Workshop on Digitalisation

EDP Journey

Nuno Guedes

Salto Grande, Aug 27-28, 2018

Agenda

1. EDP at a glance
2. Starting point
3. Our Journey

   Skipper (OSI-PI): The enabler

   Strategic Approach

   Industrial Internet Of Things Platform (IIoT)

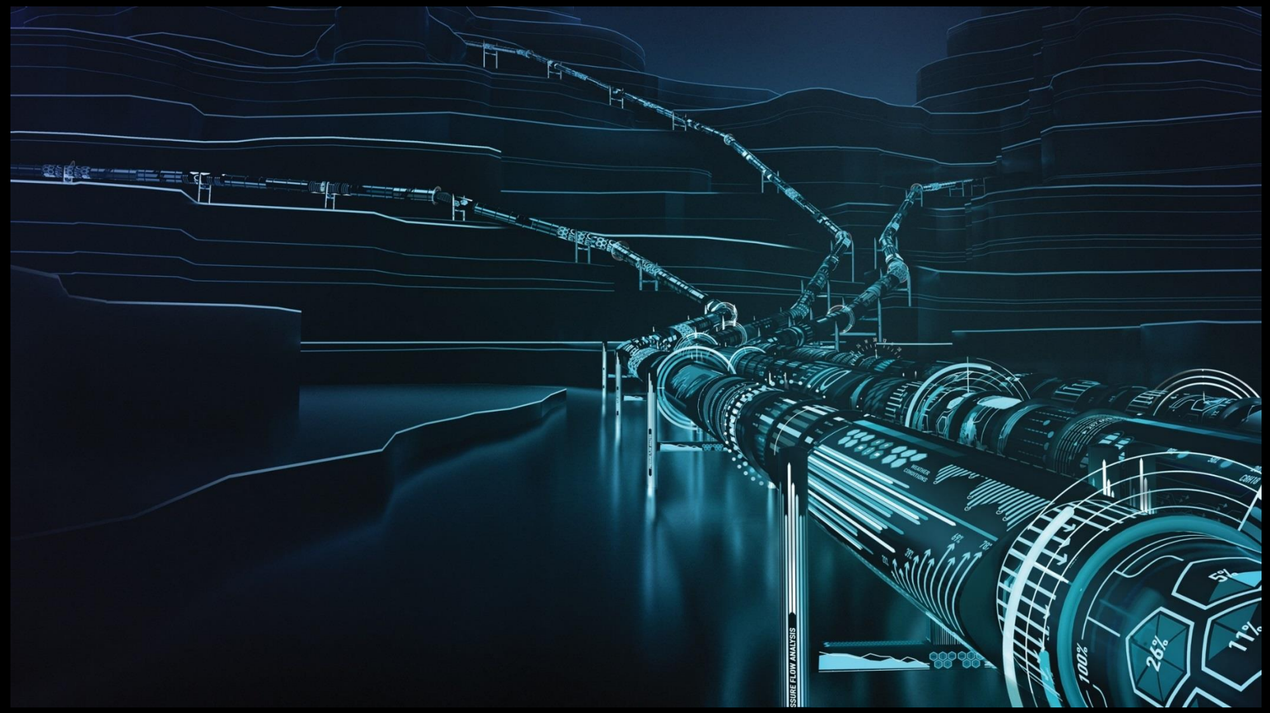
   Scope of the contract (Iberia)

   Digital Solutions

   Implementation Programme

   Implementation Example (Hydro)

   Towards an integrated Monitoring & Diagnostics Center



1. EDP at a glance

EDP is a multinational (present in 14 countries), vertically integrated utility company, present throughout the electricity value chain …

