



How Air Liquide Leverages on PI Technologies to Optimize its Operations - SIO.Optim program

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Agenda

- Introduction to Air Liquide
- The Smart Innovative Operations initiative
- ALIZENT, a key partner
- The Smart Innovative Operations Centre in Kuala Lumpur
- Business Challenge
- Method and Results
- Conclusion

Conference Theme & Keywords



Air Liquide Key Figures



66,000
EMPLOYEES

Present in
80
COUNTRIES

Revenue
€ 21
BILLION

Net profit
€ 2.1
BILLION

More than
3.6 MILLION
CUSTOMERS
& PATIENTS

Air Liquide Large Industries Operations

365

Large Air Separation Units
Oxygen, Nitrogen, Argon

50

Steam Methane Reformer Units
Hydrogen, CO, Syngas

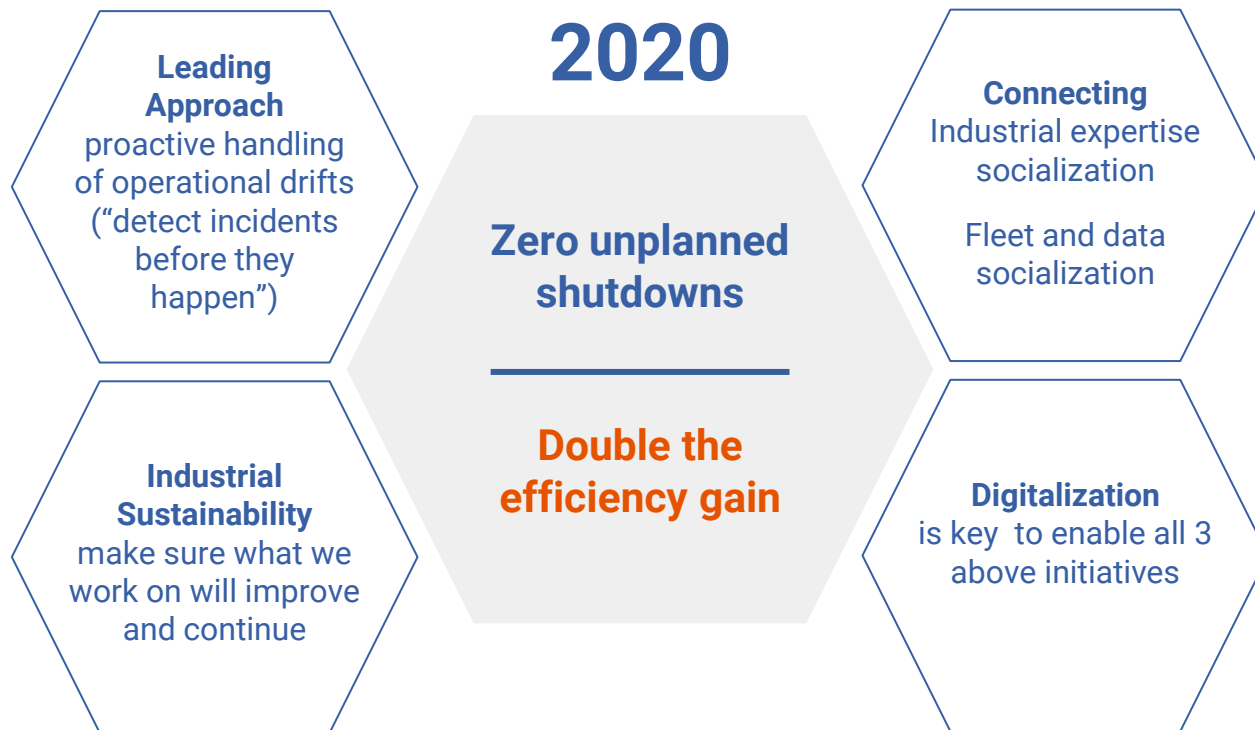
18

Cogeneration Units
Steam & Power



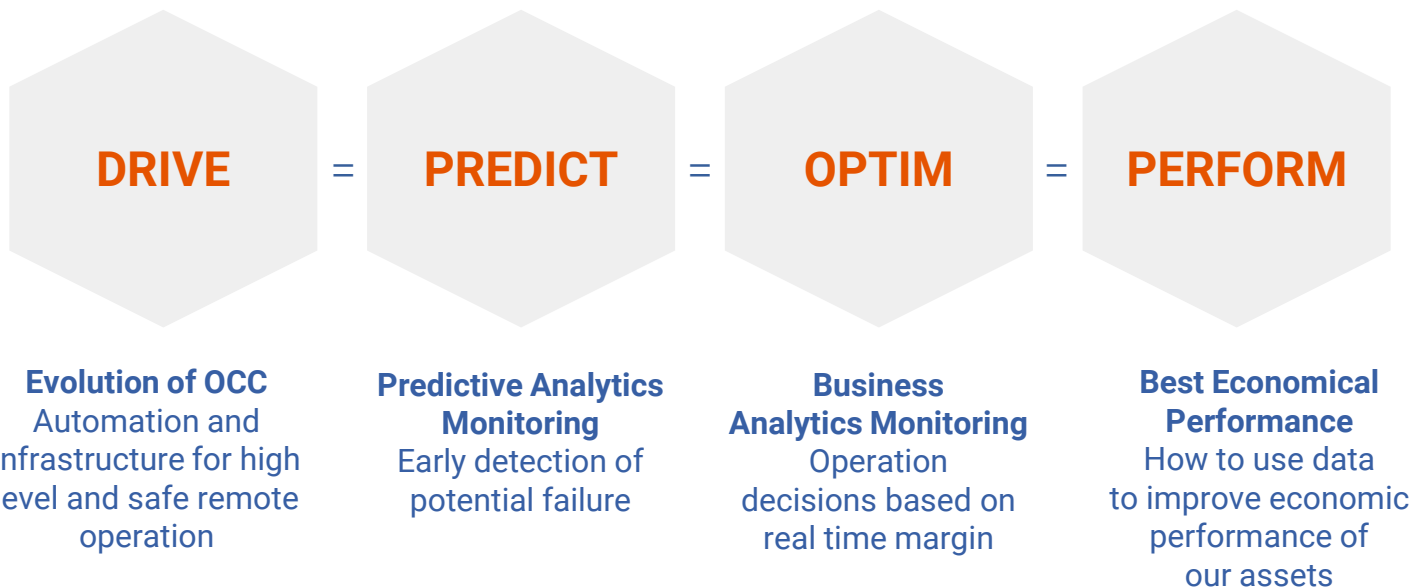
- Best in class performance in **safety** and **availability**.
- We improve the **efficiency** of our customer processes and help them preserve the environment.
- Present in every **key industrial basin** worldwide

