ANDRITZ HYDRO

PREDICTIVE MAINTENANCE OF HYDRO ASSETS

METRIS DIOMERA

2021.12.15
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ANDRITZ

ENGINEERED SUCCESS

A WORLD MARKET LEADER WITH FOUR BUSINESS AREAS

ANDRITZ

PULP & PAPER

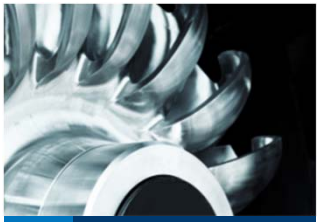
48

% order intake*

PRODUCT OFFERING

Equipment for production of all types of pulp, paper, tissue, and board; boilers for power generation; flue gas cleaning systems; recycling and shredding solutions; plants for the production of nonwovens and panelboard

HYDRO



22

% order intake*

PRODUCT OFFERING

Electromechanical equipment for hydropower plants (turbines, generators); pumps; turbo generators

METALS

19

% order intake*

PRODUCT OFFERING

Presses/press lines for metal forming (Schuler); systems for production of stainless steel, carbon steel, and non-ferrous metal strip; industrial furnace plants

SEPARATION

11

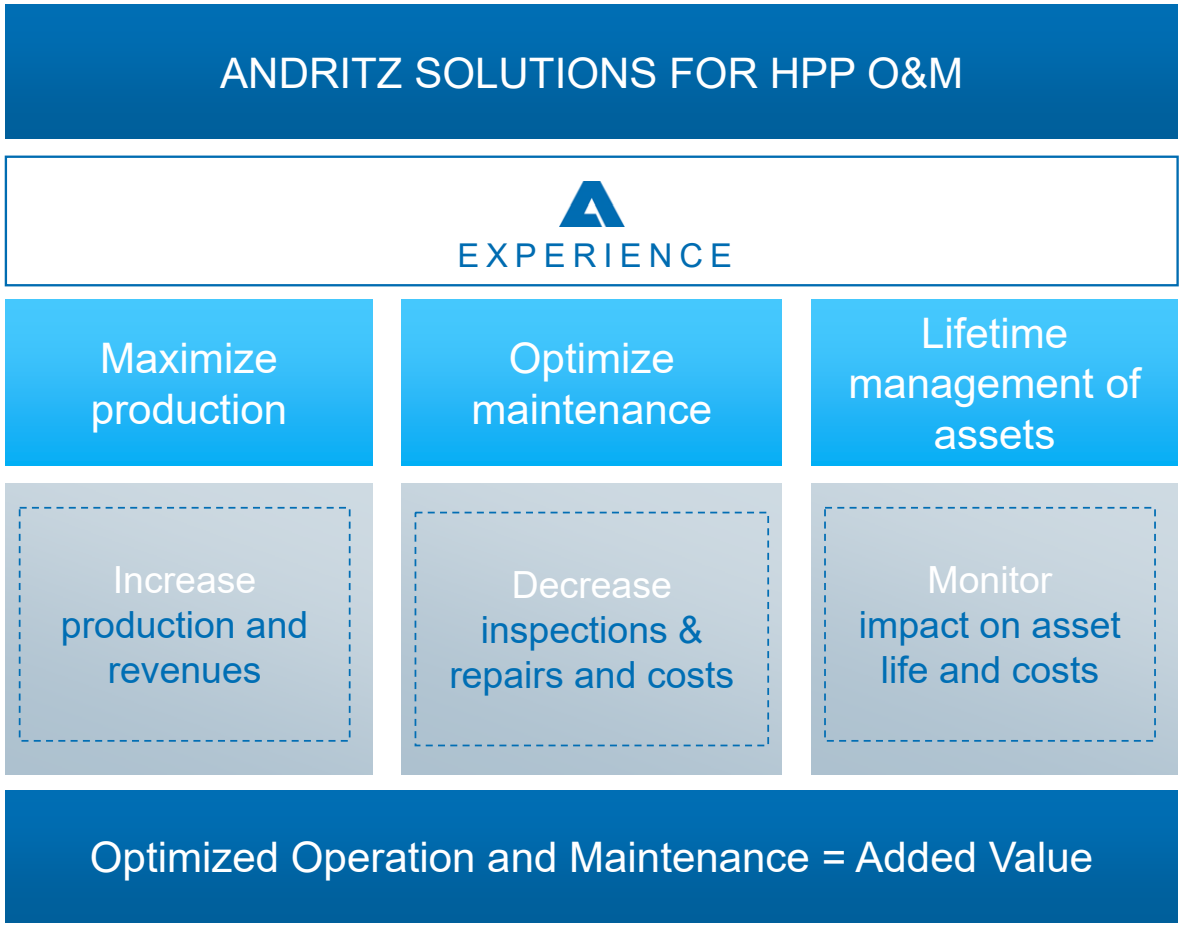
% order intake*

PRODUCT OFFERING

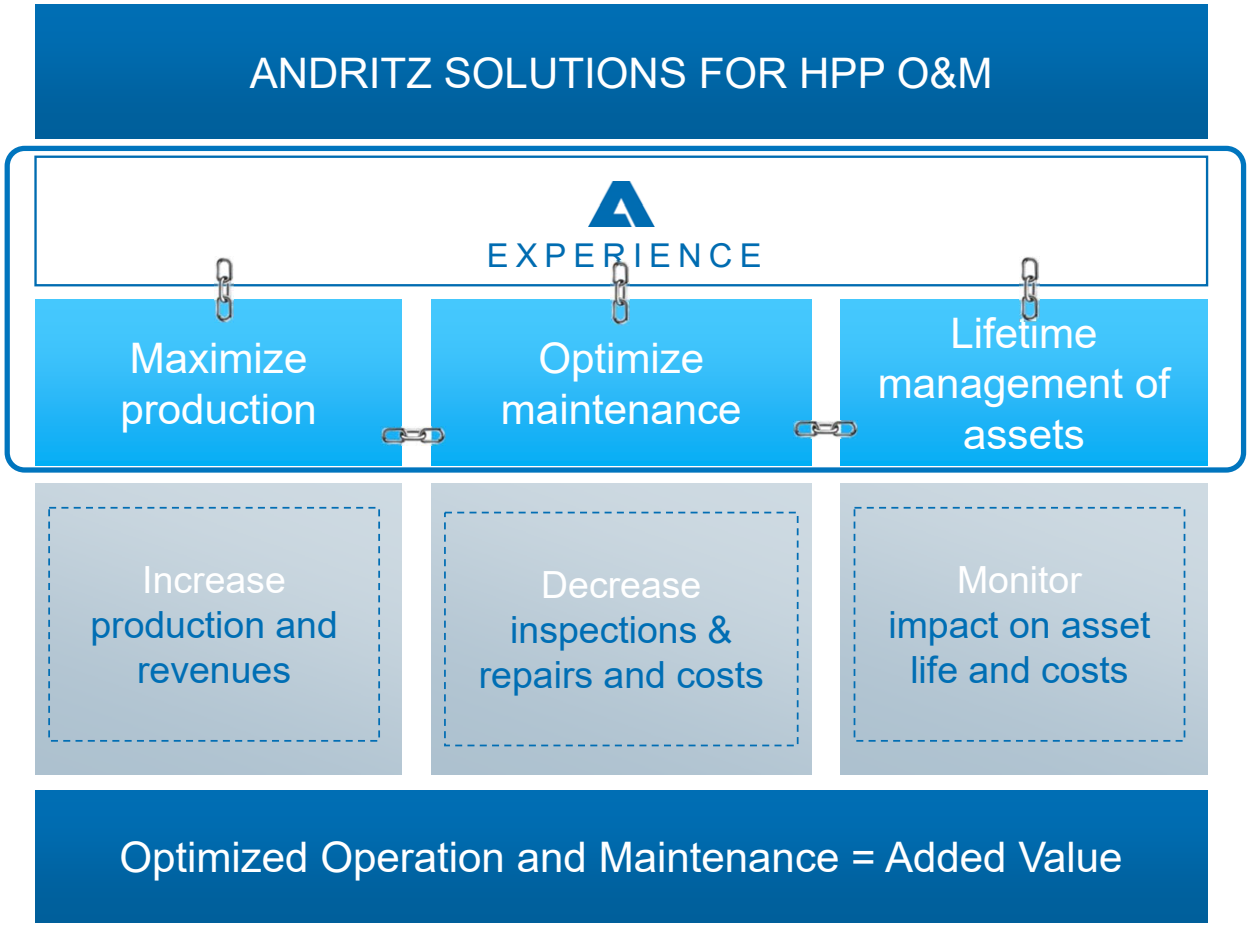
Equipment for solid/liquid separation for municipalities and various industries; equipment for production of animal feed and biomass pellets