Generation

27 GW OF INSTALLED CAPACITY

- 39% WIND
- 34% HYDRO
- 14% CCGT
- 12% COAL
- 1% OTHERS

70 TWH OF NET ELECTRICITY GENERATION

56% RENEWABLE SOURCES

Transport

1,297 km
of transport network under construction

Distribution

338,179 KM OF NETWORK

284,309 km
of distribution overhead lines

53,869 km
of distribution underground lines

79 TWh OF ELECTRICITY DISTRIBUTED

Retail

ELECTRICITY CUSTOMERS 9,885,775

Customers in liberalized market 5,067,981

Customers in last resort 4,817,794

GAS CUSTOMERS 1,585,345

Customers in liberalized market 1,489,079

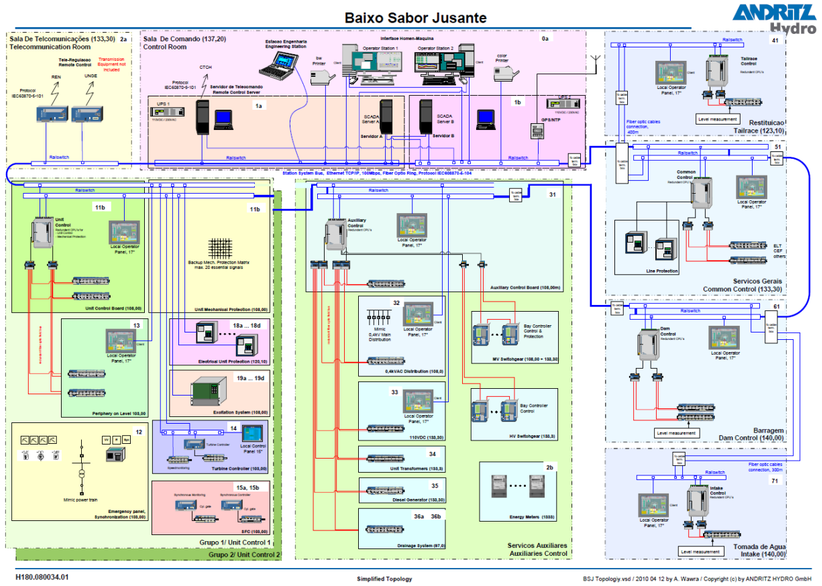
Customers in last resort 96,266

(2017 numbers)

12 000 Employees

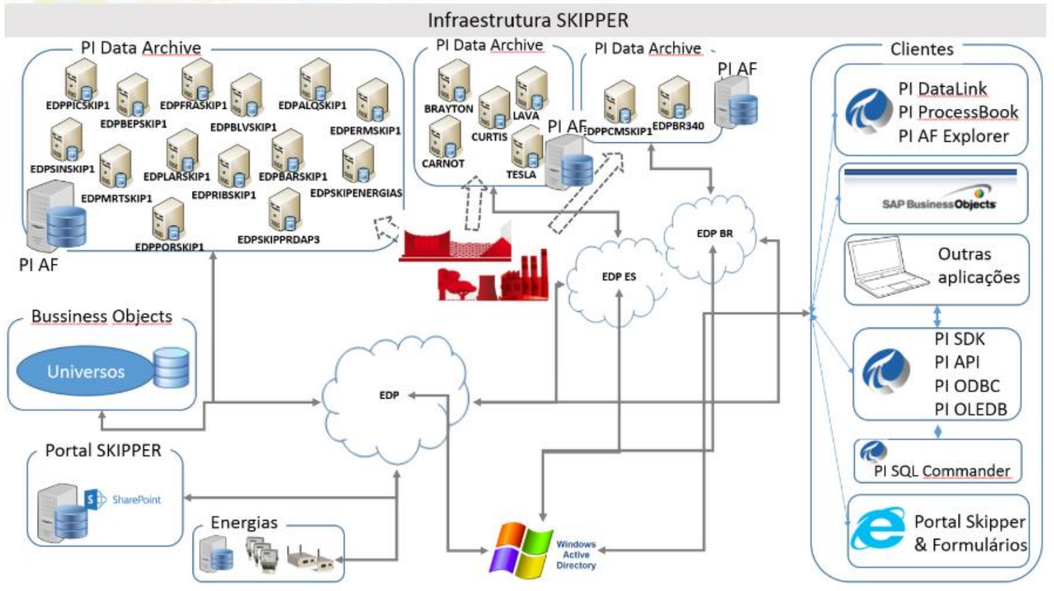
2. Starting point

Power plants with different equipment and technological solutions in service.