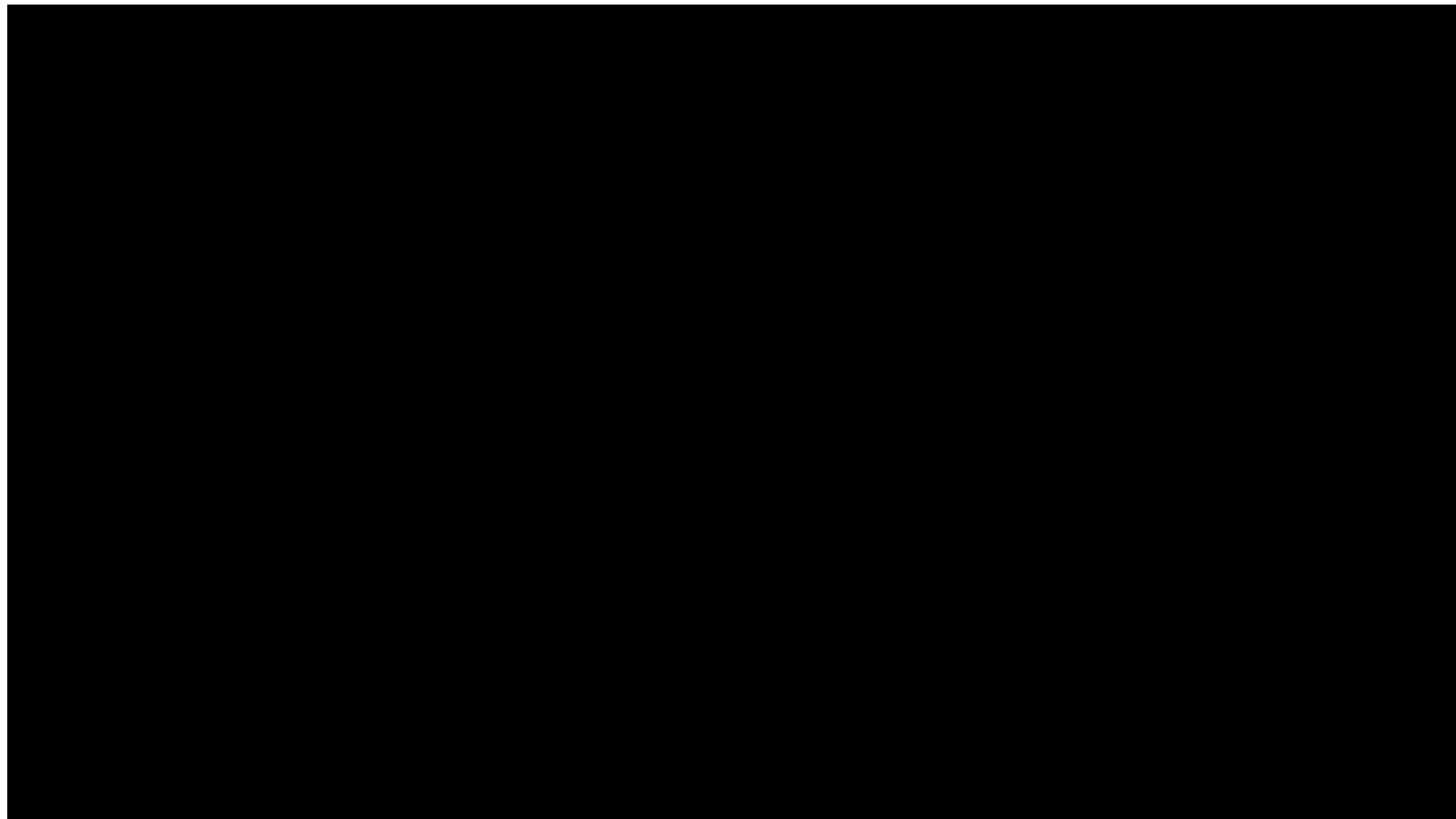
Air Liquide Large Industries Ambition



Air Liquide Large Industries Smart Innovative Operations Initiative

The Smart Innovative Operations Initiative





Alizent, an End to End Key Partner



Created by Air Liquide
to **connect industrial assets**
and being **digital technology experts**
enablers for industries
to **improve their operating model**
by **combining deep data know-how with**
skilled proficiency in industrial processes.