* Share of total Group order intake 2020

ANDRITZ HYDRO O&M – MAIN FOCUSED TOPICS

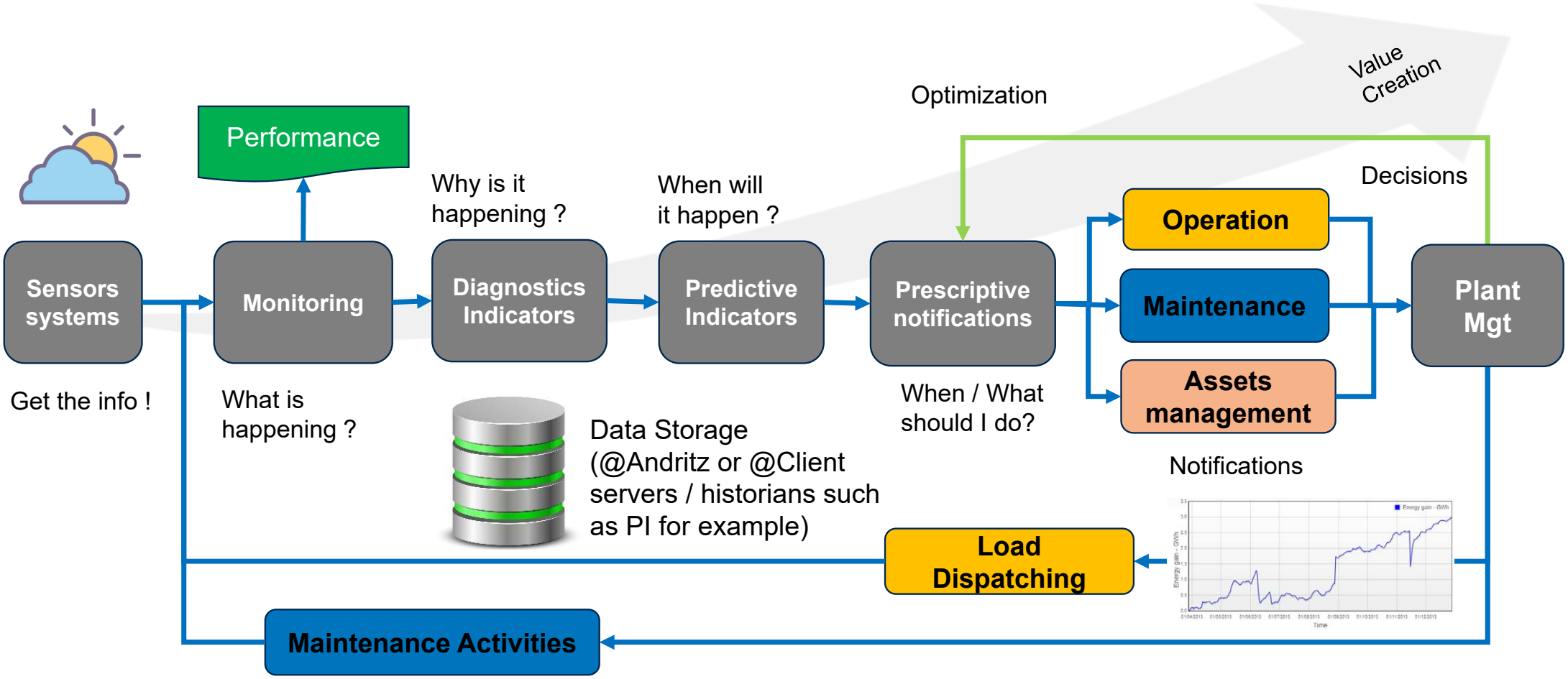


ANDRITZ HYDRO O&M – DIGITAL PLATFORM



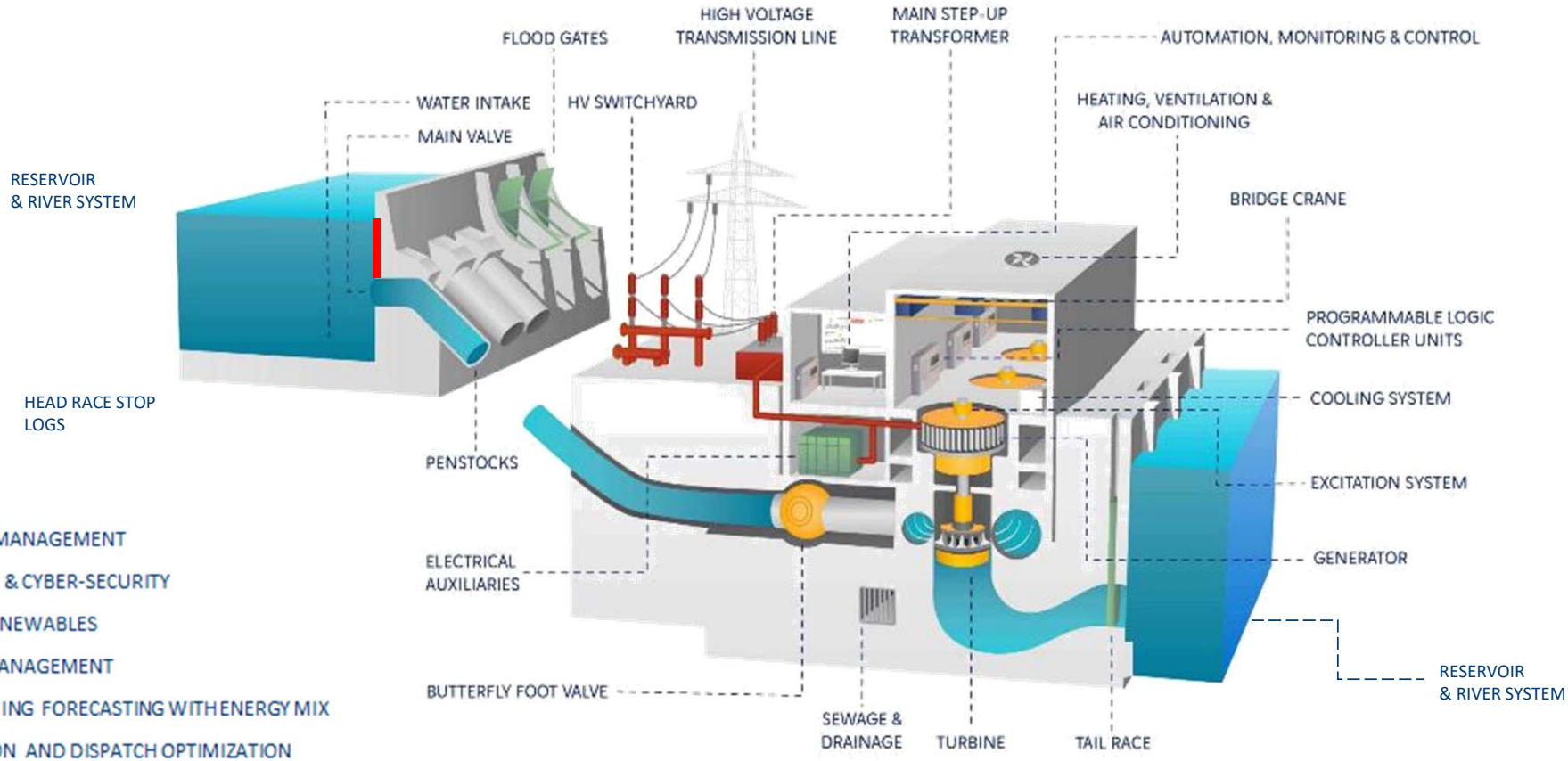
Metris DiOMera™ is a digital platform targeting improvement of Unit(s) / Plant(s) performances by a **combination** of **assessment / optimization / experience**