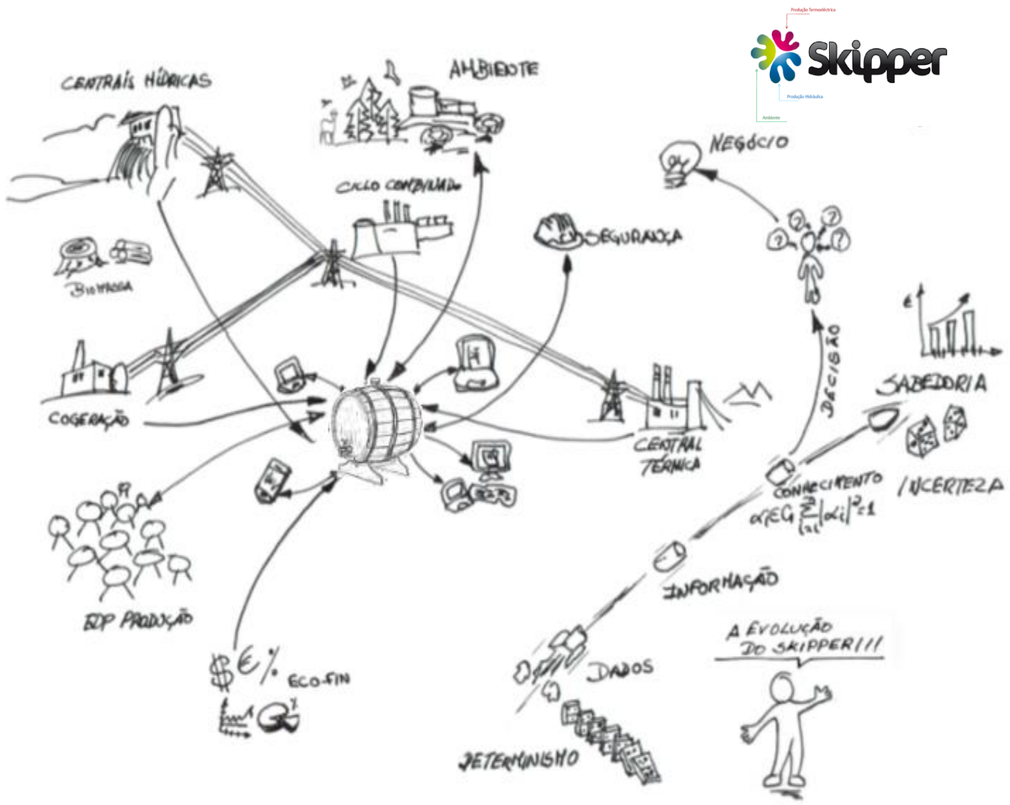
Today:

- There are databases with the historical operational data and OT information;
- There is a network infrastructure, that enables data flow from the source of information/signals to an end point (SCADA/DCS/Dispatch Center).



3. Our Journey

Skipper (OSI-PI): The enabler

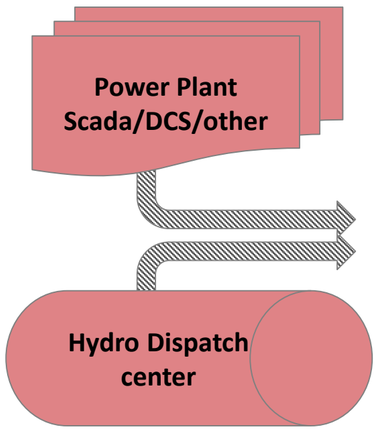


Fact Sheet

- Over **10 Yrs of experience**
- Distributed OSI PI architecture (plant process streaming data with over **170k tags**) + relational database
- Connecting multiple data sources
- BI and reporting tools
- Broad coverage:

Process Data	Resources	Sustainability
Metering	O&M	Others

…



Skipper
rede global de energia

3. Our Journey

Strategic Approach

3 possible strategic approaches to Digital Monitoring were considered …

	Strategic Approaches		
	Diagnosis-focused analysis	**Leverage commercial platform**	**Self developed models**
Value Levers	• Deep domain expertise (root-cause analysis, diagnosis and its resolution) • Access to specialized tools for specific purposes (e.g. vibration analysis)	• Extensive library of built-in asset-specific algorithms (take on the experience and R&D investment from the vendor) • Ability to use commercial platform for self-modeling and app development	• Develop proprietary algorithms specific for own asset base • Sell Big Data/IIoT solutions to 3rd parties • Innovative (and Digital) culture
Platforms (non-exhaustive)	S1 System 1* Condition Monitoring Software; SIPLUS	PREDIX; MindSphere SIEMENS; Avantis by Schneider Electric	sas; C3 IoT
Peer Positioning	IBERDROLA	gasNatural fenosa; PSEG	enel; ENGIE
Skills needed	Multi-specialty engineering skills (A)	A + Engineer/Data-Analyst combo (Business Translator) (B)	A + B + Solution development and user-interface design
Time to Value	-		+

Where do we want to be?

3. Our Journey

IIoT Platform

Partnership

@ Dec 2017

EDP Digital Transformation Deal Summary for Gas, Coal & Hydro Power Plants

Appendix B: GE Technical Proposal No. 1235764
Issue Date: December 29, 2017

In end of 2017 we chose GE's Predix IIOT (a 5 Yr contract was signed covering different solutions and domains).

