
Centralized real-time monitoring project at TAQA Morocco “E-Monitoring Center”

Mohammed Idrissi (TAQA Morocco)

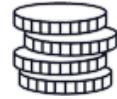
Marco Lanteri (PIMSOF T)

Agenda

- Company presentation
- Company needs and challenges
- Project design
- PI System technologies used
- Improvement case study
- Overall benefits

About TAQA Morocco

Leader IPP in Morocco with a 25 years track record. TAQA Morocco is the first choice supplier of the Moroccan energy market, securing ~38% of the national production with 19% installed capacity, and the ambition to serve Morocco's energy transition by 2050



MAD 8 Billion
2021 Turnover



STRONG PREDICTABLE
Long-term Cash flow



2,056 MW
Production capacity



15 MILLIONS
People supplied annually



92.8%
2021 Availability rate



TOP QUARTILE IPP
Committed to Operating Excellence

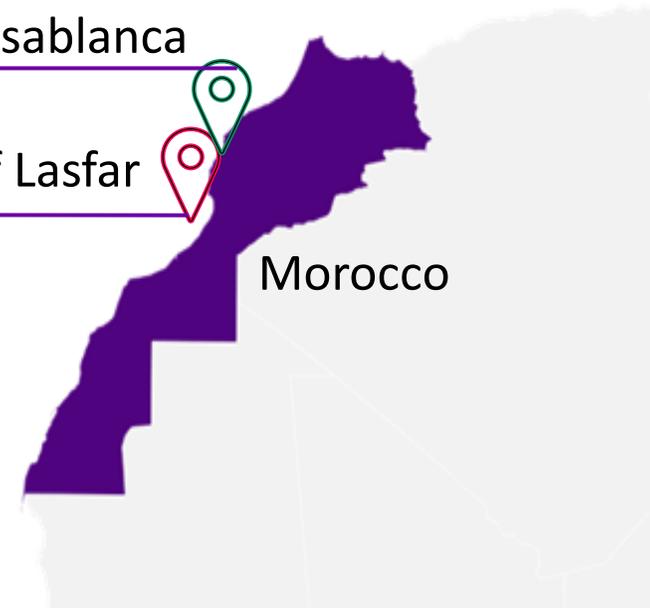


MAD 300 MILLIONS
Cumulated investment in
environment facilities

Initial scenario



- Casablanca
- Jorf Lasfar



- 3 Business Coal fired Units
- 1994: 2x315 MW, Alstom – ALSPA
- 2000: 2x329 MW – ABB – ABB Advant
- 2014: 2x329 MW – MD– Emerson Ovation

Goals

Rationalize

Common infrastructure;
Better standardization
across the company;

On-premise platform: Data
capitalization in a
dedicated Smart Room;

Endow TAQA Morocco
with an **Expertise &
Innovation Data Center**.

Centralize

Unique data repository
distributing information across
the company;

Timely data availability;

Aggregation of information for
better analysis;

**Scalable, customized and
configurable** system depending on
the needs and on the visions of
users (new tags, KPI, reports...);

Pilot project for TAQA Morocco to
assure the company's immersion
in the **Industry 4.0** domain
through a sure-fire digital
transformation.

Improve

Operations

- Faster reaction time
- Prevent or reduce plant
upset/shutdowns

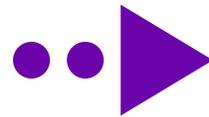
Management

- Clear summary of unit performances
- Better economical figures

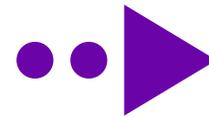
Learning

- **Know-how & best practices transfer**
guaranteed through the creation of
a melting pot environment of
knowledge
- **Contribution of SME, data
engineers, diverse domain experts,
asset managers**,... to the data lake
structuration

Pimsoft selected as provider of a PI System based solution



PiMSOFT
INNOVATIVE SOLUTIONS



25+ years experience with PI System

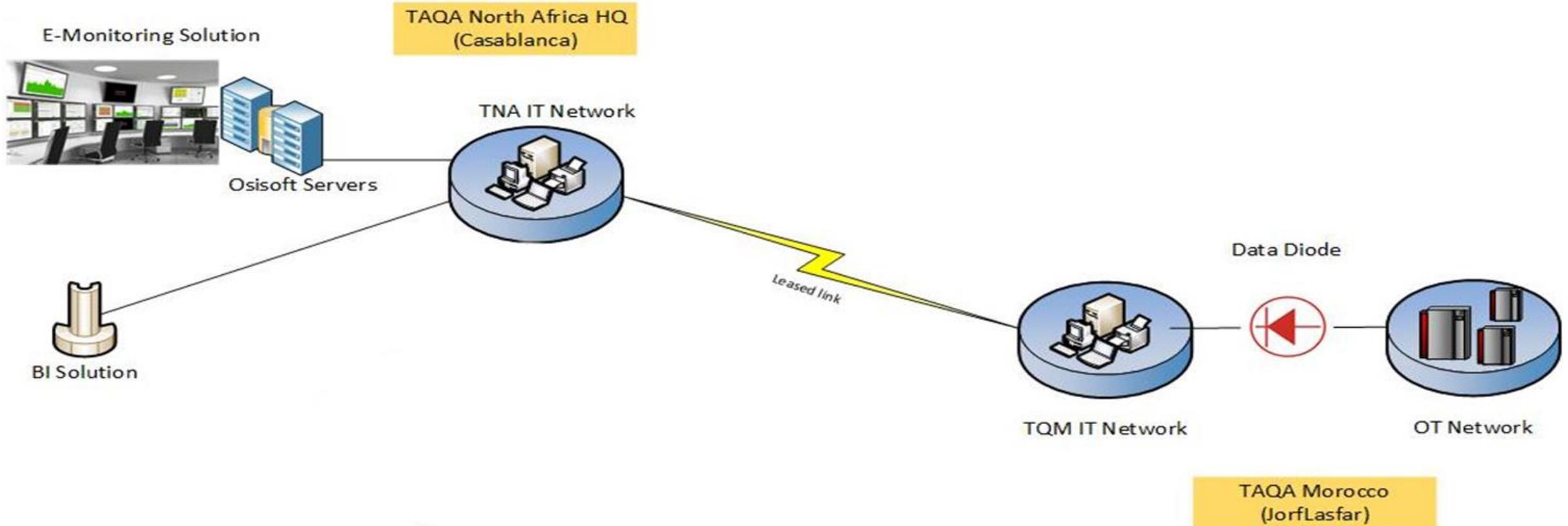
PI System Application provider:

SIGMAFINE[®]