Alizent, a Global Reach for the SIO Initiative



5 PI system accreditation



250+ employees



12 nationalities

People

- 3 continents
- Data Scientists
- IT Architects
- PI Experts

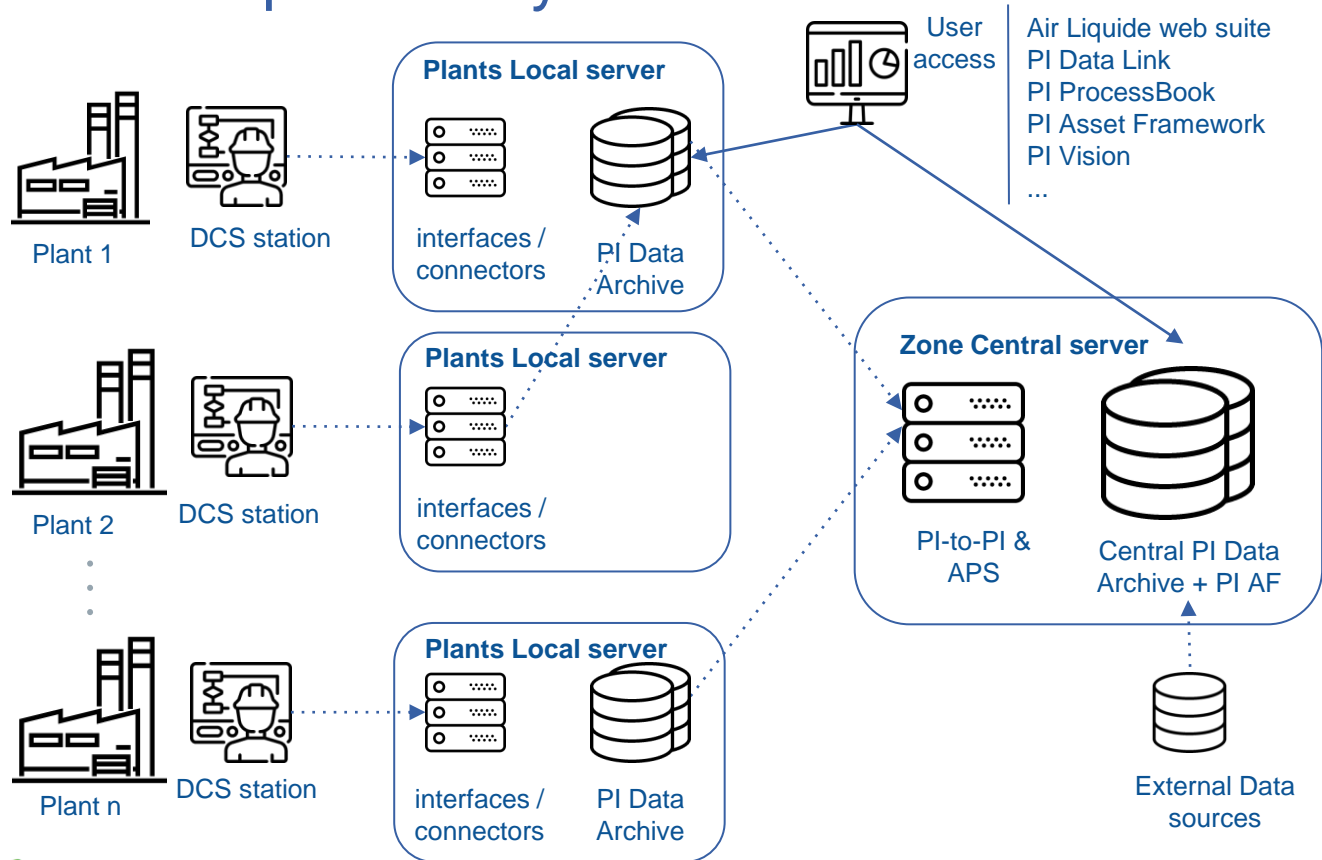
Processes

- Agile
- Iterative
- Collaborative
- Customer focused

Phases

- Proof of Concept
- Pilot
- Industrialize
- Operate

PI Suite Operated by Alizent



Technical information

- + 250 plants

PI Data Archive

- 2 central servers
- 20 TB of Data
- + 600 000 tags
- + 1 B Data collected everyday

PI Assets Framework

- 2 central servers
- + 40 databases

OSIsoft-Air Liquide Enterprise Agreement: a Key Enabler

Before

Open license limiting;