O&M DIGITALIZATION JOURNEY



ADDRESSING THE ENTIRE ECO-SYSTEM

Any component that can impact O&M shall be addressed

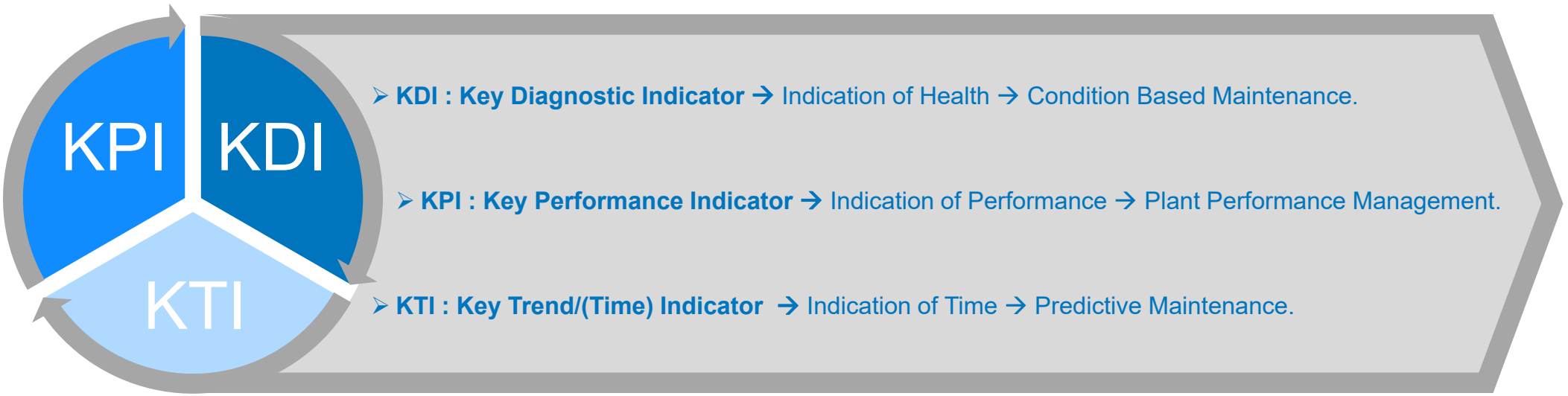


OTHERS

- FACILITY MANAGEMENT
- PHYSICAL & CYBER-SECURITY
- OTHER RENEWABLES
- WATER MANAGEMENT
- DISPATCHING FORECASTING WITH ENERGY MIX
- OPERATION AND DISPATCH OPTIMIZATION

DIOMERA INDICATORS

Indicators for different purposes



DIOMERA INDICATORS

Creating different categories of predictive indicators

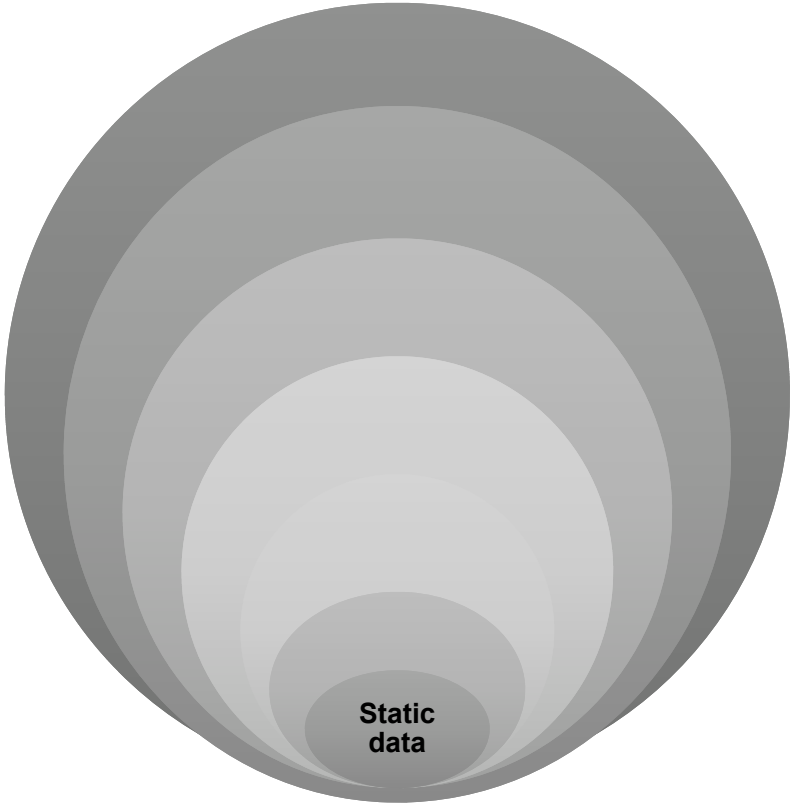
Maintenance or else Indicators (KDI, KTI) are derived from different types of Meta-models :

- Based on Andritz Hydro´s extensive experience and know-how.
- Enriched by the Client/Operator knowledge of the plant.
- Generic Mathematical Models
- Data Analysis
- Machine Learning Algorithms

Universal Models based on general physical laws and technical knowledge, like for example the water density as a function of temperature or residual life analysis of turbine's runner.	e.g. Pelton runner inspection intervals, Francis runner cost of operation, wear of Kaplan runner regulating mechanism…
Models requiring a training on a reference period, representing a known physical context and rooted in technical knowledge.	e.g. Head losses, efficiency hill chart…
Models purely based on data created from Machine Learning and unveiling specific behaviours whereby the physical meaning is not trivially obvious.	e.g. Predictions of bearing vibration, bearing temperature, generator temperature …

DATA CATEGORIES

A growing data landscape in an heterogeneous fleet of plants

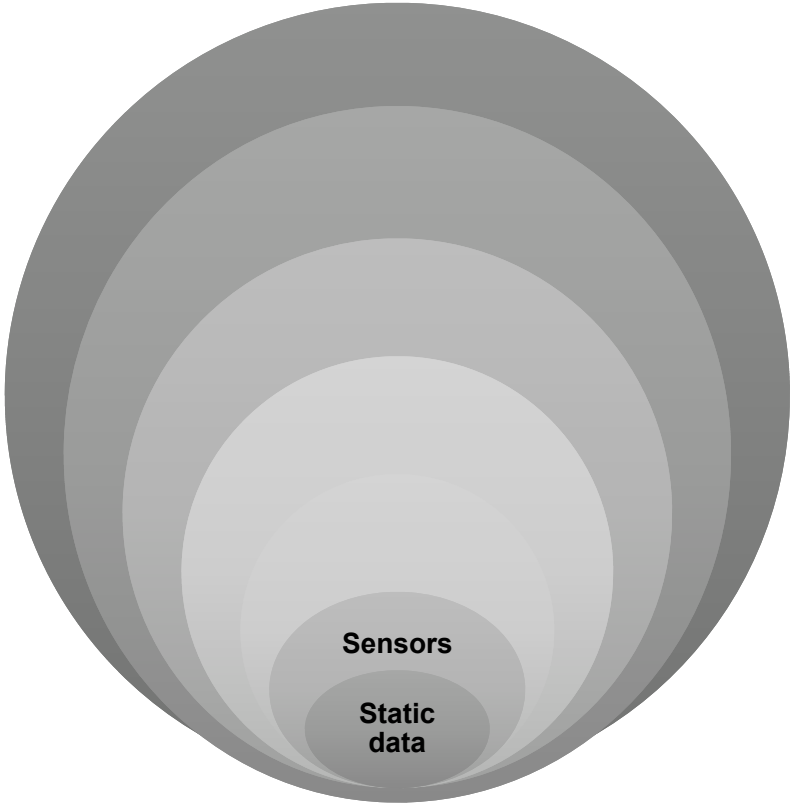


STATIC DATA

- Main dimensions, plant drawings, data sheets, characteristic curves…

DATA CATEGORIES

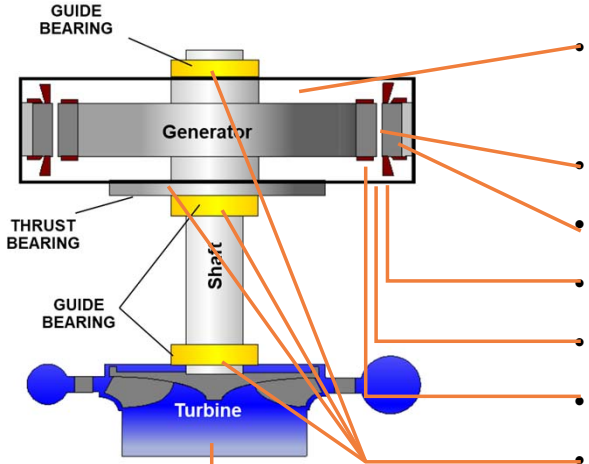
A growing data landscape in an heterogeneous fleet of plants