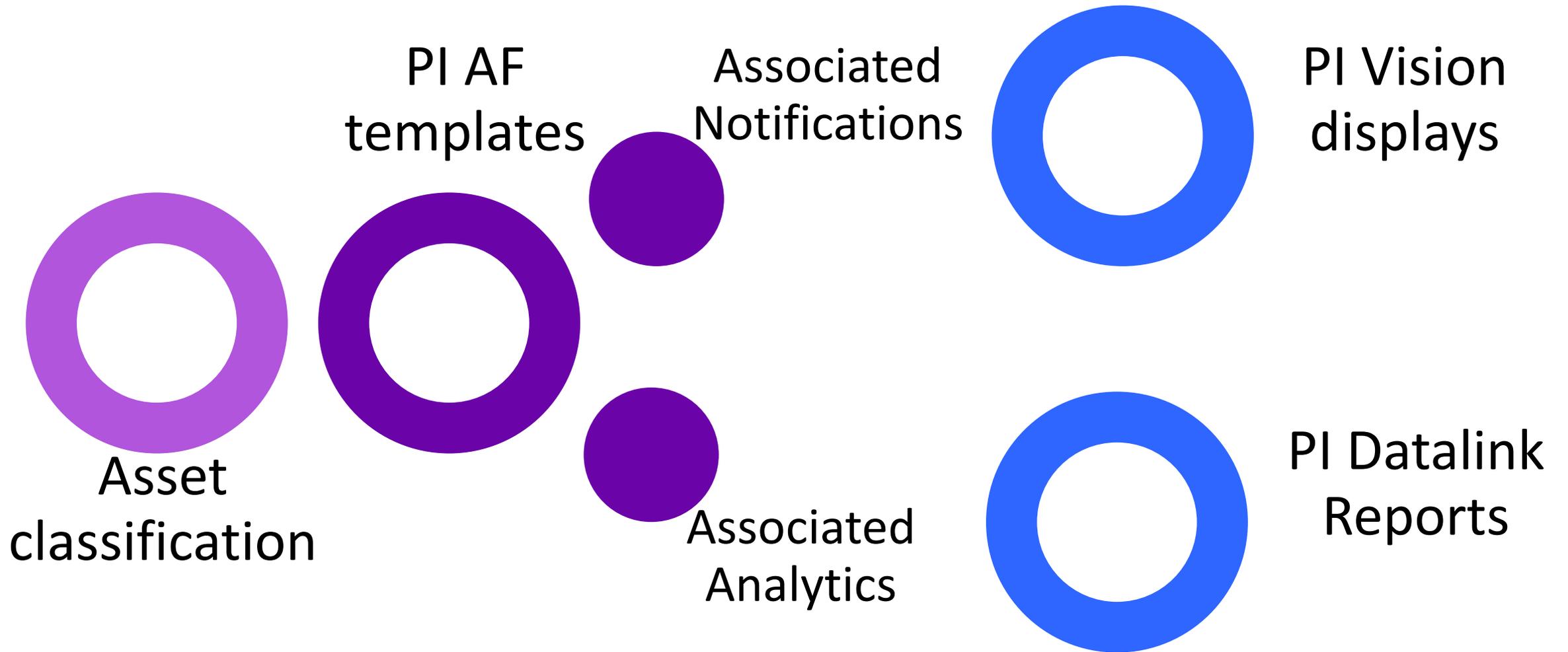
SIGMAFINE[®]App

- **2020:** project awarded
- **2020/21:**
 - Project design
 - Project implementation
 - Testing
- **2022:**
 - Roll-out
 - Training
 - Further developments

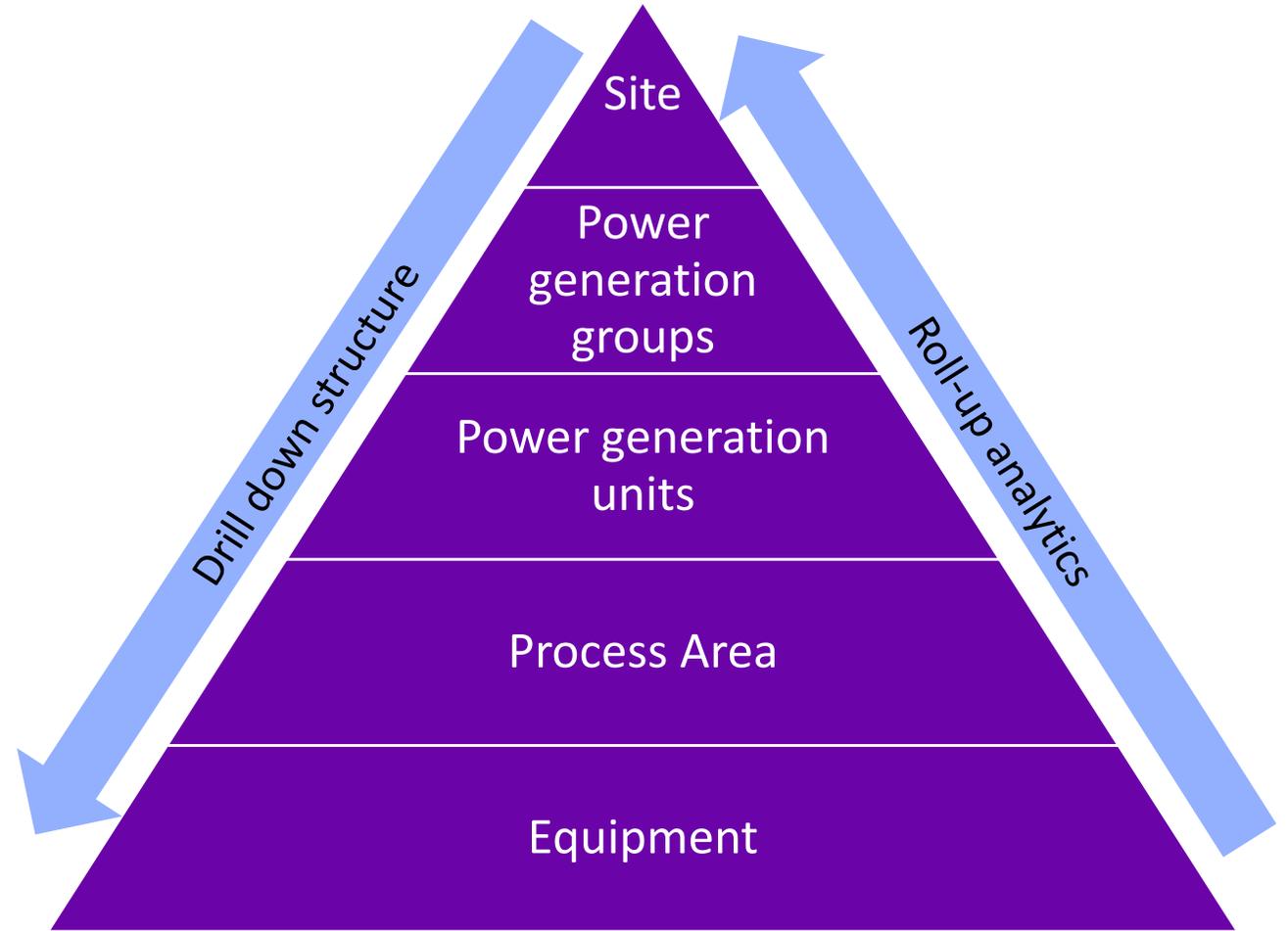
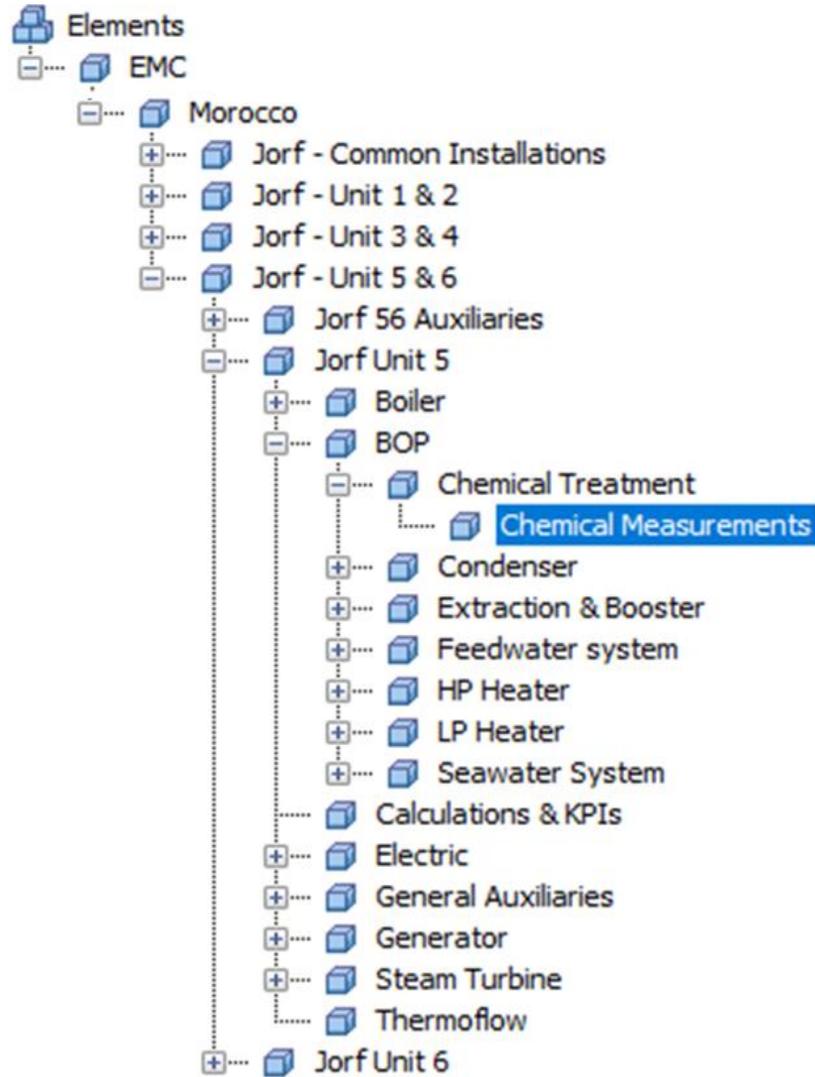
General IT Architecture