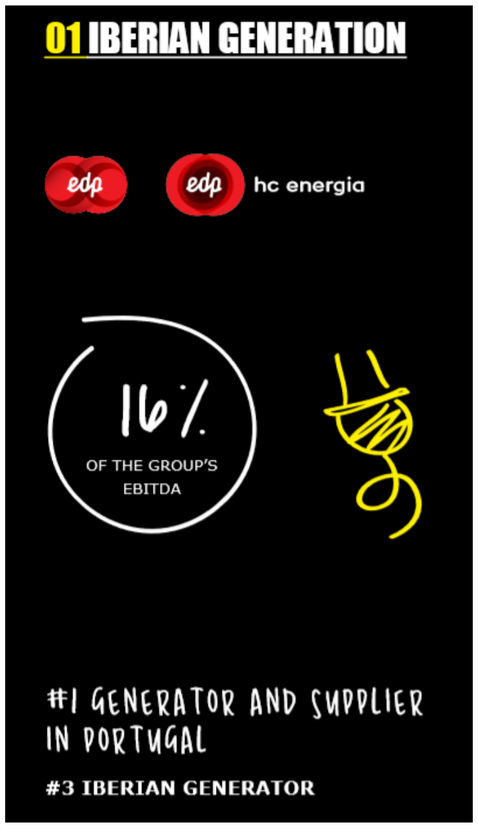
Source: GE

Platform Implementation	**2018**	**2019**	**2020**		
Platform Usage	**2018**	**2019**	**2020**	**2021**	**2022**

Operations Optimization **OO**	**Efficient & high performance fleet** ↑ Productivity ↑ Operational Flexibility
Asset Performance Management **APM**	**Financially optimized maintenance approach** ↑ Reliability & Availability ↓ Maintenance Costs ↓ Compliance Costs
PREDIX	**Scalable & secure infrastructure** ↑ Scalability ↑ Flexibility (Self Developed Analytics)

3. Our Journey

Scope of the contract (Iberia)



		Hydro	Coal	CCGT
Total Iberian Generation		• 168 units with a total installed capacity of 6951,3 MW • 35 units with a total installed capacity of 433 MW	• 4 units with a total installed capacity of 1200 MW • 3 units with a total installed capacity of 1283 MW	• 5 units with a total installed capacity of 2110,6 MW • 4 units with a total installed capacity of 1721 MW
Scope of the Contract		• 50 units with a total installed capacity of 5319 MW • 6 units with a total installed capacity of 199 MW	• 4 units with a total installed capacity of 1200 MW • 2 units with a total installed capacity of 917 MW	• 5 units with a total installed capacity of 2110,6 MW • 4 units with a total installed capacity of 1721 MW

3. Our Journey

Digital Solutions

Operations Optimization

OO

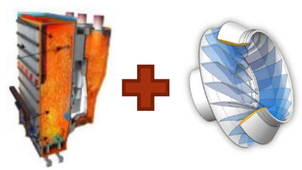
	Strategic Planning	Range Extension	Boiler Opt
Description	**Performance Indicators:** Monitor a set of KPIs for each plant including heat rate, output and fuel consumption in startups. **What if Scenarios**: Access the impacts of an input condition change to output metrics. **Day Ahead Forecasting**: Determine the capacity of a power plant for a set of forecasted variables, including ambient conditions.	Extension of the operational range of hydro turbines, reducing the technical minimums or extending the nominal capacity, to enable the optimization of other services (like ancillary services, with a greater range).	**Combustion Optimizer**: Use neural networks models to dynamically determine the optimal mix of air and fuel and control the systems do make the necessary adjustments in real-time. **Soot Cleaning Optimizer**: Use neural networks to balance boiler cleaning actions to reduce tube erosion and excessive thermal shocking, minimizing fouling, plugging and slagging events in real-time.
Scope	 **Coal + Gas Power Plants**	 **Subset of Hydro Power Plants (5)**	 **Coal Power Plants**