SENSORS

- Classical set of sensors for operation, control and supervision (pressures, temperatures, positions of actuators, flows, rotation speed)
  - ≈ 100-150 signals per generating unit

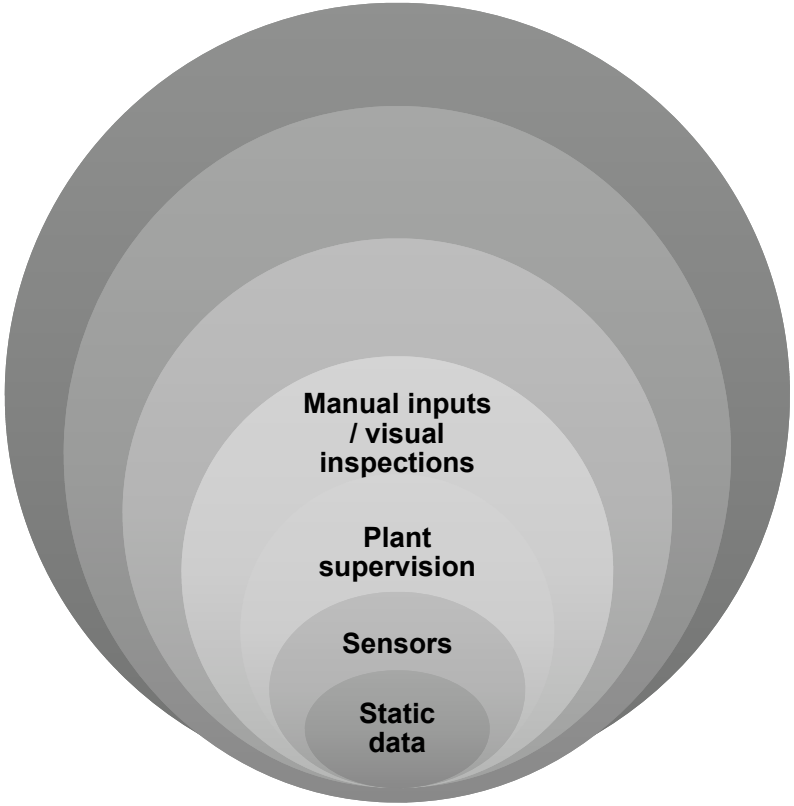
- Special sensors for advanced monitoring



- Cooling Air Analysis (Ozone and Hydrocarbons)
- Magnetic Flux
- Structure Borne Sound
- Partial Discharge
- Air Gap
- Rotor pole temperature by IRD
- Vibration
- Sediment concentration

DATA CATEGORIES

A growing data landscape in an heterogeneous fleet of plants



PLANT SUPERVISION

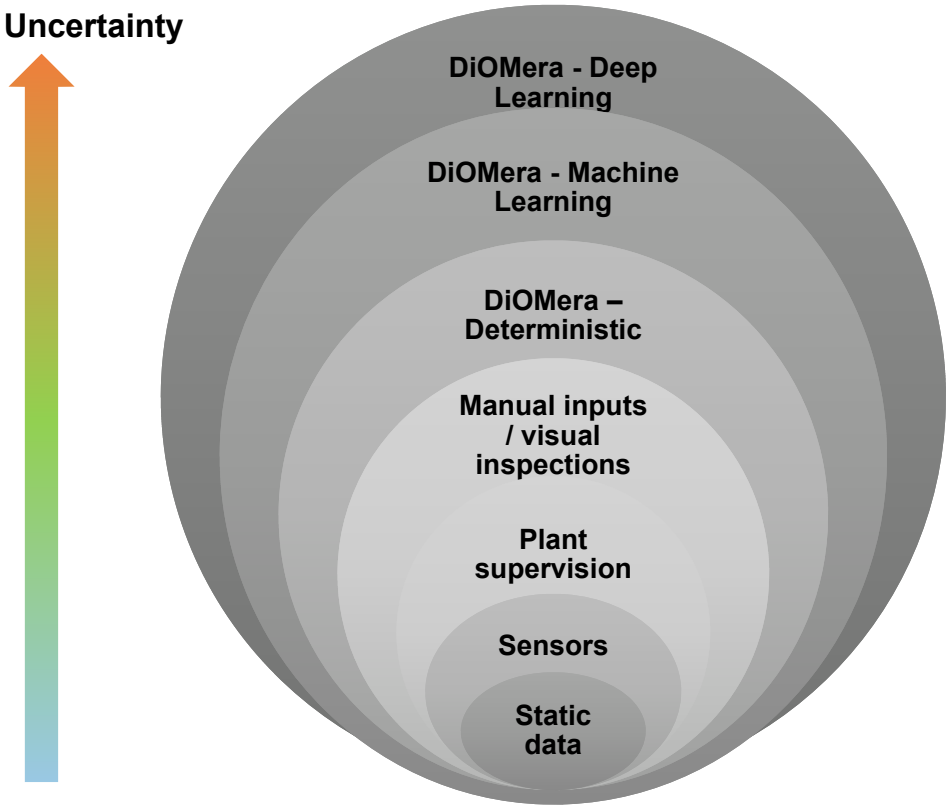
- Computed tags in SCADA (head, flow, energy, service hours…)
- Setpoints
- Alarms

MANUAL INPUTS – VISUAL INSPECTIONS

- Sediment concentration from manual water samples
- Non-wired sensors (indicators)
- Turbine erosion characteristics
- Shaft seal erosion

DATA CATEGORIES

A growing data landscape in an heterogeneous fleet of plants



DIOMERA DETERMINISTIC

- Universal models

DIOMERA ML

- Models based on physics but requiring a training

DIOMERA DL

- Models purely based on data

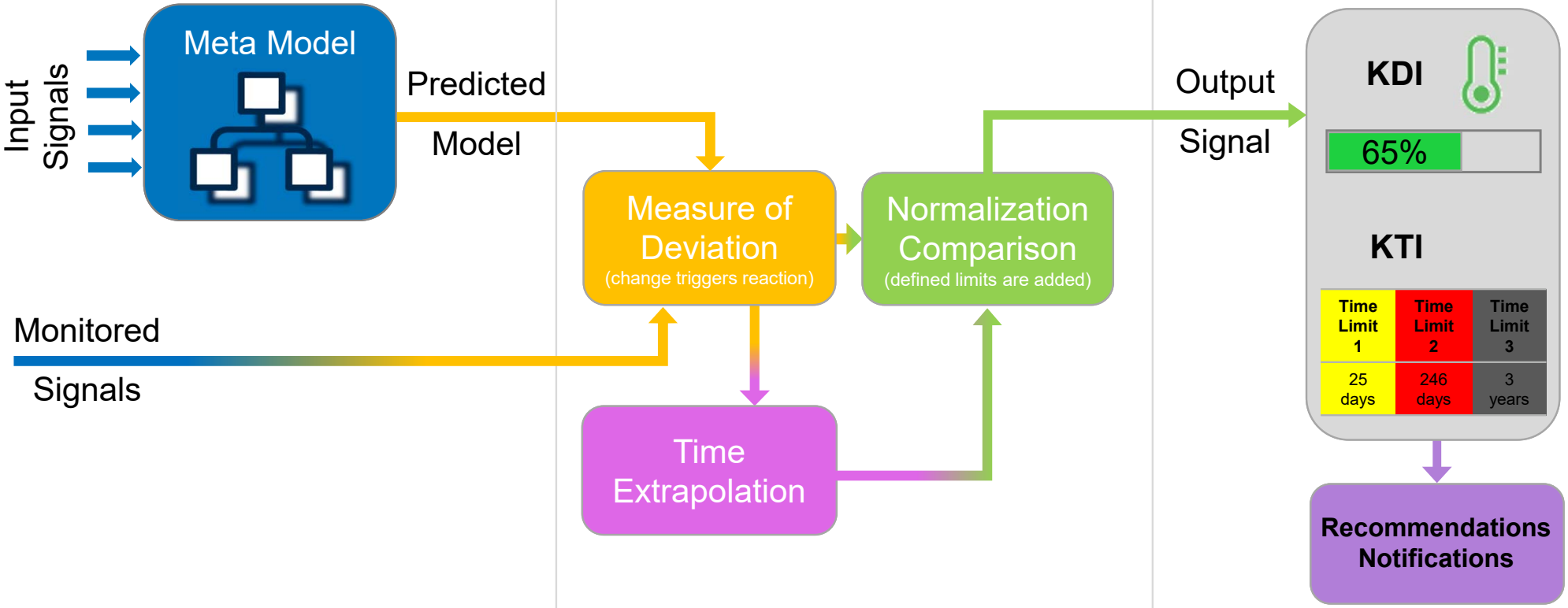
DIOMERA INDICATORS: PROCESS

From metamodels to KDIs & KTIs

1. Raw Signal Processing Phase :
Signals are acquired and/or computed. Monitored signals (e.g. index efficiency) are computed from a combination of several other individual signals.

