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Driving Sustainability with Energy Digital Twin

Technical Presentation

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Our story

- **PETRONAS** is a **Progressive Energy and Solutions Partner** with presence in over 50 countries.
- PETRONAS operations covers Upstream, Downstream, Gas Business and Clean Energy Solutions.
- Our team is part of the Process Department of Group Technical Solutions, Project Delivery & Technology (PD&T)
- As PETRONAS' **Centre of Excellence**, PD&T unites expertise in project, technical, digital and technology, to deliver sustainable energy and progressive value for the entire Group.

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Steam is the number ONE choice for heating medium in the process industry

Steam generation:

- Standalone
- Centralised

Challenges:

- High fuel gas costs
- CO2 emissions

Digital driven system to improve efficiency & sustainability

SUSTAINABLE DEVELOPMENT GOALS

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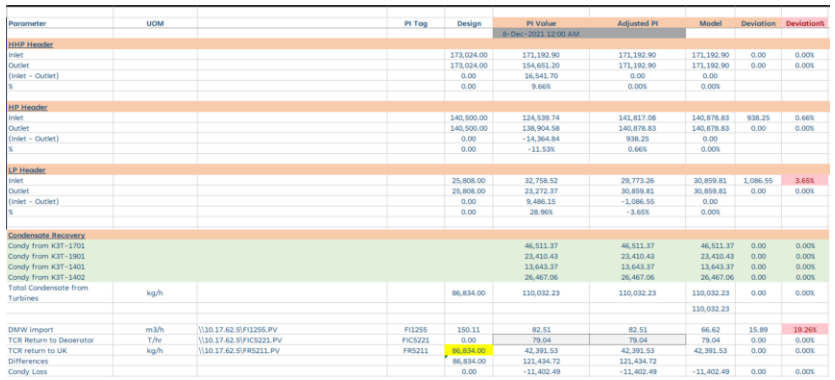
Lifecycle application of first-principle model in energy audit and performance monitoring increases overall value



Parameter	UOM		PI Tag	Design	PI Value	Adjusted PI	Model	Deviation	Deviation%
					8-Dec-2021 12:00 AM				
HHP Header									
Inlet				173,024.00	171,192.90	171,192.90	171,192.90	0.00	0.00%
Outlet				173,024.00	154,651.20	171,192.90	171,192.90	0.00	0.00%
(Inlet - Outlet)				0.00	16,541.70	0.00	0.00		
%				0.00	9.66%	0.00%	0.00%		
HP Header									
Inlet				140,500.00	124,539.74	141,817.08	140,878.83	938.25	0.66%
Outlet				140,500.00	138,904.58	140,878.83	140,878.83	0.00	0.00%
(Inlet - Outlet)				0.00	-14,364.84	938.25	0.00		
%				0.00	-11.53%	0.66%	0.00%		
LP Header									
Inlet				25,808.00	32,758.52	29,773.26	30,859.81	1,086.55	3.65%
Outlet				25,808.00	23,272.37	30,859.81	30,859.81	0.00	0.00%
(Inlet - Outlet)				0.00	9,486.15	-1,086.55	0.00		
%				0.00	28.96%	-3.65%	0.00%		
Condensate Recovery									
Condy from K3T-1701					46,511.37	46,511.37	46,511.37	0.00	0.00%
Condy from K3T-1901					23,410.43	23,410.43	23,410.43	0.00	0.00%
Condy from K3T-1401					13,643.37	13,643.37	13,643.37	0.00	0.00%
Condy from K3T-1402					26,467.06	26,467.06	26,467.06	0.00	0.00%
Total Condensate from Turbines	kg/h			86,834.00	110,032.23	110,032.23	110,032.23	0.00	0.00%
							110,032.23		
DMW import	m3/h	\\10.17.62.5\FI1255.PV	FI1255	150.11	82.51	82.51	66.62	15.89	19.26%
TCR Return to Deaerator	T/hr	\\10.17.62.5\FICS221.PV	FICS221	0.00	79.04	79.04	79.04	0.00	0.00%
TCR return to UK	kg/h	\\10.17.62.5\FRS211.PV	FRS211	86,834.00	42,391.53	42,391.53	42,391.53	0.00	0.00%
Differences				86,834.00	121,434.72	121,434.72			
Condy Loss				0.00	-11,402.49	-11,402.49	-11,402.49	0.00	0.00%

Manual spreadsheeting for steam balance reporting

DIGITAL

TRANSFORMATION

Regular automated reporting plus:

- Engineering analysis
- Optimization
- Troubleshooting
- OTS

It is an accepted best practice to perform a structured energy audit to identify value leakages and improvement opportunities.