3. Our Journey

Digital Solutions

Asset Performance Management

APM

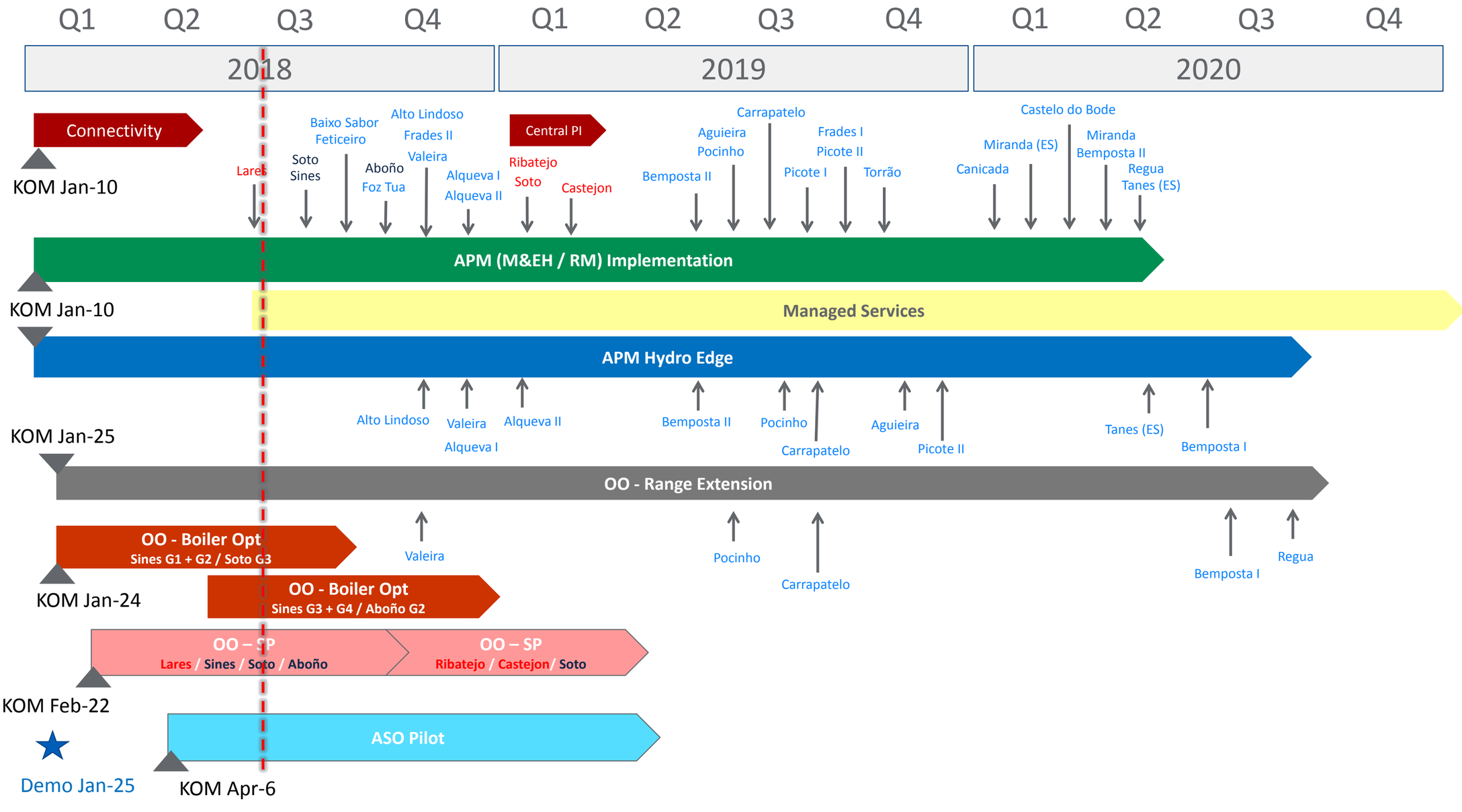
	Reliability Management	Asset Strategy Optimization
Description	**Predictive Analytics:** Anticipate or identify failure of an asset with longer lead time to improve reliability and performance by modeling the expected versus observed states of the asset parameters. **Analytics Catalog and Orchestration**: Access a catalog of analytics for different assets (failure modes embedded specific to those assets). **Case Collaboration Management**: Enable collaboration between domain experts (SMEs) for a specific issue, workflow management and record all interactions and information (knowledge management).	**Maintenance Optimization Policy:** Common methodology to define actions and their mitigated risks from any asset and evaluate existing plans with basic qualitative risk analysis. PILOT
Scope	 **Coal + Gas + Hydro Power Plants** (the most relevant units in terms of the revenue generated)	 **Coal + Hydro Power Plants** (1 coal + 1 hydro)

Requires investment to install new sensors (DGAs for the transformers, flow transmitters for the hydro units, …)

