective to engage operators in the project
- Ideas presented on a root cause tree

Step 4: **Advanced Analytics**

- Preparation of historical data -> KPI calculation (flag possible data quality issues)
- Analyse trends and assess long, mid-term (like seasonality) and "local" variability
- Compare performance, failure rates, with best historical performance or industry benchmarks
- Define a realistic target considering production, availability and quality requirements
- Quantify the performance gap and failure rates reduction
- Estimate the potential cost savings

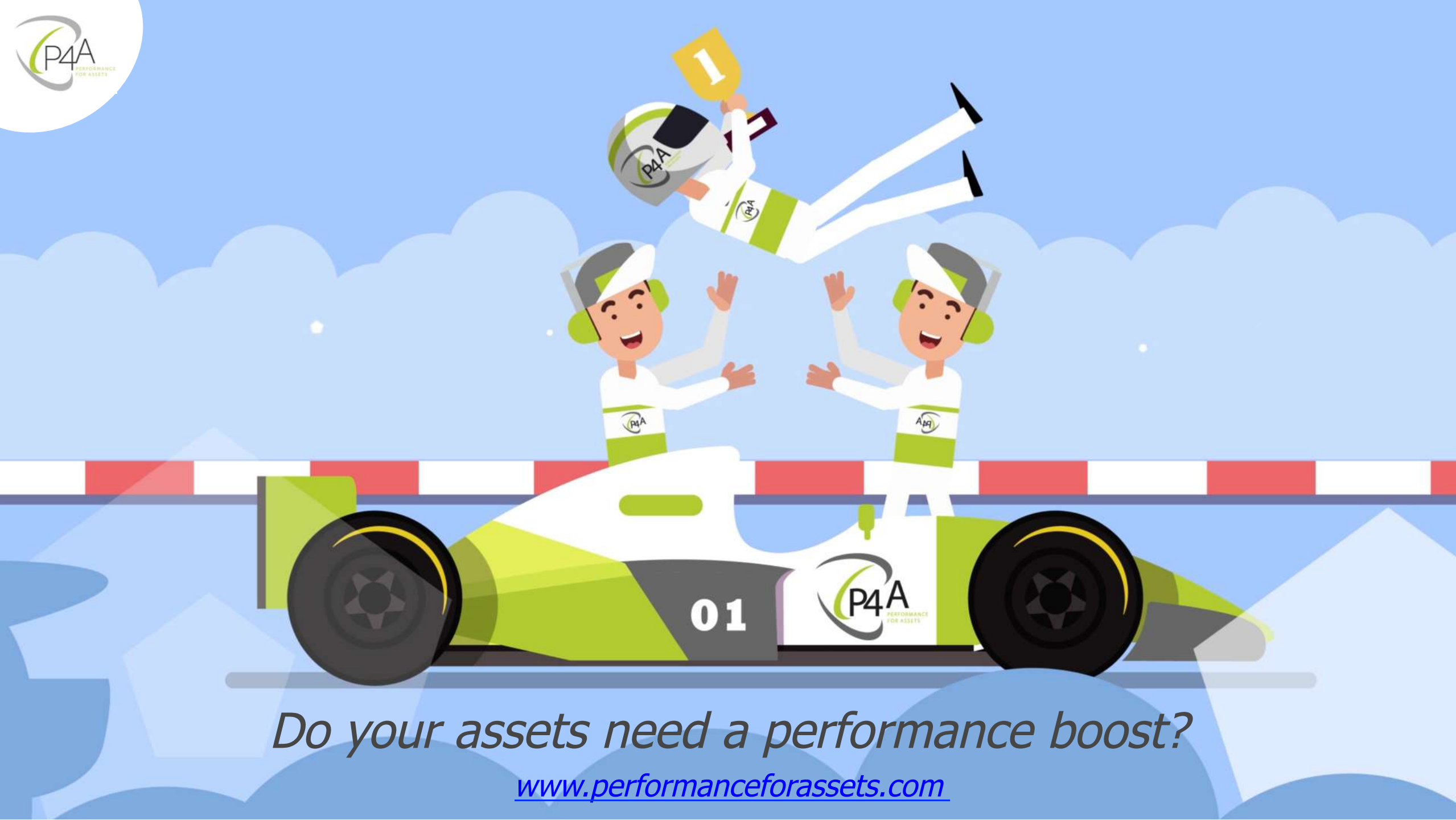
Project flow

Step 5: **Model development & offline testing**

- Key parameter identification
- Model development and evaluation
- Model testing offline with independent/new data sets

Step 6: **Online implementation**

- Setup of prototype dashboard through Wintell web portal
- Online implementation



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