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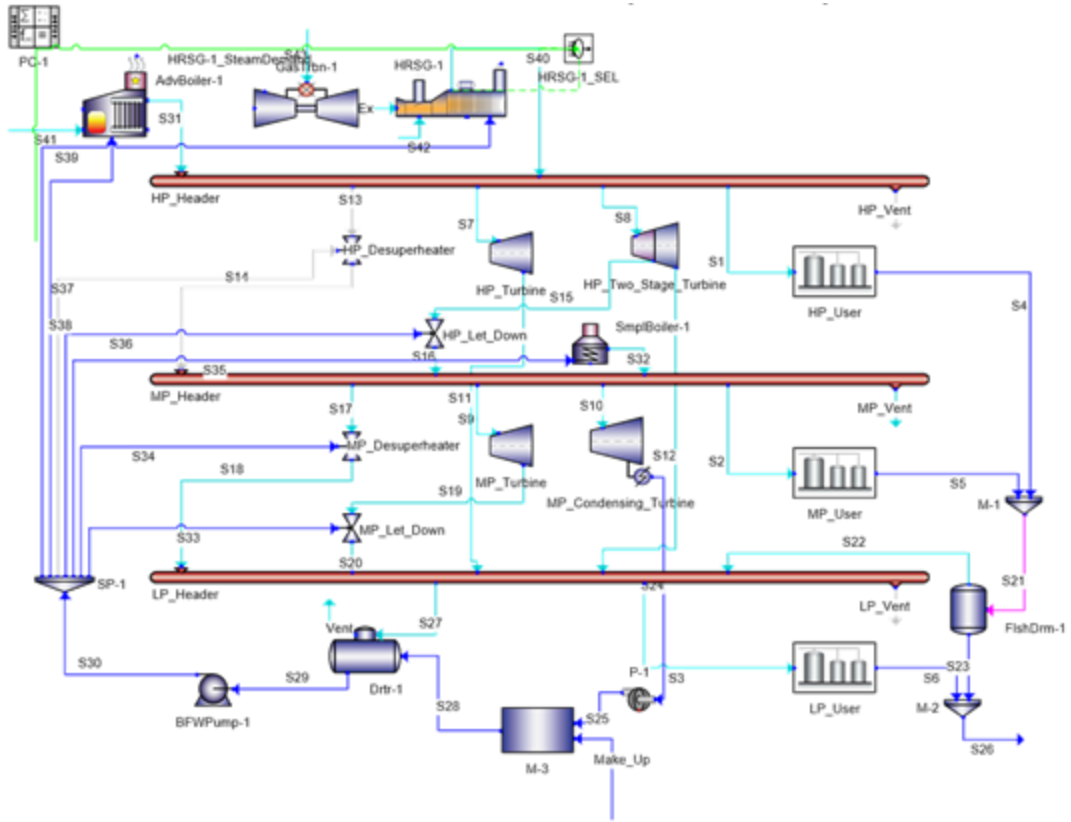
PETRONAS uses the Symmetry iCON® iUO, a custom energy modelling feature within Symmetry iCON® platform to construct a first principle model that runs an energy digital twin for a utility system

- Packaged boiler
- Steam Header
- Deaerator



- Steam Turbine
- Gas turbine
- Heat Recovery Steam Generator (HRSG)