2. Predicted Signal Conditioning Phase :
Corresponds to the reference behaviour of asset. Time extrapolations enables estimation of future evolution of the deviation.

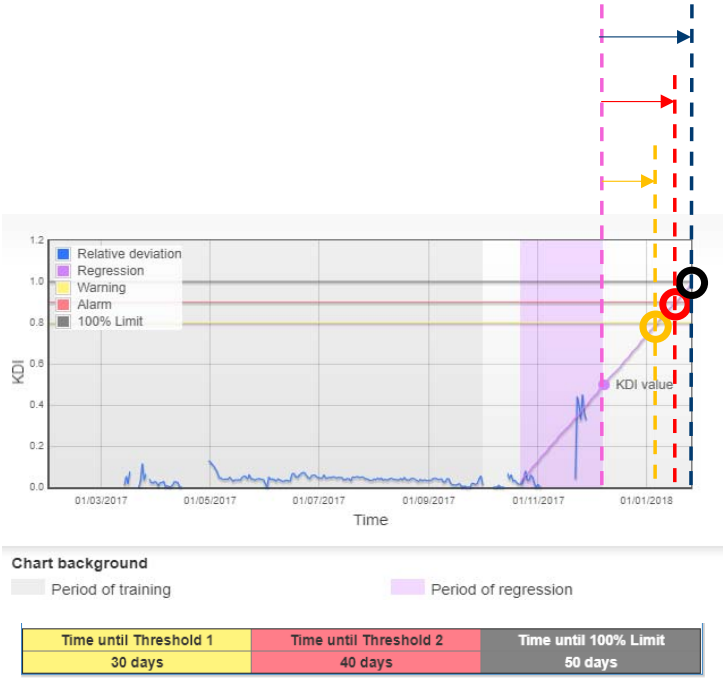
3. Final Signal Result/Output :
Adjustable according to the combined experience of ANDRITZ Hydro and plant operators. Delivers the estimation of KDI & KTI for the parameter.



DIOMERA INDICATORS

From metamodels to KDIs & KTIs

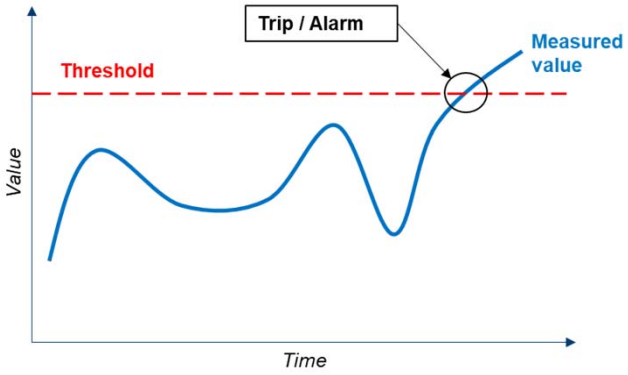
- KDI & KTI are an additional layer above metamodels
  - Metamodels are objects able to deliver a prediction (a simulation) of a data signal
  - A KDI is an object able to compare the output of a metamodel with the corresponding measured signal. It requires:
    - **A scaling value**: this is the allowed maximum deviation between measurement and prediction, corresponding to a KDI value of 100%
    - A **warning** and an **alarm thresholds**: used to generate notifications prior to reaching the maximum allowed deviation
    - A **regression period**: used to smooth the evolution of the instantaneous deviation and capture the average trend
  - The KTI expresses the remaining time before reaching warning, alarm and maximum thresholds
    - Calculated via an extrapolation of the average trend captured over the regression period



DIOMERA INDICATORS

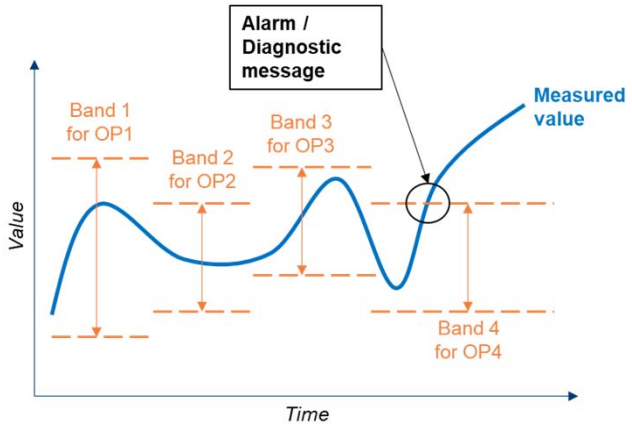
Difference with protection and Monitoring & Diagnostic

Protection



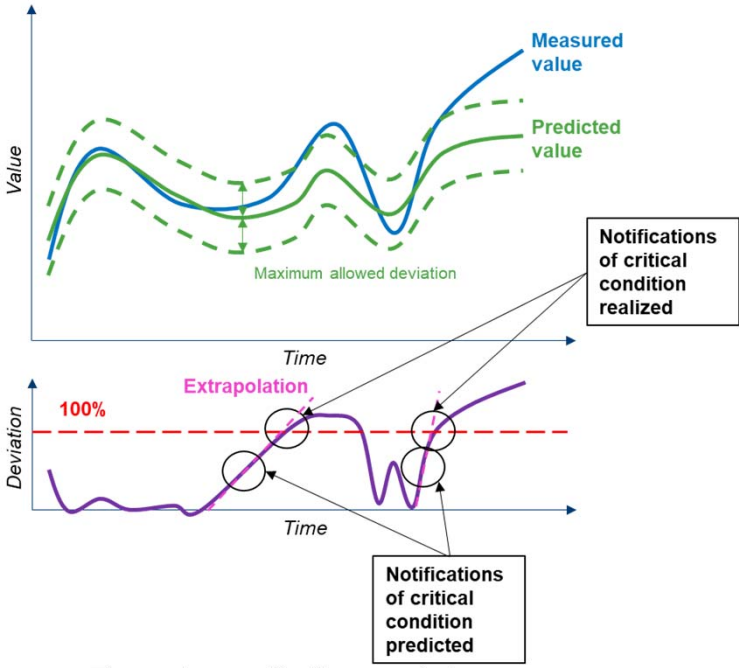
- **Target: safety and integrity of asset**
- Static threshold value
  - Often defined via norms
- Strong interaction with control

Monitoring & Diagnostic



- **Target: condition monitoring**
- Thresholding via mostly one-dimensional operating parameter ajusted during commissioning