3. Our Journey

Implementation Program

EDP Digital Transformation - Program



3. Our Journey

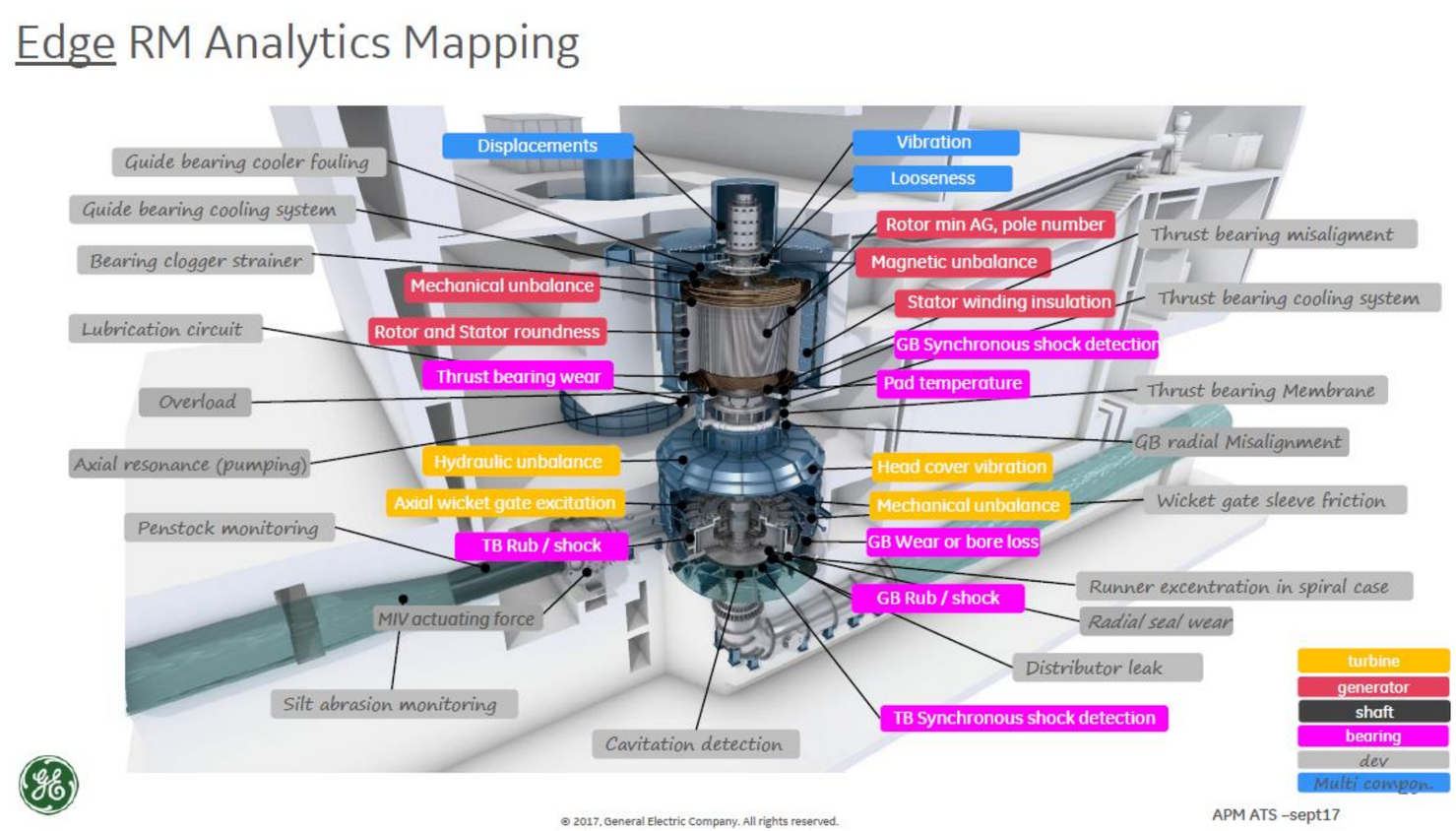
Implementation example (Hydro)

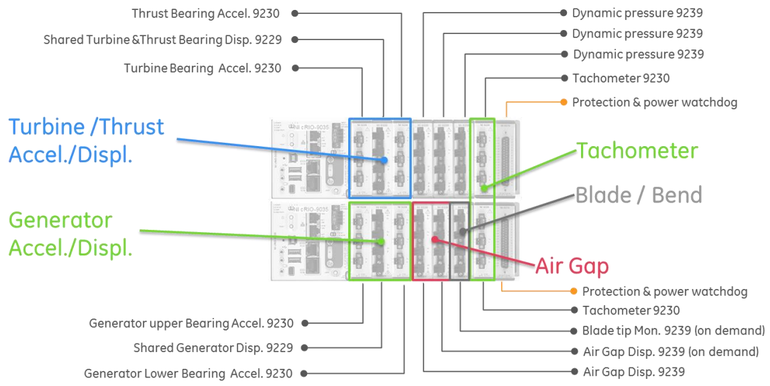
Key assets (for this phase):

- Hydro turbine (wicked and intake gates, vibrations, temperatures, bearings, flows, etc.);
- Generator (temperatures, air gaps, PDAs, etc.);
- Unit/Main Transformer (DGA, temperatures, voltages/currents).

Requirements:

- Tag mapping and available in OSI PI
- Capture all the relevant data:
  - ❑ DGA installation and connection to DCS and PI
  - ❑ Vibration and Airgaps connection to DCS and PI
  - ❑ Cooling, flow, etc. tags connections to DCS and PI
  - ❑ Permanent online Partial Discharge Analyzers (with new equipment that allows the connections to the PD sensors).