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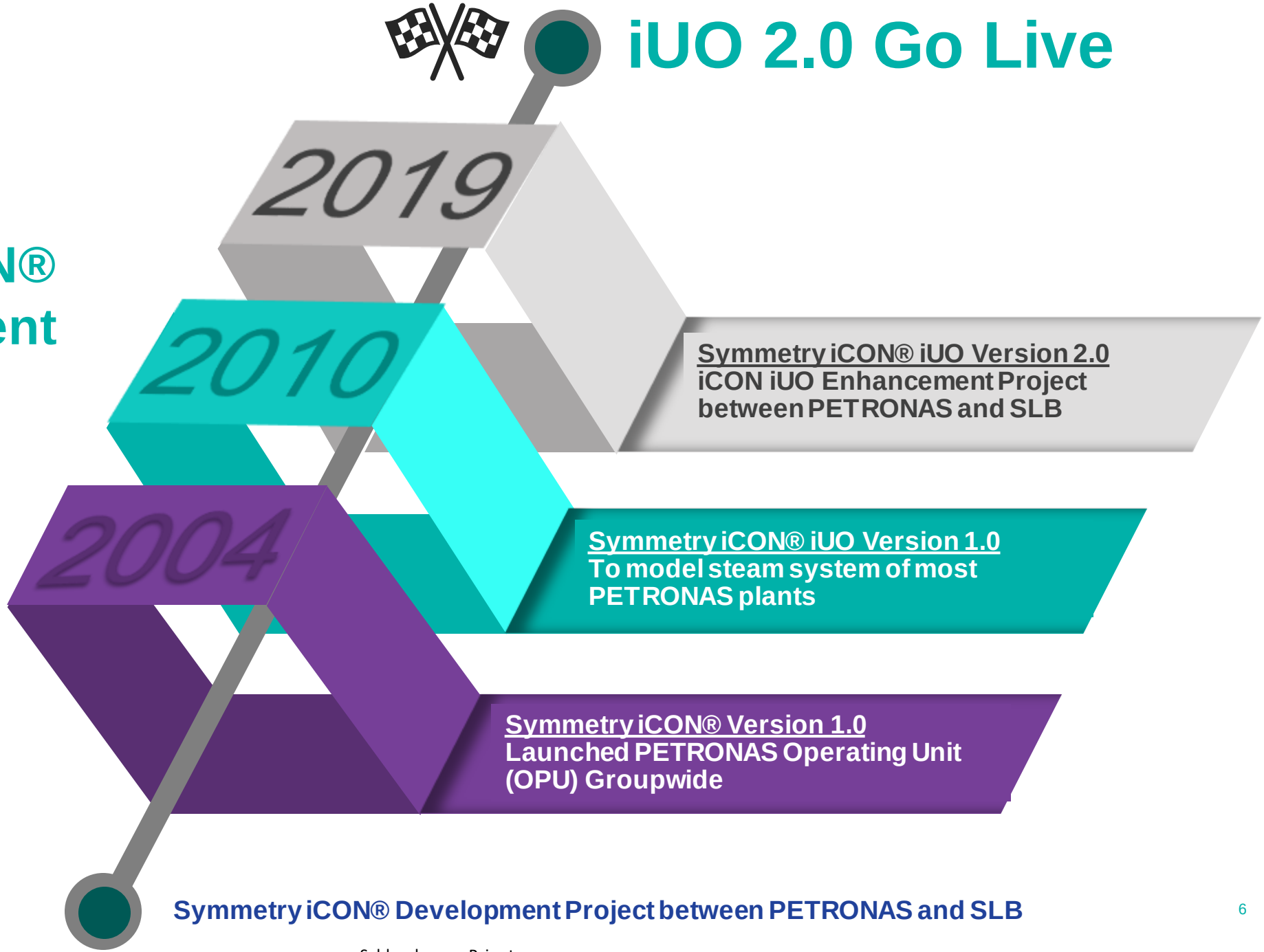
Symmetry iCON® iUO Development