Predictive

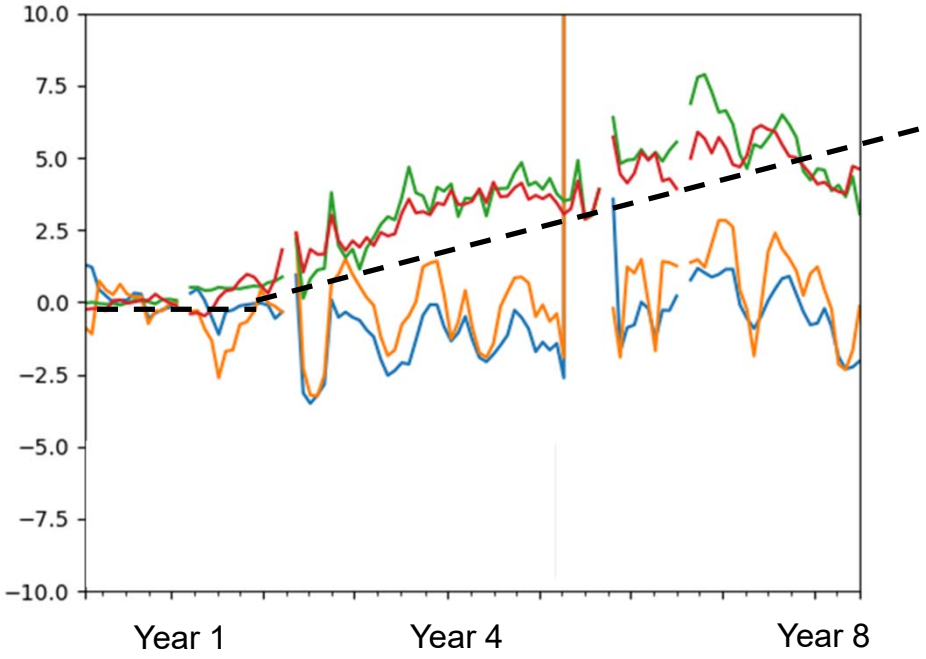


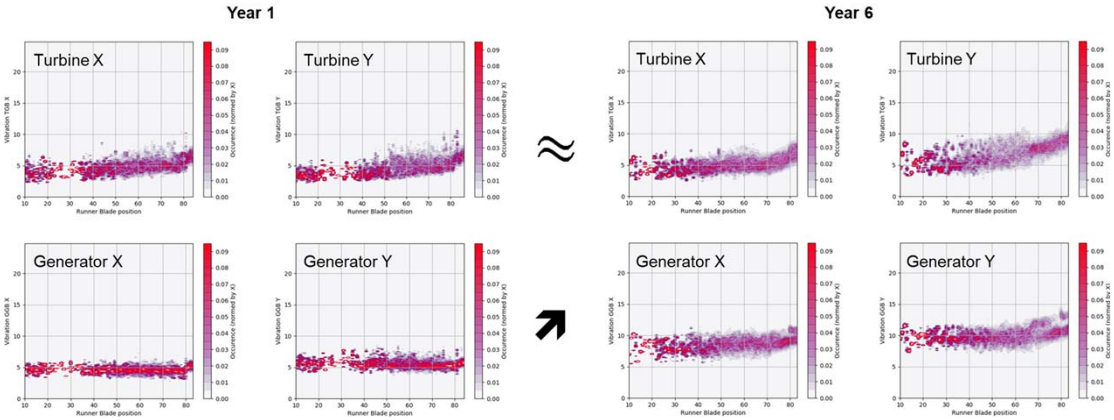
- **Target: predictive maintenance**
- Predicted (simulated) value is a reference defining the normal range of evolution of the measured quantity
- Extrapolation of deviation aims at detecting critical condition before they occur

DIOMERA INDICATORS - EXAMPLES

Increase of bearing vibrations

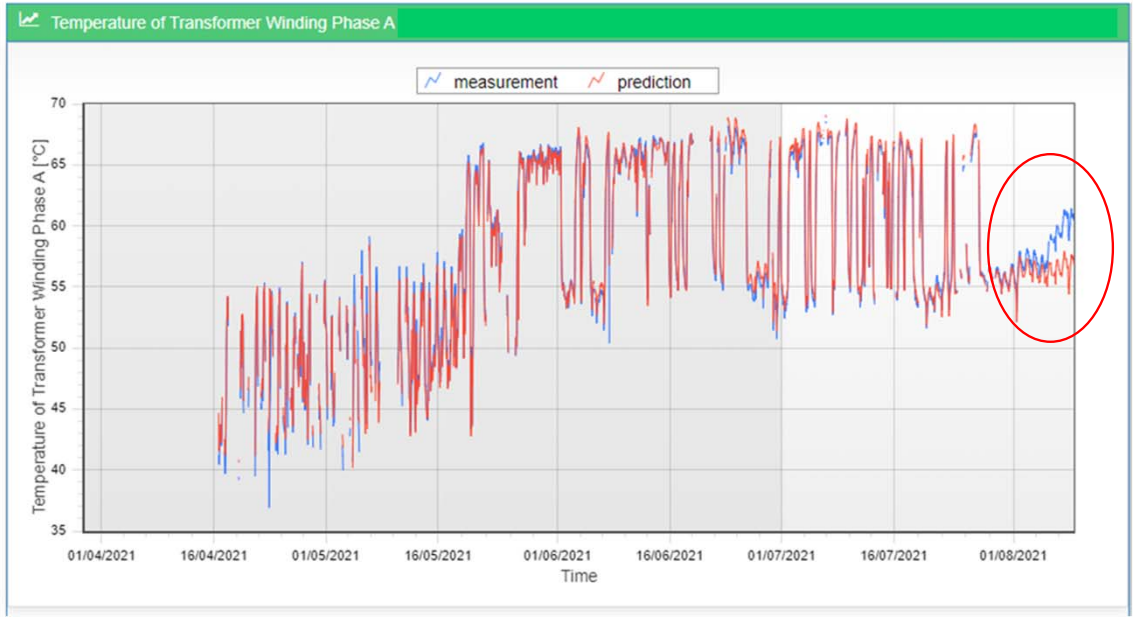
9x Kaplan – Canada
Slow increase of generator's bearing vibrations over 8 years on one unit