Project framework



Asset hierarchy drill down



Event generation through analytics

Tracking events improves alarm management and root-cause analysis

Group by: Category Template

Filter

Name	[15. 17:34:19....	Duration	Start Time	End Time	Description	Ca
Unit Shutdown or Long Trip 2022-04-06 16:59:58.003		15:17:34:20.036	4/6/2022 4:59:58.003 PM		Unit Shutdown...	Alarm&
Grid Frequency Analog 2022-04-06 17:01:09.019		15:17:33:09.024	4/6/2022 5:01:09.019 PM		Grid Frequency	Alarm&
High Chemical Parameter 2022-04-07 07:58:47.069		15:2:35:30.976	4/7/2022 7:58:47.069 AM		High Chemical ...	Alarm&
Unit Shutdown or Long Trip 2022-04-09 03:16:44.095		13:7:17:33.953	4/9/2022 3:16:44.095 AM		Unit Shutdown...	Alarm&
Boiler MFT Trip 2022-04-09 03:27:56.100		13:7:06:21.949	4/9/2022 3:27:56.1 AM		Boiler MFT Trip	Alarm&
OPC Interface Error 2022-04-13 10:50:00.000		5:23:26:36.843	4/13/2022 10:50:00 AM	4/19/2022 10:16:36.843 AM		
OPC Interface Error 2022-04-13 10:50:00.000		5:23:26:36.843	4/13/2022 10:50:00 AM	4/19/2022 10:16:36.843 AM		
High Heat Rate Deviation 2022-04-14 10:03:24.979		8:0:30:53.076	4/14/2022 10:03:24.979 AM		High Heat Rat...	Alarm&
OPC Interface Error 2022-04-14 12:40:00.000		7:21:54:18.058	4/14/2022 12:40:00 PM			
OPC Interface Error 2022-04-14 12:40:00.000		7:21:54:18.06	4/14/2022 12:40:00 PM			

Condition based notifications

Notification opened due to high conductivity



To

@taqamorocco.ma

Event: High Chemical Parameter 2022-04-20 15:12:48.018

Name: High Chemical Parameter

Server:

Database:

Target Unit: Jorf Unit

Start Time: 4/20/2022 3:12:48 PM Coordinated Universal Time (GMT00:00:00)

Send Time: 4/20/2022 3:27:56 PM Coordinated Universal Time (GMT00:00:00)

Main Steam Conductivity: 12.593uS/cm

Main steam Sodium: 0.17257ppb

Correspondent Limits:

- Conductivity: 10 uS/cm
- Sodium: 10 ppb

Notification closed as parameter is back in the limits



To

@taqamorocco.ma

Event: High Chemical Parameter 2022-04-20 15:12:48.018

Name: High Chemical Parameter

Server:

Database:

Target Unit: Jorf Unit

Start Time: 4/20/2022 3:12:48 PM Coordinated Universal Time (GMT00:00:00)

Send Time: 4/20/2022 7:43:50 PM Coordinated Universal Time (GMT00:00:00)

Main Steam Conductivity: 9.992uS/cm

Main steam Sodium: 0.07835ppb

Correspondent Limits:

- Conductivity: 10 uS/cm
- Sodium: 10 ppb

Key performance monitoring

Overall overview to assess performances of the power generation units

Overall plant performance report (Excel+PI Datalink)



Jorf Unit 1 Heat Rate Report

16/03/22

Item	Jorf U1	Value	UOM
Overall Unit	Gross Turbine Heat Rate (Test)	8072.76	kJ/kWh
	Turbine Heat Rate	8324.00	kJ/kWh
	Measured Gross Turbine Output	337.89	MW
	Measured Net Turbine Output	315.39	MW
	Corrected Gross Turbine Output	316.40	MW
	Corrected Net Turbine Output	314.38	MW
	Feedwater mass flow rate	1010.00	t/h
	Cold reheat flow	891.76	t/h
	Throttle Flow	1006.50	t/h
	Soot blowing flow	0.60	t/h
	Main Steam Enthalpy	3391.73	kJ/kg
	Economizer Inlet Enthalpy	1124.91	kJ/kg
	Cold Reheat Enthalpy	3049.80	kJ/kg
	Hot Reheat Enthalpy	3533.24	kJ/kg
	Boiler Output	2727.69	GJ/h
	Cooling Water Correction	1.0025	-
	Steam Auxiliary Consumption Factor	1.0024	-
	SBC Soot Blowing Correction	1.00	-
	Corrected Boiler Efficiency	92.77	%
	Net generator output adjusted for power	315.00	MW
	Total Auxiliary Correction	0.62	MW
	Net Unit Heat Rate (Test)	9409.64	kJ/kWh
	Corrected Net Unit Heat Rate	9398.98	kJ/kWh