- number of tags
- types of interface upgrades

With Enterprise Agreement

1 unlimited license with NO LIMIT on

- tag
- user tools
- Access to Osisoft tool
- Training

Boost the SIO Projects

Interconnect the solutions

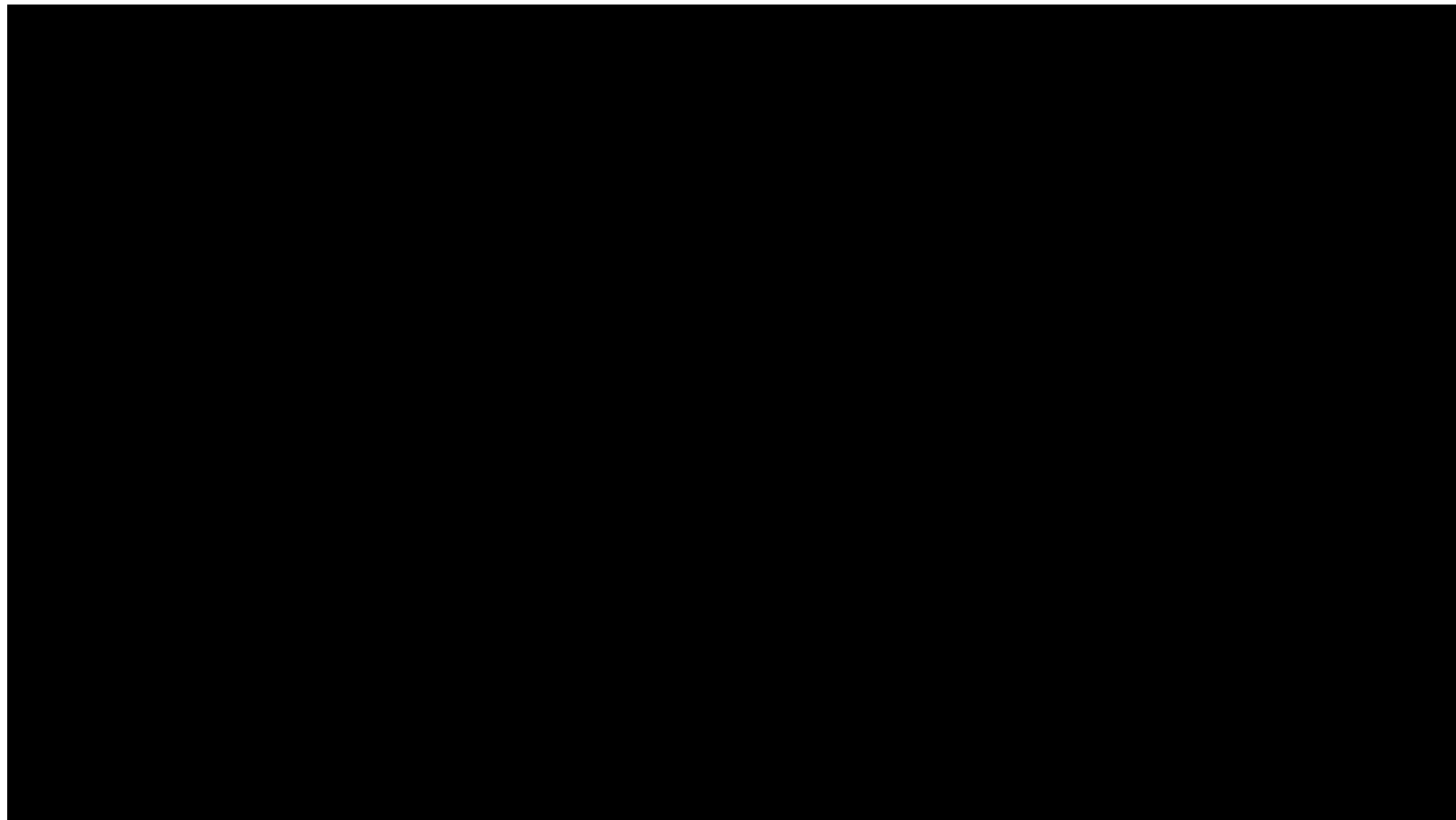
Collect more data from the field

Visualize the data

Air Liquide Business Services in Malaysia **The Smart Innovative Operations Centre (SIOC)**

The Remote Operations Control Centres (ROCCs)





Remote Operations Control Centre

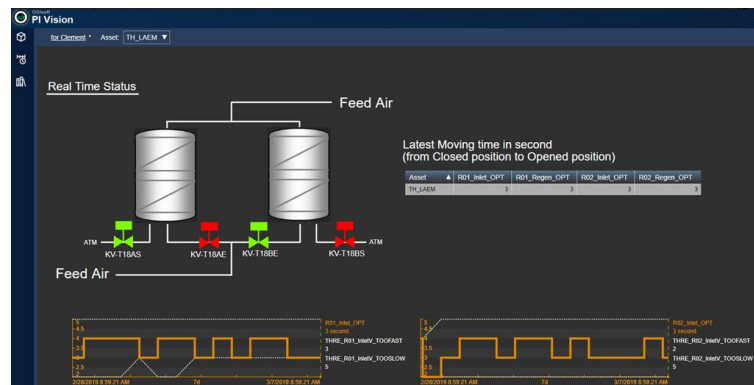
The ROCC missions:

- control and drive production 24/7
- in parallel, operate at the best economical points in real time
- conduct predictive maintenance actions
- optimize the networks