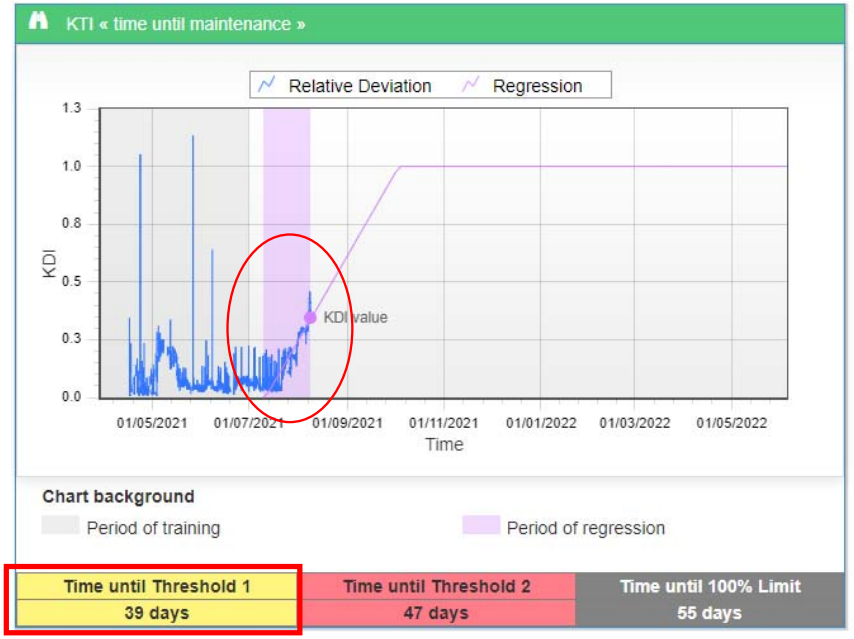
DIOMERA INDICATORS - EXAMPLES

Transformer temperature



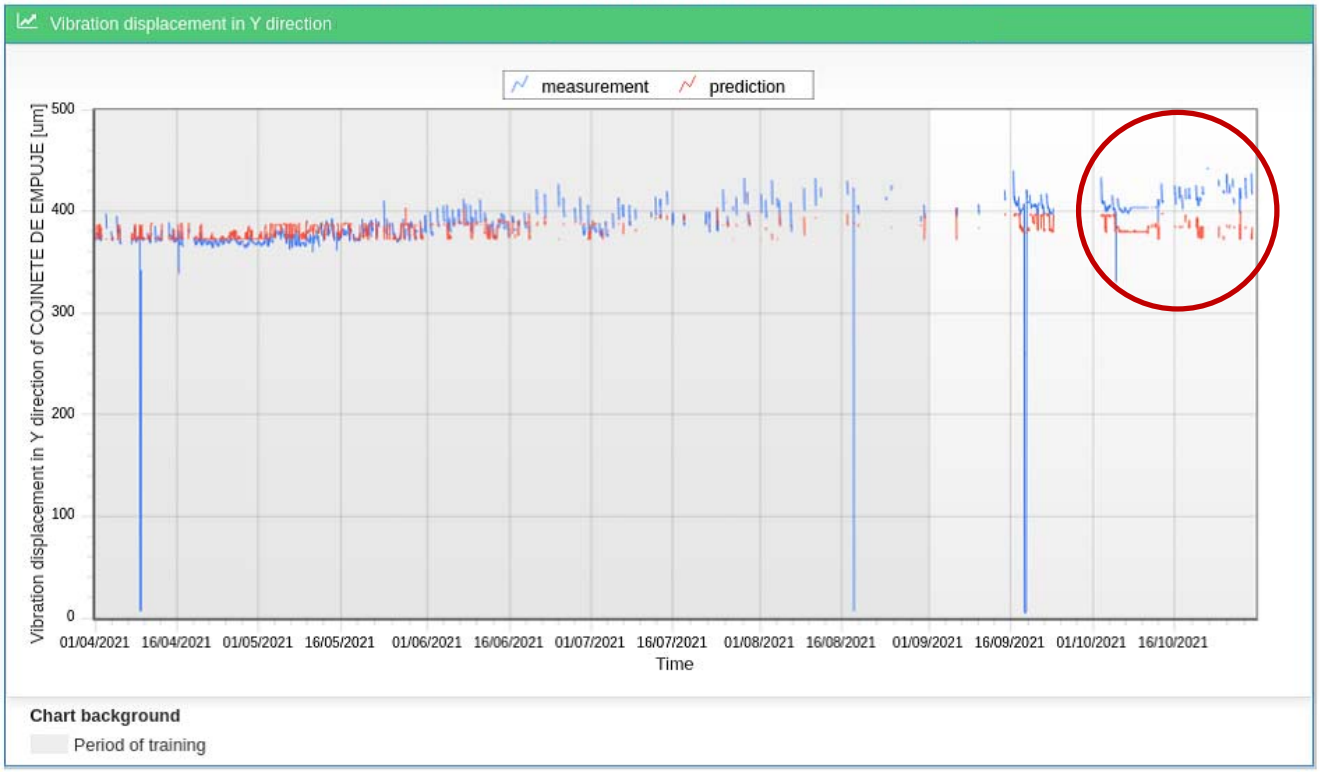
- Indicator: **Status of temperature of transformer winding**

- ON SCADA Temp value were in nominal range of 55 to 62 °C
- Very fast increase of deviation detected
- KDI value not alarming but change of KDI value (i.e., trend) is alarming

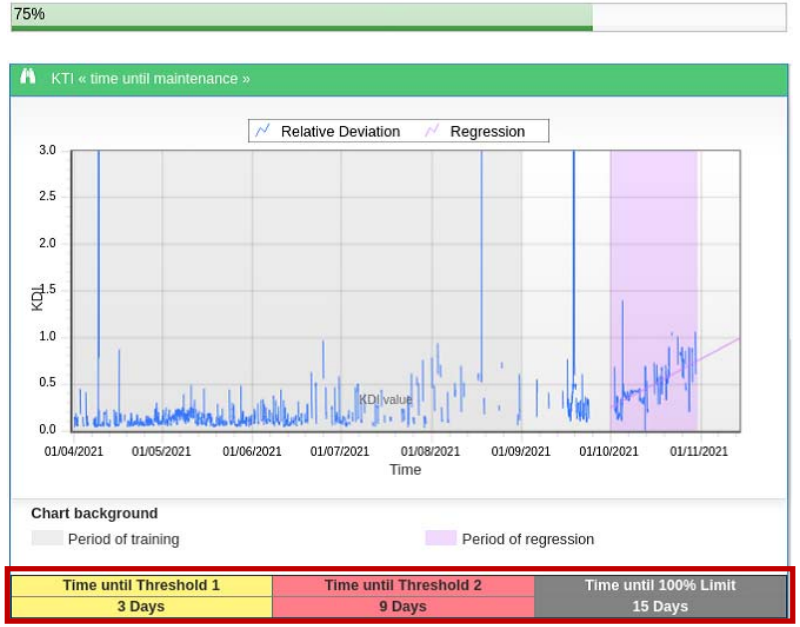


DIOMERA INDICATORS - EXAMPLES

Bearing vibration in a vertical Francis unit



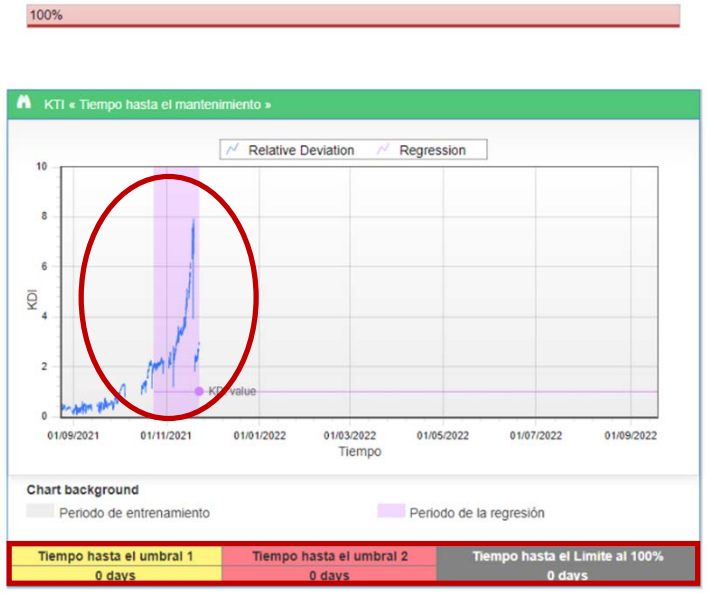
- KDI value not alarming yet (close to first threshold)
- Change of KDI value (i.e., trend) is alarming (KTI = few days)



DIOMERA INDICATORS - EXAMPLES

Bearing vibration in a vertical compact Axial unit

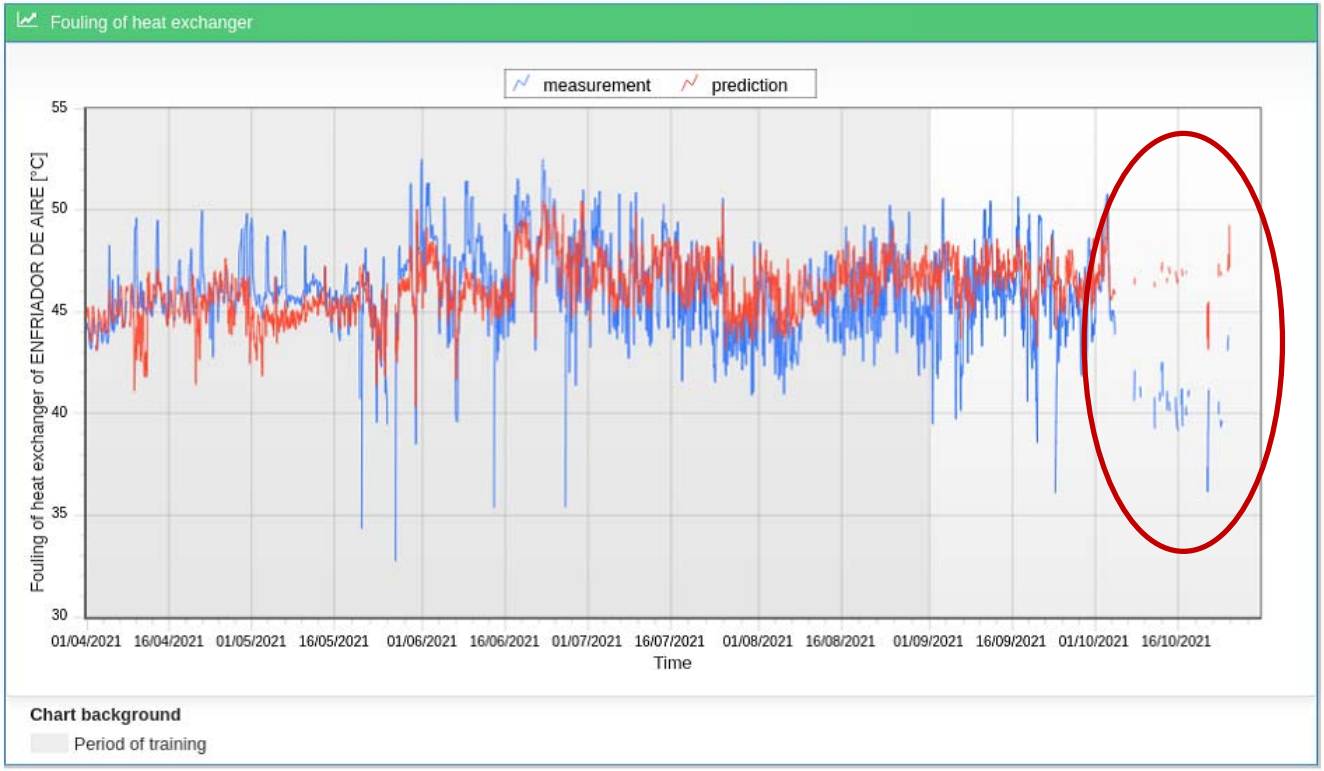
- Rapid increase of vibration levels on thrust bearing detected
- Problem in speed converter detected