Symmetry iCON® Development Project between PETRONAS and SLB

Internal

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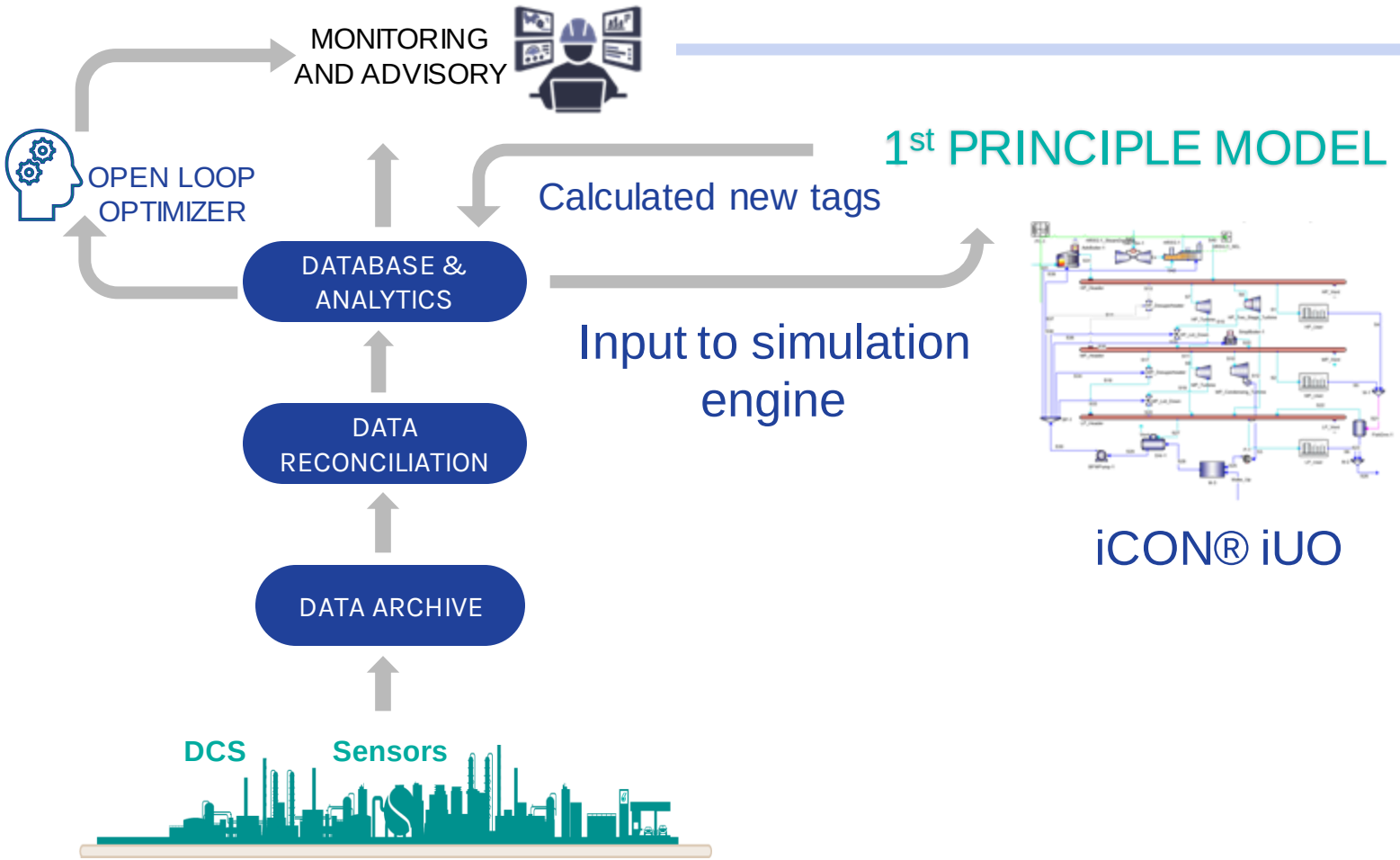
The Energy Digital Twin architecture can be configured into a descriptive and predictive functionality to enhance the operation experience



REAL TIME ENERGY ADVISORY DASHBOARD

- Real-time steam balance
- Plant Energy KPI (Energy Index)
- Equipment & overall energy consumption
- Equipment and overall plant efficiencies
- GHG Emissions, steam venting and loss management