Power generation unit overall display (PI Vision)

KPI's - Jorf Unit 2

Balance of Plant

Overall Unit

Name	Value	Units
Calculations & KPIs/Measured Net Unit Output	313.43	MW
Calculations & KPIs/Measured Gross Turbine Output	335.93	MW
Calculations & KPIs/Efficiency_Measured	39.85	%
Calculations & KPIs/Efficiency_Corrected	39.53	%
Calculations & KPIs/Corrected Net Unit Heat Rate	9,106.19	kJ/kWh
Calculations & KPIs/Corrected Gross Turbine Output	314.44	MW
Calculations & KPIs/Corrected Boiler Efficiency	94.94	%

Steam Turbine

Name	Value	Units
Calculations & KPIs/Turbine Heat Rate	7,990.24	kJ/kWh
Calculations & KPIs/PLP Turbine Isentropic Efficiency	94.89	%
Calculations & KPIs/HP Turbine Isentropic Efficiency	85.06	%
Calculations & KPIs/Corrected Gross Turbine Output	314.44	MW

Generator

Name	Value	Units
Calculations & KPIs/IG Leak Rate	4.74	Nm3/d

Chemical Parameters

Name	Value	Units
Calculations & KPIs/Steam/Water Cycle pH	9.27	pH
Calculations & KPIs/Desulf Unit absorber pH	NA	
Chemical Measurements/Main Steam / Na	0.00	ppb
Calculations & KPIs/Steam/Water Cycle Conductivity	0.99	µS

Boiler Combustion (coal)

Name	Value	Units
Calculations & KPIs/Unburned Ratio / Flying	91.60	%
Calculations & KPIs/Ashes Ratio	91.60	%
Calculations & KPIs/Corrected Gas Temperatures	124.16	°C
Calculations & KPIs/Air Heater Leakage - CO2 (%)_Corrected	19.62	%
Calculations & KPIs/Air Heater Temperatures_diff with dew point	2.85	delta °C

Emissions

Name	Value	Units
Calculations & KPIs/Desulf Unit Efficiency	N/A	
Calculations & KPIs/Concentration Dust_Corrected	42	
Calculations & KPIs/Concentration NOx_Corrected	280.00	ng/J
Calculations & KPIs/Concentration SO2_Corrected	1	

Pulverizers

Name	Value	Units
Calculations & KPIs/Pulverizer E dp	1.82	kPa
Calculations & KPIs/Pulverizer D Motor Shaft Power	N/A	
Calculations & KPIs/Pulverizer D dp	2.08	kPa
Calculations & KPIs/Pulverizer C Motor Shaft Power	N/A	
Calculations & KPIs/Pulverizer C dp	2.12	kPa
Calculations & KPIs/Pulverizer B Motor Shaft Power	N/A	
Calculations & KPIs/Pulverizer B dp	2.01	kPa
Calculations & KPIs/Pulverizer A Motor Shaft Power	N/A	
Calculations & KPIs/Pulverizer A dp	0.00	kPa