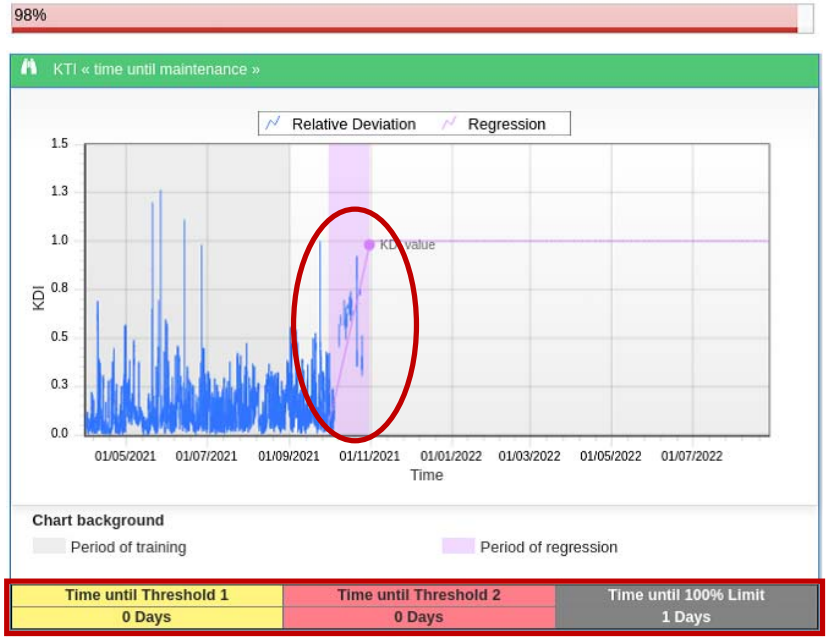


DIOMERA INTEL
EXAMPLES OF TRUE POSITIVES

Fouling of heat exchanger

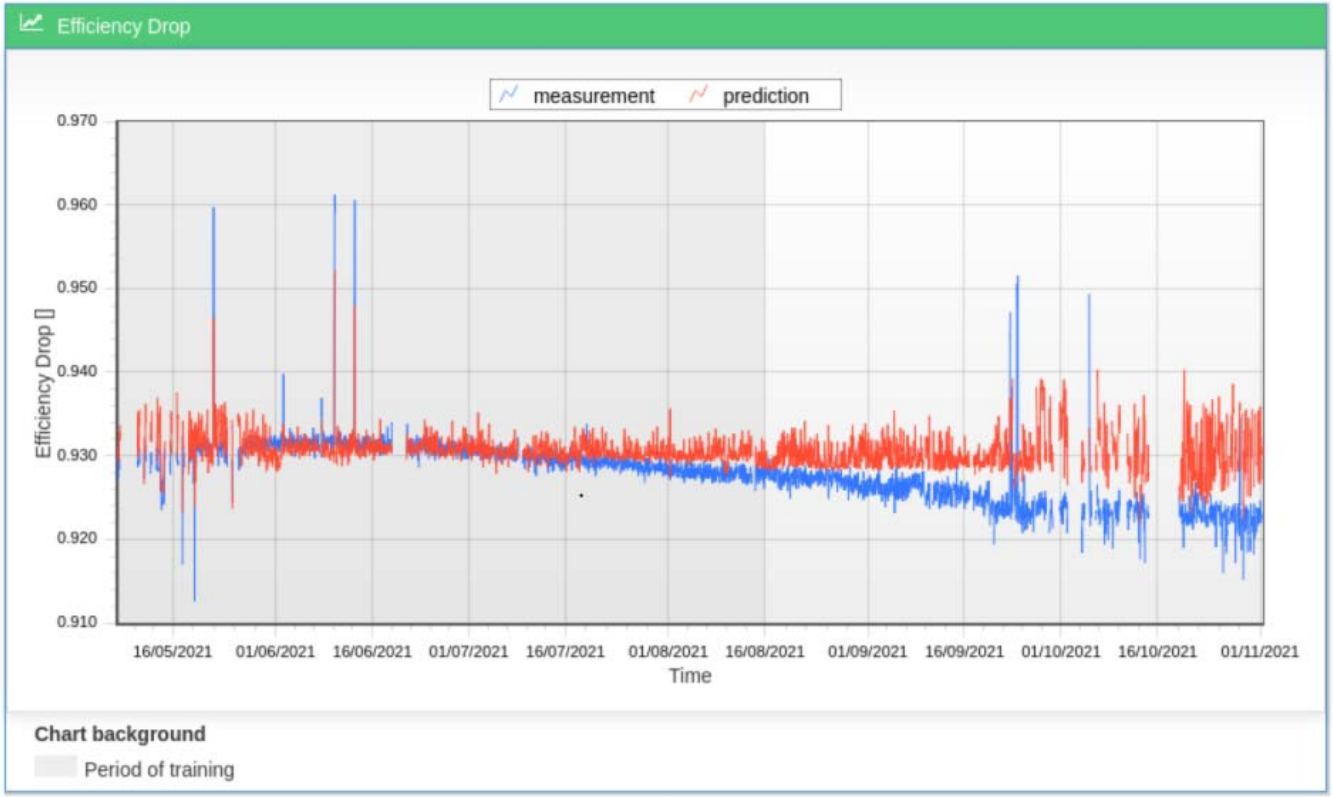
- Air temperature at inlet is much lower than expected, indicating a degradation of the heat flux exchange
- The low water flow alarm level in the heat exchanger system has been changed at site
- KDI value is alarming
- Change of KDI value (i.e., trend) is alarming



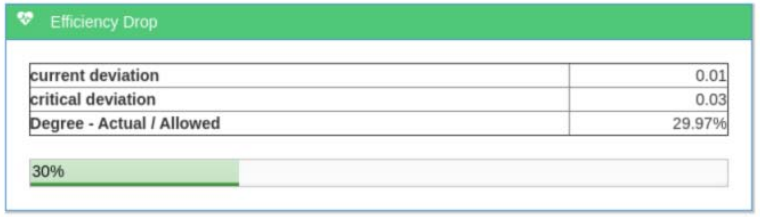


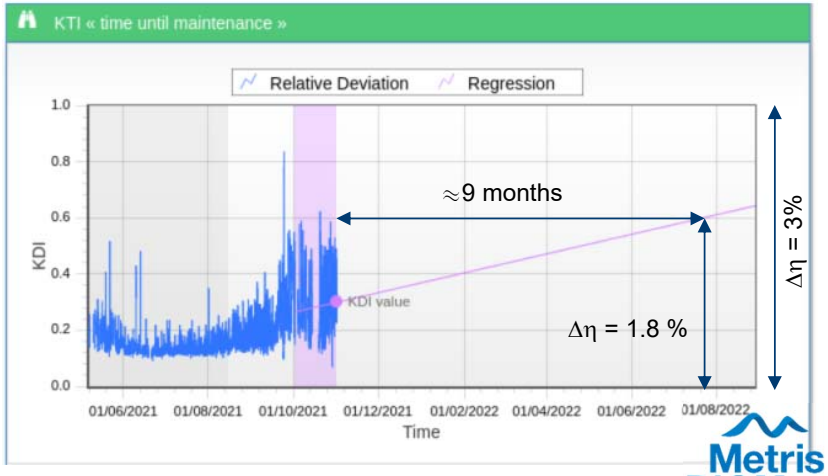
DIOMERA INTEL
EXAMPLES OF TRUE POSITIVES

Drop of index efficiency in Monsoon region



- Monitoring of drop of index efficiency compared to chosen reference period
- Values of critical deviations can be adapted to maintenance practices





Metris DiOMera

METRIS DIOMERA IN THE FIELD

A success factor for ANDRITZ Hydro O&M services

FLEXIBLE DEPLOYMENT SOLUTIONS

- Plant
- Customer cloud
- Hosted in ANDRITZ Hydro Global Control Center

FIGURES

- First commissioning in 2016
- 26 DiOMera systems running
  - 44 plants
  - 134 units
  - 2000+ indicators

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