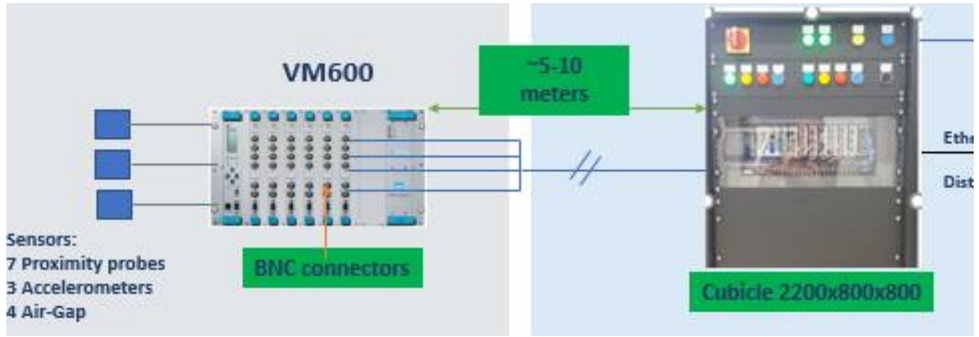


3. Our Journey

Implementation example (Hydro)

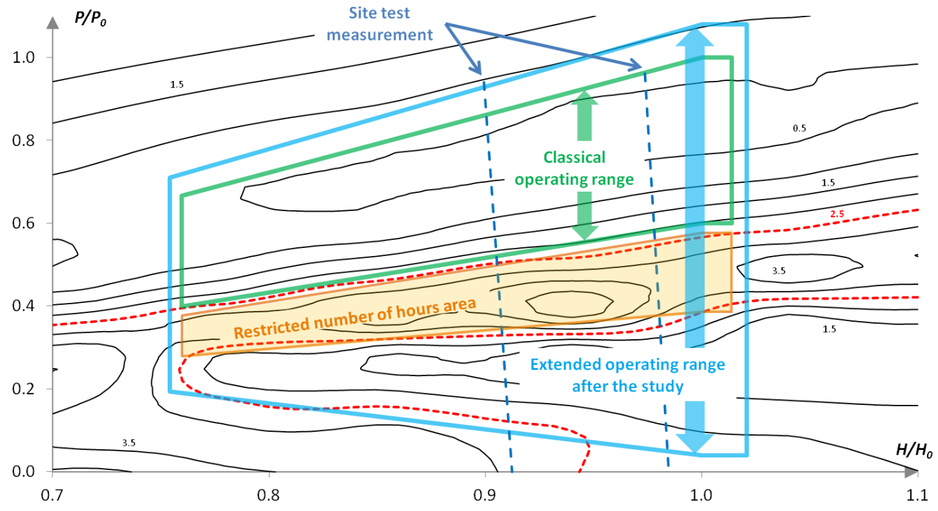
intelligent Condition Monitoring System (iCMS)

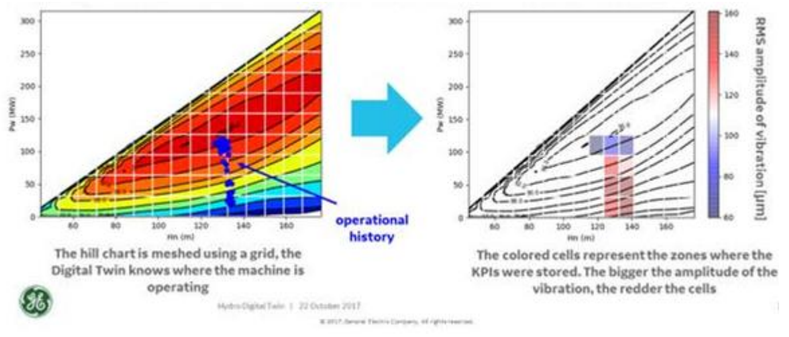
- The Edge Analytics will be installed in 12 Hydro power plants (critical/important assets);
- Local real time signal processing, specific for hydro machines, with high resolution data.



Hydro Operating Range Extension

- Risk management methodology related to Operation Optimization;
- The aim is to extend the operational range of hydro turbines, 5 hydro power plant studies are included in this contract;
- Characterize the relative performance, Efficiency and the dynamic behavior of the machine -> new working domain proposal;
- A risk or severity chart showing a set of dynamic measurement indicator (Vibrations and shaft displacement levels) with time series of main relevant KPI.