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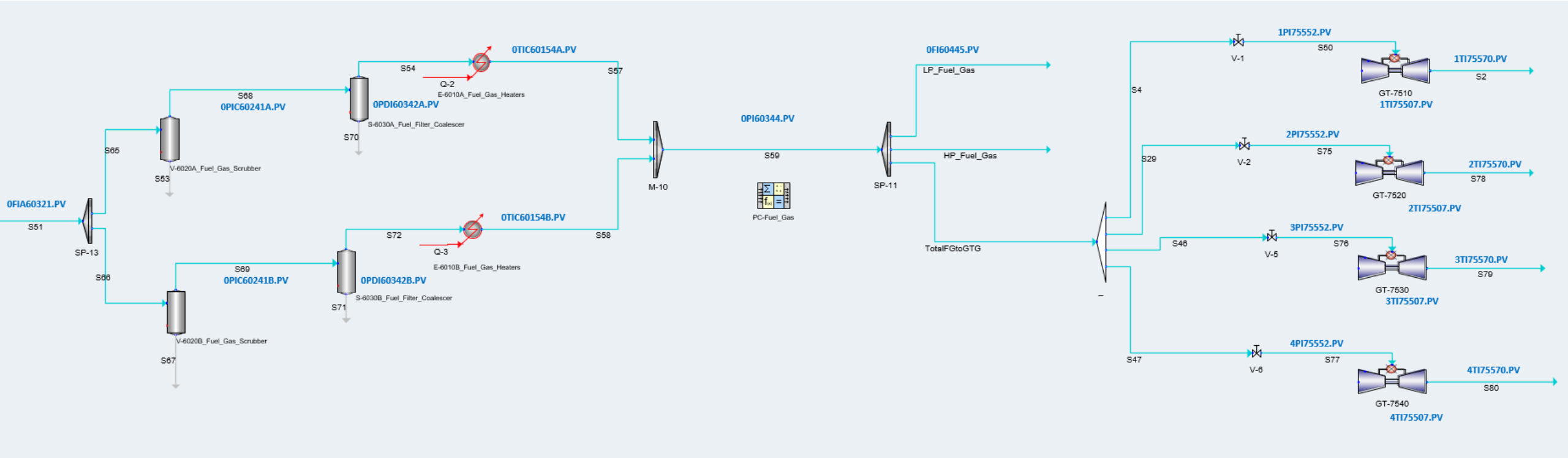
USE CASE 1

An O&G terminal uses gas turbines to generate power and heat to bring up hot oil to the specified temperature



- Power and heat combined cycle using gas turbine generators.
- Gas turbine exhaust sent to a waste heat recovery unit to re-heat returning heat transfer oil.
- Decision to analyse the optimum number of turbines to run with WHRU to reduce fuel gas consumption and greenhouse gas emissions.

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USE CASE 1