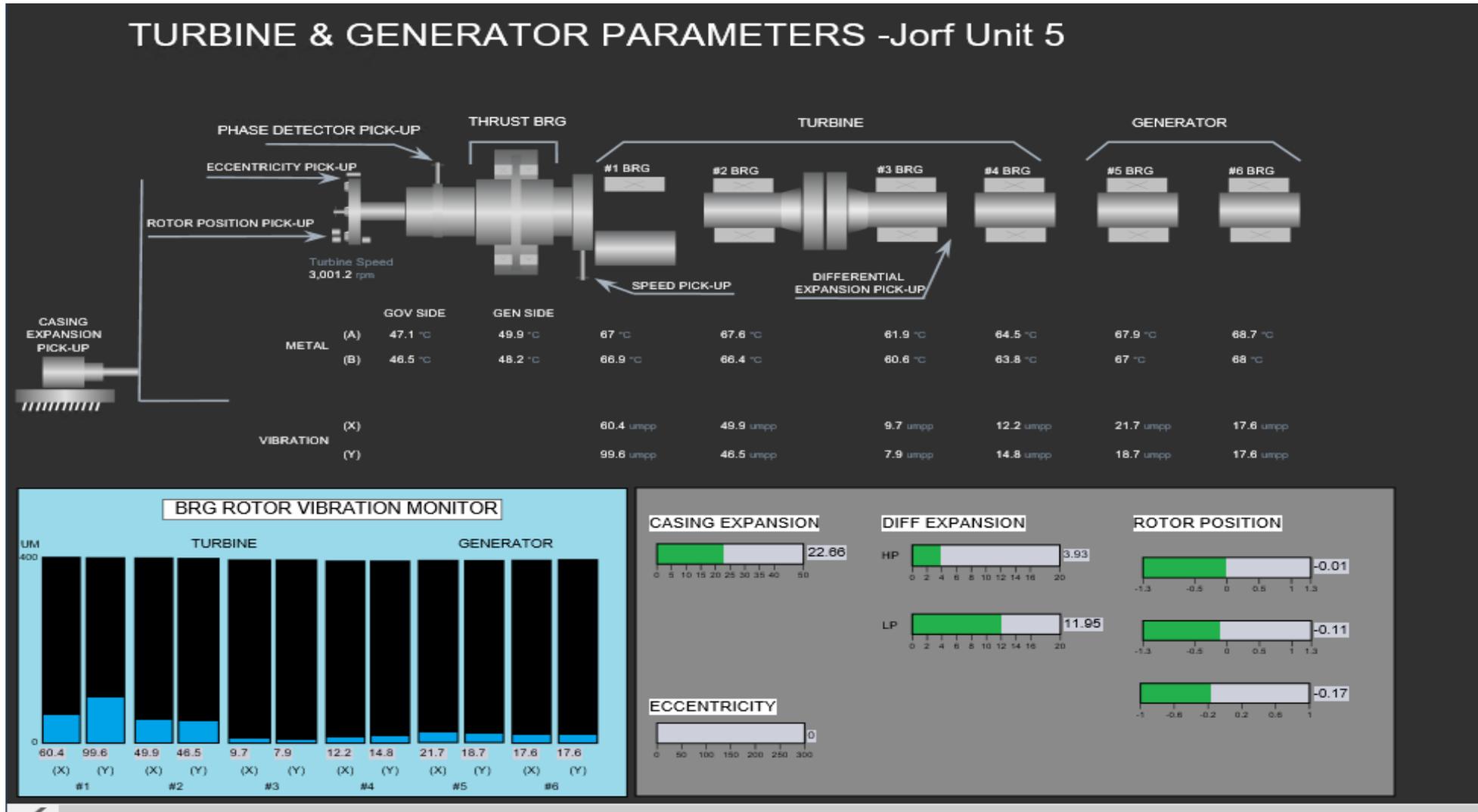
Main Pumps

Name	Value	Units
Calculations & KPIs/SeaWater Pump 2 Shaft Power	N/A	
Calculations & KPIs/SeaWater Pump 1 Shaft Power	N/A	
Calculations & KPIs/Sea Water Pump 2 Flowrate	20,000.00	kg/h
Calculations & KPIs/Sea Water Pump 1 Flowrate	20,000.00	kg/h
Calculations & KPIs/FeedWater Pump 3 Shaft Power	N/A	
Calculations & KPIs/FeedWater Pump 3 Flowrate	418,719.70	kg/h
Calculations & KPIs/Feedwater Pump 3 Activated	N/A	
Calculations & KPIs/FeedWater Pump 2 Shaft Power	N/A	
Calculations & KPIs/FeedWater Pump 2 Flowrate	25,355.96	kg/h
Calculations & KPIs/Feedwater Pump 2 Activated	N/A	
Calculations & KPIs/FeedWater Pump 1 Shaft Power	N/A	
Calculations & KPIs/Feedwater Pump 1 Flowrate	456,462.53	kg/h
Calculations & KPIs/Feedwater Pump 1 Activated	N/A	
Calculations & KPIs/Extraction Pump 2 Shaft Power	N/A	
Calculations & KPIs/Extraction Pump 2 Flowrate	N/A	
Calculations & KPIs/Extraction Pump 1 Shaft Power	N/A	
Calculations & KPIs/Extraction Pump 1 Flowrate	N/A	
Calculations & KPIs/CCW Pump Shaft Power	N/A	
Calculations & KPIs/CCW Pump Flowrate	N/A	

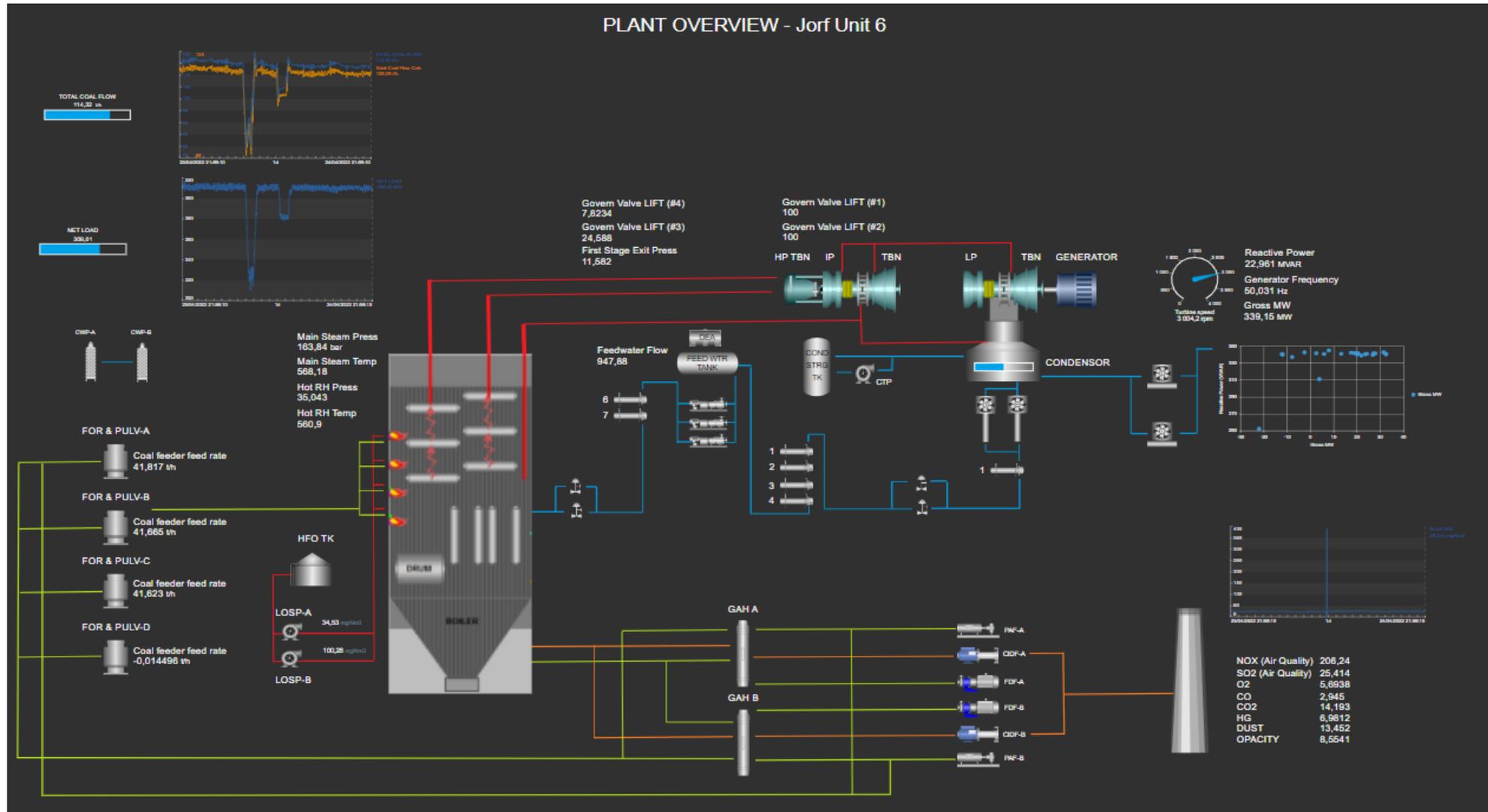
ID and FD Fans & Motors

Name	Value	Units
Calculations & KPIs/FD Fans A Efficiency	N/A	
Calculations & KPIs/FD Fans A Shaft Power	N/A	
Calculations & KPIs/FD Fans B Efficiency	N/A	
Calculations & KPIs/FD Fans B Shaft Power	N/A	
Calculations & KPIs/ID Fans A Efficiency	N/A	
Calculations & KPIs/ID Fans A Shaft Power	N/A	
Calculations & KPIs/ID Fans B Efficiency	N/A	
Calculations & KPIs/ID Fans B Shaft Power	N/A	