Data is the raw material:

- leveraging up to 10 years history
- and PI technologies
 - **700** daily users accessing PI data
 - More than **1000 pages** shared among the community
 - Deploying PI Vision pages



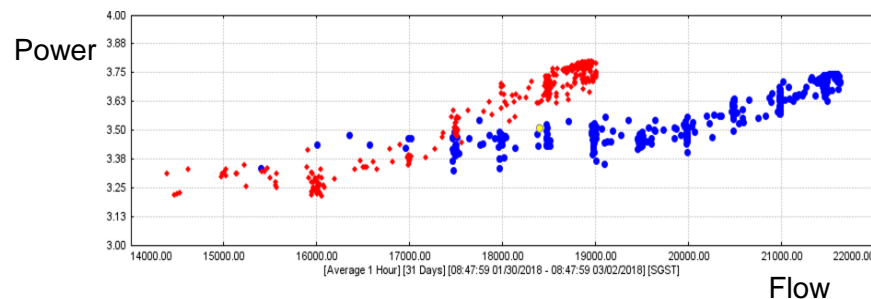
Air Liquide Singapore Pipeline Network

Air Liquide Singapore pipeline network:

- ~200 km long
- 5 production plants
- **Dozens** of rotating equipment
- Serving Large Industries **major customers**

Challenges:

- **Machines** with different technologies and generations
- In such complex system, a decision-support tool is required to ensure the **optimal combination** of equipment and **plant load** to serve at best our customers



SIO.Optim: Data Analytics and Optimization for Large Industries

- Using operating data, a generic model is trained to mimic the system behaviour.
- This **Digital Twin** of the Singapore Network is used to find the optimal combination of compressors and plant loads
- Live for months in ROCC
- A collaborative work between
 - Performance Analytics Engineers
 - Real Time Engineers



How to Build the Models?

Step #1: Template definition & creation with PI System Explorer



Template

Asset Framework

Data
Archive

ROCC
+
Plant
+
Experts
=
X templates

	Name	Description	Default Value
Category: Mandatory Attribute			
	Antisurge_MV	Bypass/Venting valve	0 %
	Compressor_Flow		0 Nm3/h
	Cooling_Temperature		0 °C
	Discharge_Pressure		0 bar
	IGV_MV	Needed ?	0 %
	Load_Factor_Flow		0 %
	Load_Factor_Flow_1day		0 %
	Load_Factor_Power		0 %
	Load_Factor_Power_1day		0 %
	Motor_Power		0 kW
	Number_of_Stop_Over_Month		0
	Product		
	Ready_To_Start		False
	Running_Status		False
	Stage		
	Suction_Pressure		0 bar
Category: Model			
	Motor_Power_Linear_Model	Newly developed	0 kW

Step #2: Deployment Using PI AF



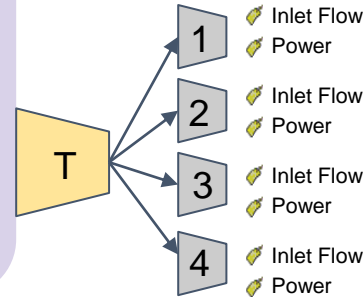
ROCC
+
Plant
=
Validated tag



Quick
deployment

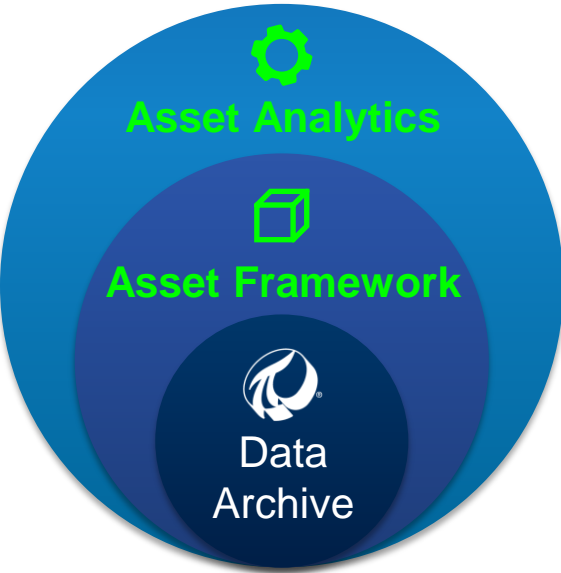


A screenshot of the PI AF software interface. It shows a tree view on the left with 'Assets' expanded, and a main pane on the right displaying a list of attributes for a selected asset. The attributes are organized into categories like 'Configuration', 'Location', 'Basic', and 'Mandatory'. Each attribute has a name, a value, and a status (e.g., 'Valid', 'Invalid').