Optimising the number of gas turbines in operations resulted in cost savings and reduced equipment carbon footprint

Fuel gas optimisation study conducted in the facility recommended to operate with two GTs running instead of three.

Case Study	Fuel Gas Consumption (%)
Running two (2) instead of three (3) gas turbines	- 20%

Potential of cost savings of:

More than USD 1 Million per year

From Carbon Footprint Assessment, this may contribute to the reduction in CO2 emissions:

~ 400 tonnes of CO2e per year

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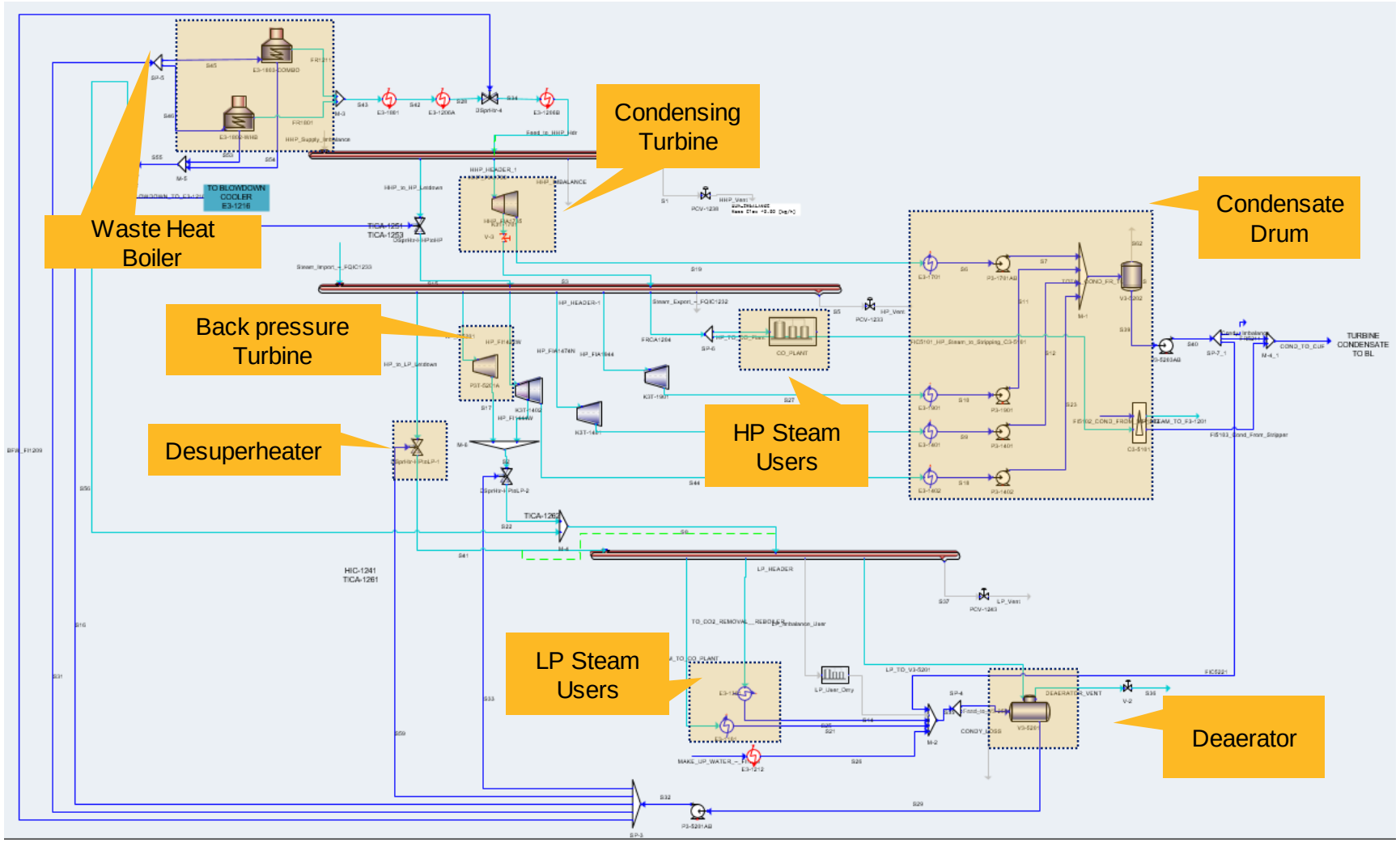
USE CASE 2