Key performance monitoring

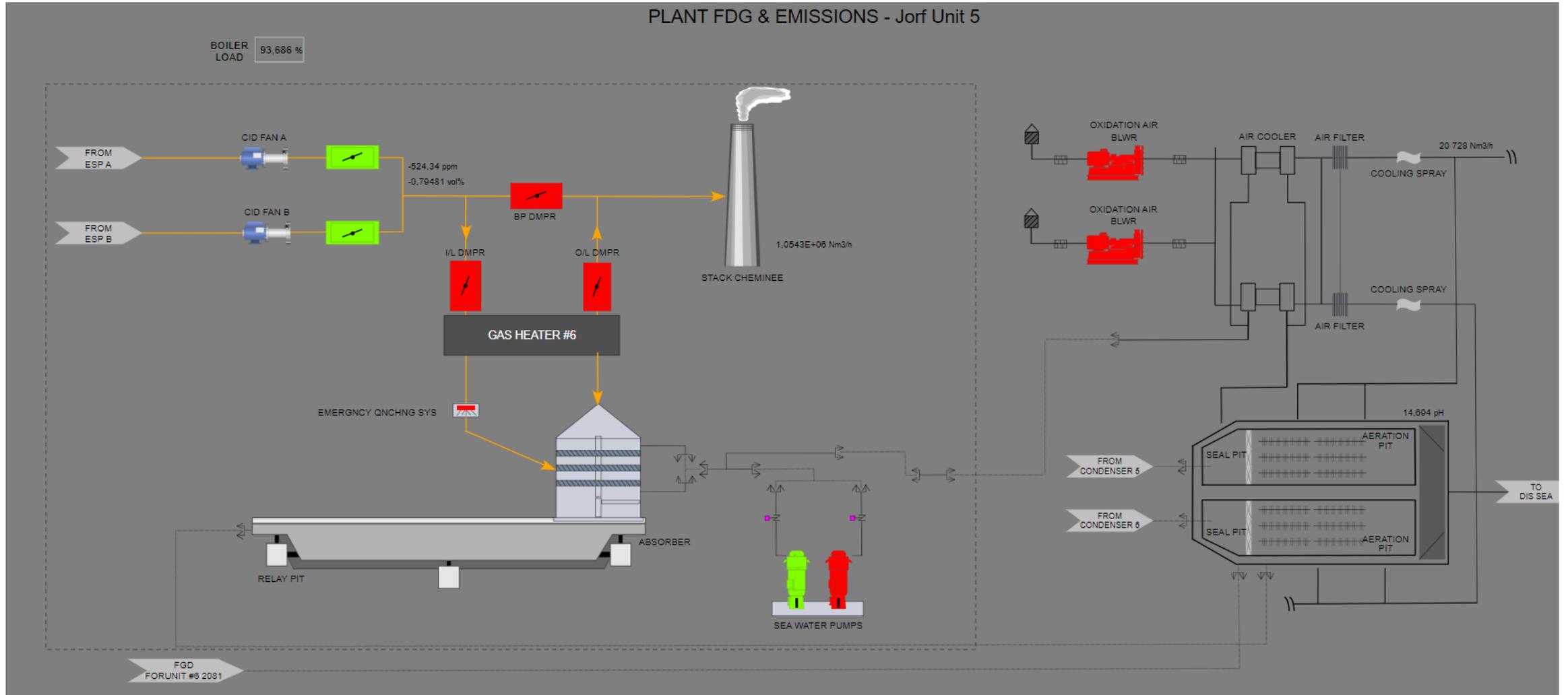


Key performance monitoring

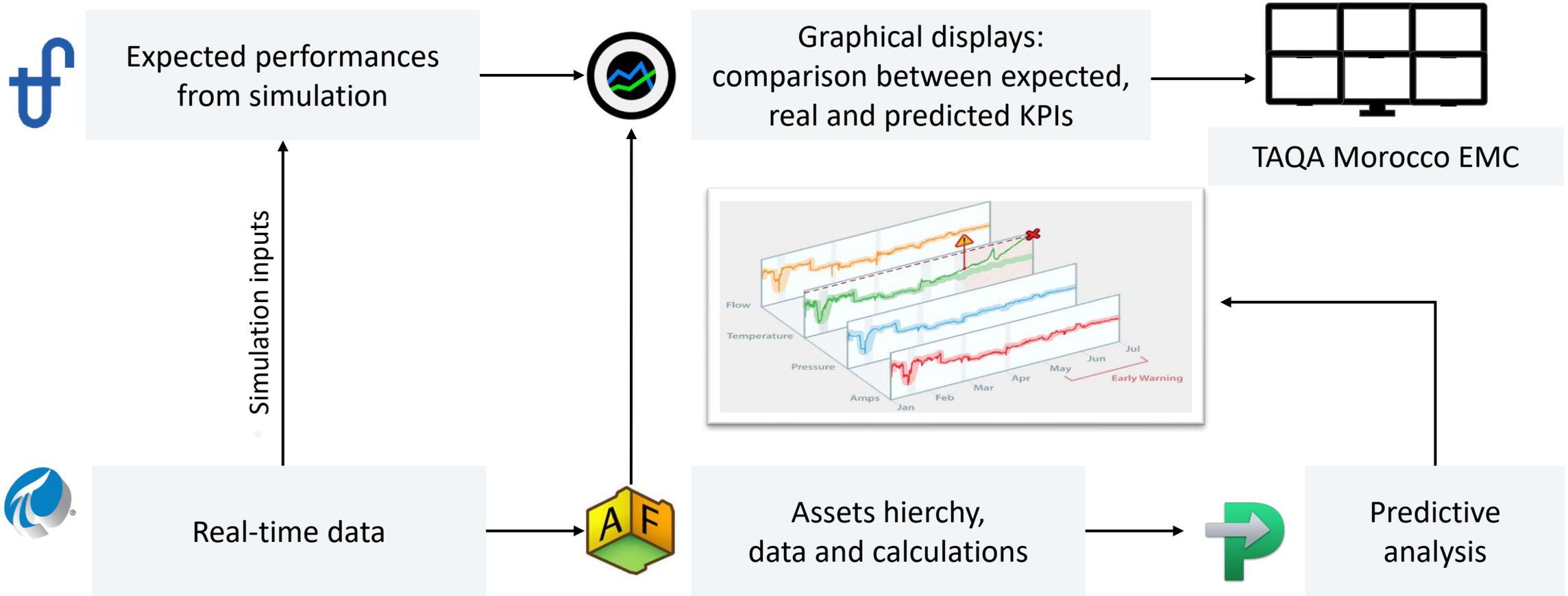


Key performance monitoring

PLANT FDG & EMISSIONS - Jorf Unit 5

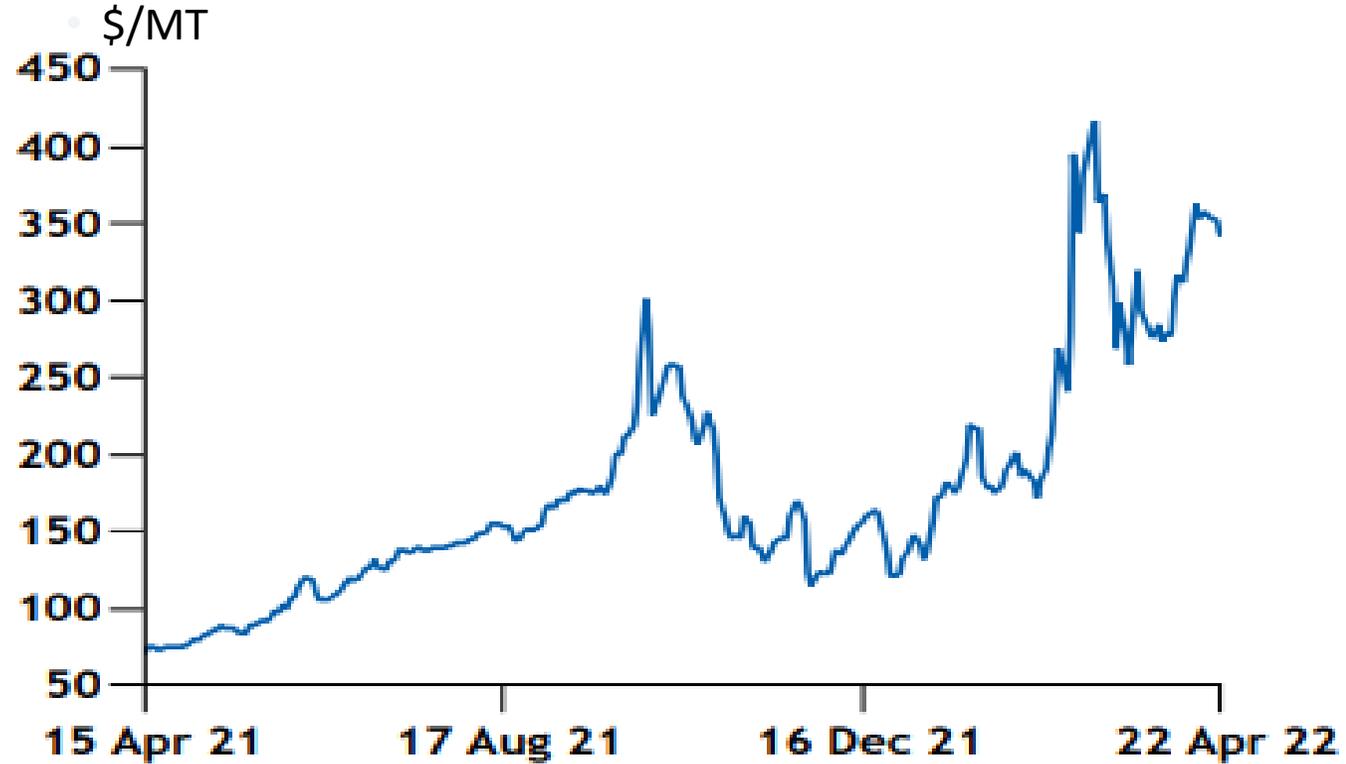


Integration with third parties to further improve operations



Thermoflow integration

Coal price in ARA zone



Source :

Argus cif ARA spot coal assessment

Comparison between simulated and actual conditions

Timestamp		Therموflow		PI (DCS)		Delta		Ratio		HR Impact		HR Imp 24H Avg		Excess Coal Flow		Ex Coal Flow 24H Avg	
Time	Description	Value	Units	Value	Units	Value	Units	Value	Units	Value	Units	Value	Units	Value	Units	Value	Units
24/04/2022 21:33:00	TMF - Generator MW (gross)	335.17	MW	339.91	MW	4.73	MW	1.41	%								
24/04/2022 21:33:00	TMF - Net Load	306.00	MW	309.92	MW	3.92	MW	1.28	%								
24/04/2022 21:33:00	TMF - Wattage Measuring A (HV side UAT)	28.33	MW	29.34	MW	1.00	MW	3.54	%								
24/04/2022 21:33:00	TMF - Final SH Oil main steam pressor	17.01	MPa	16.80	MPa	-0.42	MPa	2.45	%								
24/04/2022 21:33:00	TMF - Boiler outlet main steam temperature	566.41	°C	571.02	°C	4.60	°C	0.81	%		kJ/kWh		kJ/kWh		kg/h		kg/h
24/04/2022 21:33:00	TMF - Boiler outlet main steam flow	897.61	t/h	940.30	t/h	42.69	t/h	4.76	%								
24/04/2022 21:33:00	TMF - Hot Reheat Steam pressor	3.82	MPa	3.76	MPa	0.13	MPa	3.72	%								
24/04/2022 21:33:00	TMF - Boiler outlet hot reheat steam temperature	567.34	°C	567.68	°C	0.35	°C	0.06	%		kJ/kWh		kJ/kWh		kg/h		kg/h
24/04/2022 21:33:00	TMF - DEA Flow	810.24	t/h	855.08	t/h	44.84	t/h	5.53	%								
24/04/2022 21:33:00	TMF - LP FWH No1 In Pressor	1.36	MPa	1.40	MPa	0.04	MPa	2.94	%								
24/04/2022 21:33:00	TMF - LP FWH out Temp	61.72	°C	63.66	°C	1.94	°C	3.15	%								
24/04/2022 21:33:00	TMF - CEP Dishage condensate flow	723.70	t/h	1 025.97	m3/h	302.27	t/h	41.77	%								