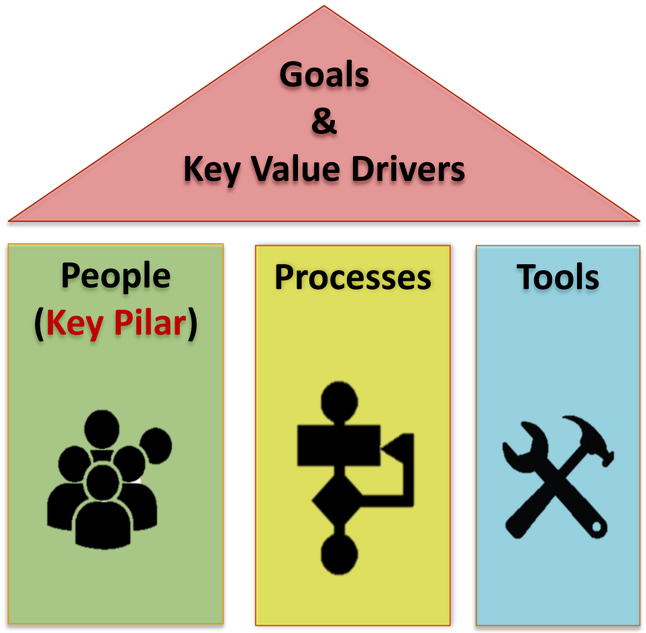


3. Our Journey

Towards an integrated Monitoring & Diagnostics Center

What a **M&D Center** is not:

- its purpose is not to remotely operate the power plants,
- neither to access the performance of the O&M personnel,
- it is not built to hierarchically top up the power plants,
- it is not an emergency response team,
- and it is definitely not a decision center.



Goals: Develop insights from monitoring the health and efficiency of the assets in a **predictive** manner and turn them into value.

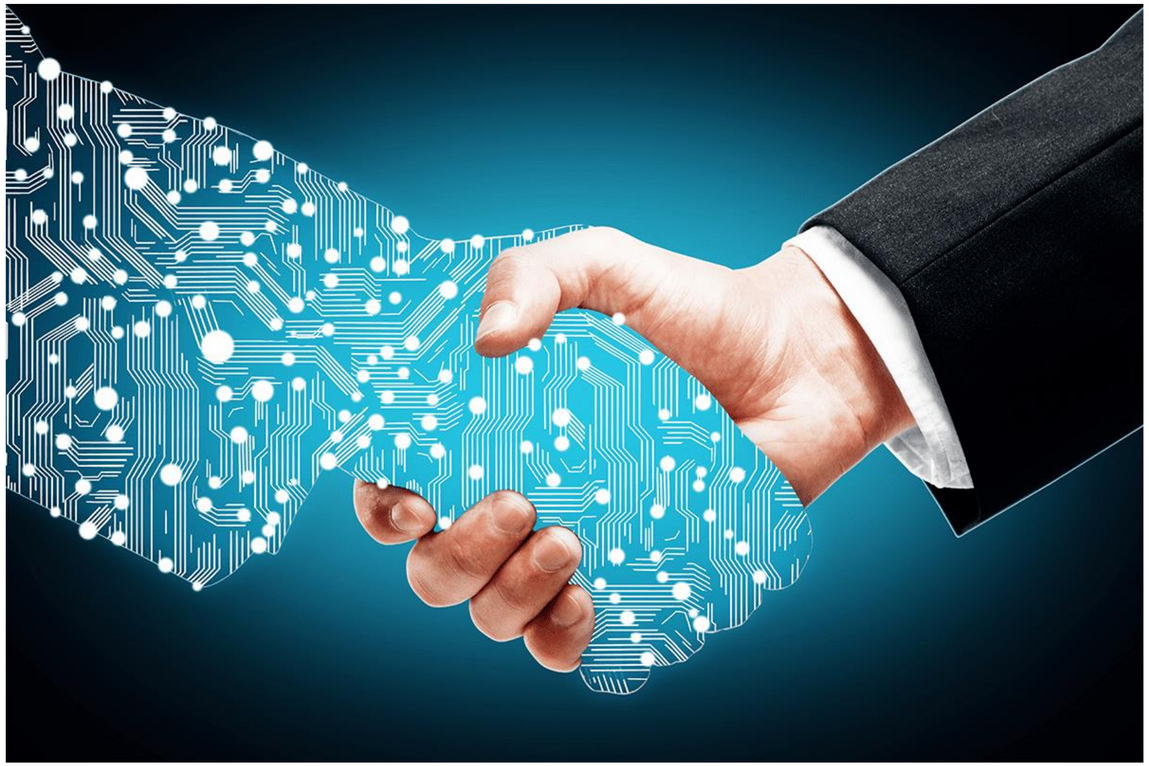
Key Value Drivers:

- Avoid efficiency losses
- Increase the availability (reducing unscheduled downtime by anticipating failures)
- Reduce maintenance costs (**early warnings** prior to failures allows for a better resource allocation)
- New working dynamics and mindset

Scope:

Coal + Gas + Hydro Power Plants

Thank You



Nuno Guedes

Nuno.Guedes@edp.pt