An online energy digital twin developed using Symmetry iCON® iUO



Model Description:

- 3 Steam Header Level (HHP, HP, and LP)

Input to Model:

- Steam Header Pressure
- Steam user's flowrate
- Steam turbine discharge conditions (P&T)

Output from Model

- Steam Header temperature
- Overall steam balance
- Steam turbine duty and efficiency
- LP steam flowrate to deaerator

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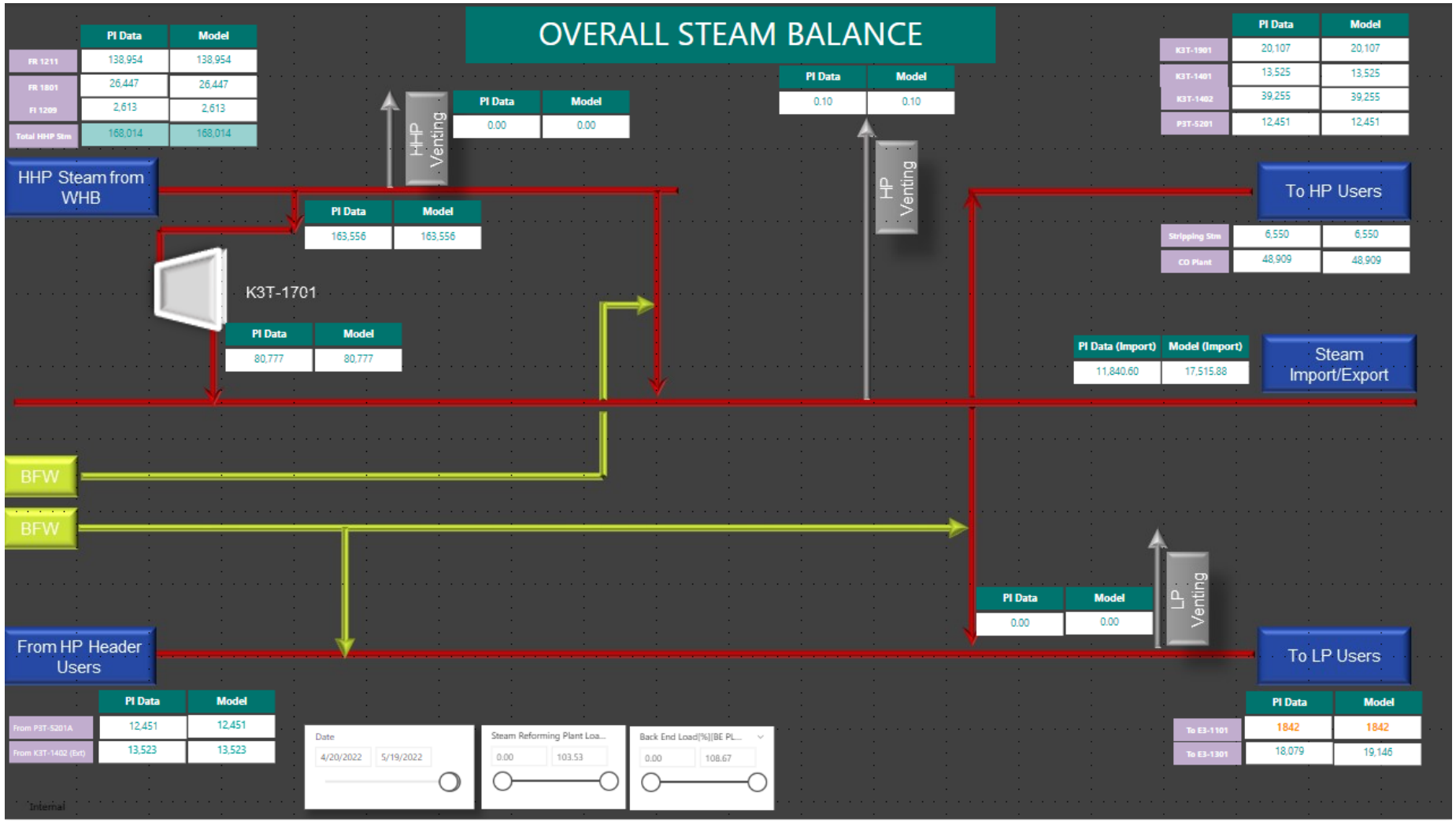
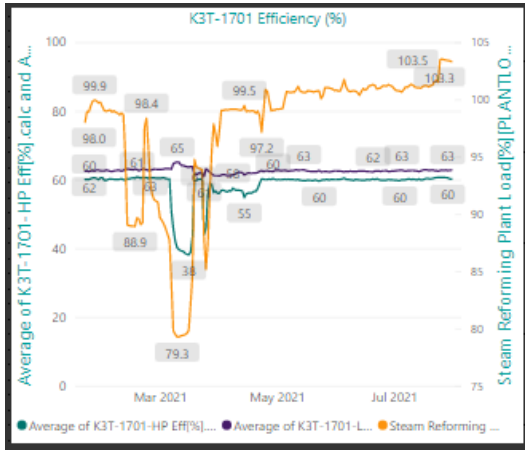
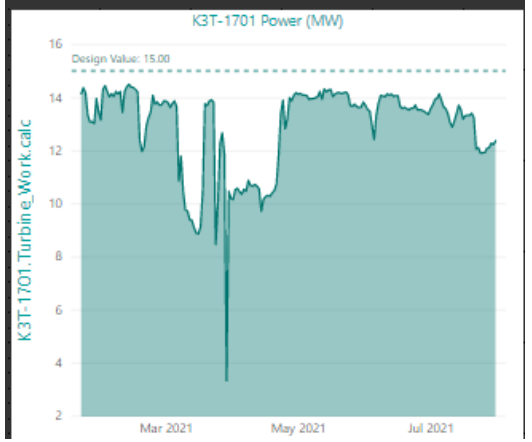
USE CASE 2

A sample dashboard showing the comparison between plant data simulation model results and trending







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USE CASE 2

Equipment performance such as efficiency and duty can be monitored near real-time

Date Selection

Plant Load Selection

- Deviation between modelled and plant data could be detected via near real time monitoring.
- The discrepancies could trigger discussion among the technologist and operations to investigate the potential issues identified.