24/04/2022 21:33:00	TMF - Condenser shell temp	31.36	°C	29.28	°C	-2.08	°C	6.64	%								
24/04/2022 21:33:00	TMF - Condenser vacuum	45.85	mbar	50.16	mbar	4.31	mbar	9.39	%		kJ/kWh		kJ/kWh		kg/h		kg/h
24/04/2022 21:39:32	TMF - ECO IN MN Feedwater Temp	245.30	°C	242.26	°C	-3.04	°C	1.24	%		kJ/kWh		kJ/kWh		kg/h		kg/h
24/04/2022 21:39:32	TMF - Exhaust gas temp	120.00	°C	134.03	°C	14.03	°C	11.69	%		kJ/kWh		kJ/kWh		kg/h		kg/h
24/04/2022 21:39:32	TMF - UBC	5.00	%	4.41	%	-0.59	%	11.80	%		kJ/kWh		kJ/kWh		kg/h		kg/h
24/04/2022 21:39:32	TMF - Gross Turbine HR	7 793	kJ/kWh	8 127.12	kJ/kWh	334.12	kJ/kWh	4.29	%		kJ/kWh		kJ/kWh		kg/h		kg/h
24/04/2022 21:39:32	TMF - Boiler efficiency	94.30	%	94.37	%	0.07	%	0.08	%		kJ/kWh		kJ/kWh		kg/h		kg/h
24/04/2022 21:39:32	TMF - TTD 6	-1.00	°C	3.43	°C	4.43	°C	442.81	%		kJ/kWh		kJ/kWh		kg/h		kg/h
24/04/2022 21:39:32	TMF - TTD 7	-1.00	°C	9.36	°C	10.36	°C	1 036.03	%		kJ/kWh		kJ/kWh		kg/h		kg/h
24/04/2022 21:39:32	TMF - DCA 6	5.80	°C	9.74	°C	4.14	°C	73.98	%		kJ/kWh		kJ/kWh		kg/h		kg/h
24/04/2022 21:39:32	TMF - DCA 7	5.80	°C	8.48	°C	2.88	°C	51.01	%		kJ/kWh		kJ/kWh		kg/h		kg/h
24/04/2022 21:39:32	TMF - Electrical consumption	8.50	%	8.82	%	0.32	%	3.79	%		kJ/kWh		kJ/kWh		kg/h		kg/h
24/04/2022 21:39:32	TMF - HP turbine efficiency	81.58	%	83.34	%	1.76	%	2.16	%		kJ/kWh		kJ/kWh		kg/h		kg/h
24/04/2022 21:39:32	TMF - MP turbine efficiency	89.35	%	90.16	%	0.81	%	0.91	%		kJ/kWh		kJ/kWh		kg/h		kg/h
24/04/2022 21:39:32	TMF - Air Heater Leakage	8.00	%	10.57	%	2.57	%	32.13	%		kJ/kWh		kJ/kWh		kg/h		kg/h
24/04/2022 21:39:32	TMF - Moisture in Fuel	12.00	%	11.00	%	-1.00	%	8.33	%		kJ/kWh		kJ/kWh		kg/h		kg/h
24/04/2022 21:39:32	TMF - Temperature air entring AH	24.40	°C	24.72	°C	0.32	°C	1.30	%		kJ/kWh		kJ/kWh		kg/h		kg/h
24/04/2022 21:30:00	PPA - Corrected Net Unit Heat Rate	9 576.21	kJ/kWh	9 459.83	kJ/kWh	-116.38	kJ/kWh	1.22	%		kJ/kWh		kJ/kWh		kg/h		kg/h