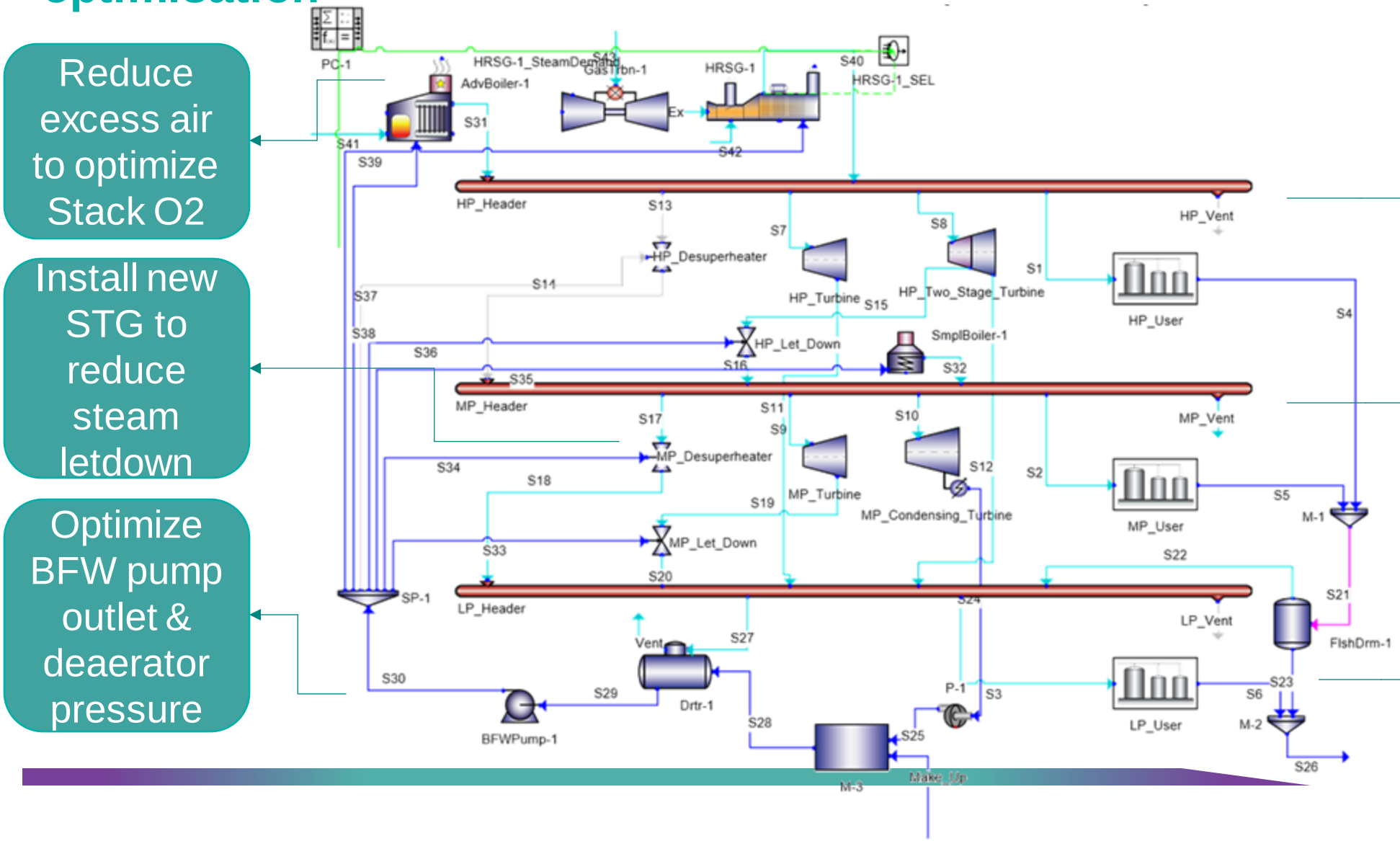
USE CASE 2

An online model acts as the foundation for an online open loop optimisation

Reduce excess air to optimize Stack O2

Install new STG to reduce steam letdown

Optimize BFW pump outlet & deaerator pressure



Optimize header pressure

Reduce MP header venting

Return condensate to reduce water import

Conclusions

- An **Energy Digital Twin** is a main enabler in moving towards digital transformation of the energy and utilities sector.

- Continuous monitoring of Key Performance Indicators (KPIs), **efficiencies and losses** enables **timely corrective and maintenance actions** by plant engineers and operators.

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Recommendations on potential new features or digital solutions

Potential new features to Symmetry or other SLB digital solutions include:

- Automated data retrieval and reconciliation
- Solutions for faster convergence and robust optimization e.g. Equation Oriented (EO) Solver, data driven models

Implementation of these recommendations will improve agility, responsiveness, and efficiency to fully leverage on the **complete digital twin experience.**

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Thank You

Special thanks to

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