Main outputs for each parameters :

Heat Rate impact

Equivalent Excess coal content

Simulated parameters

Actual parameters

Difference

Performance impact and breakdown

Comparison between simulated and actual conditions



Net Load: MW

PCI: kJ/kg

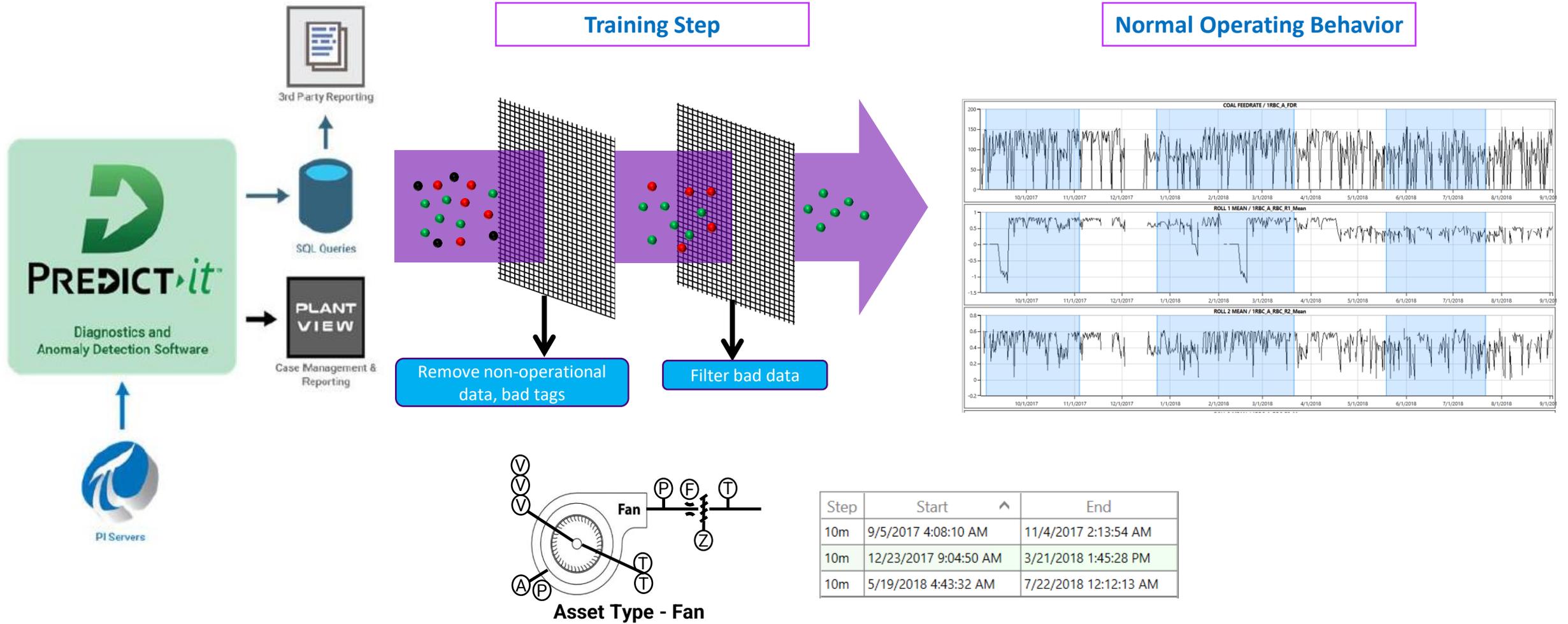
Description	HR Impact [kJ/kWh]	Excess Coal Flow [kg/h]
Total Losses		
Total Saves		
Total		

Description	24 Hr Avg
Corrected Net Unit Heat Rate 24h avg	
PPA - Corrected Net Unit Heat Rate 24h avg	
Net Load 24h avg	
Equiv Total Losses 24h avg	
Equiv Total Saves 24h avg	
Equiv Total 24h avg	
Ex.C Unknown Causes 24h avg	
Ex.C Total Losses 24h avg	
Ex.C Total Saves 24h avg	
Ex.C Total 24h avg	

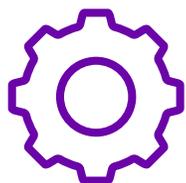
Archiving relevant parameters for analysis and interpretation

Notification for Heat Rate deviation

Predict IT Integration



Project main outcomes and benefits



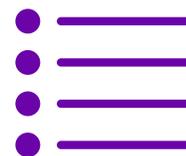
Challenge

- Aggregate and Manage information from 6 power generation
- Support Plant to establish a continuous improvement action plan



Solution

- Deployed the latest AVEVA PI System technology including PI AF and PI Vision as an advanced foundation for Process Monitoring,
- Implementation of Condition Based Maintenance & Advanced Analytics for Early Failure Detection



Benefits

- Increased visibility on production data and asset performances at both engineering and management levels.
- Advance monitoring of performance with a detailed breakdown of losses families
- Deep follow-up of improvement action to reduce excess coal consumption
- Faster reaction time thanks to comparison with simulations, predictions and notifications
- Promote industry 4.0 paradigm with a culture focused on performance and capitalization of know-how



Mohammed Idrissi

Director TAQA EMC

- TAQA North Africa S.C.A.
- mohammed.idrissi@taqamorocco.ma



Marco Lanteri

Account Manager

- Pimsoft S.p.A.
- marco.lanteri@pimsoftinc.com