Attribute → Element ↓	Inlet Flow	Power
1	FI45	P451
2	FI678	P589
3	FI986	P325
4	FI879	P598

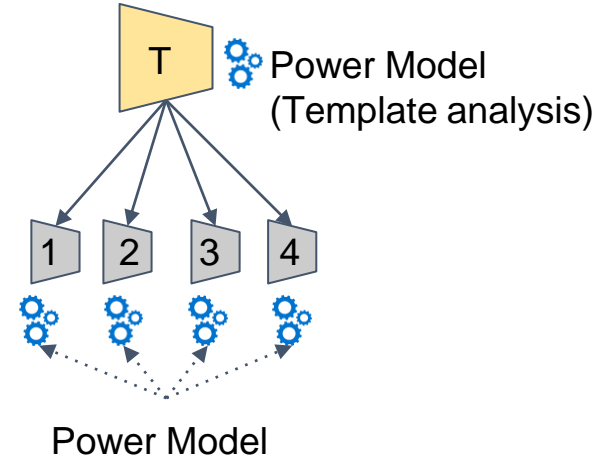
Step #3: Analytics Definition Using PI System Explorer



Area	Expression	Value at End
Flow	<code>if badval('Motor_Power_Linear_Model[Power_Model]Flow') then 0 else 'Motor_Power_Linear_Model[Power_Model]Flow'</code>	
temperatureCooling	<code>if badval('Motor_Power_Linear_Model[Power_Model]Temperature_Cooling') then 0 else Tagged('Motor_Power_Linear_Model[Power_Model]Temperature_Cooling')</code>	
pressureDischarge	<code>if badval('Motor_Power_Linear_Model[Power_Model]Pressure_Discharge') then 0 else 'Motor_Power_Linear_Model[Power_Model]Pressure_Discharge'</code>	
pressureSuction	<code>if badval('Motor_Power_Linear_Model[Power_Model]Pressure_Suction') then 1.013 else 'Motor_Power_Linear_Model[Power_Model]Pressure_Suction'</code>	
Flow	<code>'Motor_Power_Linear_Model[Power_Model](Coefficients)Coef_Flow'Flow</code>	
Temp	<code>'Motor_Power_Linear_Model[Power_Model](Coefficients)Coef_Temperature_Cooling'temperatureCooling</code>	
DischargeP	<code>'Motor_Power_Linear_Model[Power_Model](Coefficients)Coef_Pressure_Discharge'pressureDischarge</code>	
SuctionP	<code>'Motor_Power_Linear_Model[Power_Model](Coefficients)Coef_Pressure_Suction'pressureSuction</code>	
Constant	<code>'Motor_Power_Linear_Model[Power_Model](Coefficients)Coef_Constant'</code>	
PowerReal	<code>if badval('Motor_Power_Linear_Model[Power_Model]Power_PV') then 0 else Round('Motor_Power_Linear_Model[Power_Model]Power_PV')</code>	
EfficiencyReal	<code>if 'Motor_Power_Linear_Model[Power_Model]Inhibitor'='True' or Flow=0 or temperatureCooling=0 or pressureDischarge=0 or pressureSuction=0 then 0 else Round(1000*(0.000103137*temperatureCooling*Flow*(pressureDischarge/pressureSuction)/PowerReal)/10)</code>	
PowerModel	<code>if 'Motor_Power_Linear_Model[Power_Model]Inhibitor'='True' or Flow=0 or temperatureCooling=0 or pressureDischarge=0 or pressureSuction=0 then 0 else Round((Flow*Temp*Discharge*P*Suction)/PowerReal)</code>	
EfficiencyModel	<code>if 'Motor_Power_Linear_Model[Power_Model]Inhibitor'='True' or Flow=0 or temperatureCooling=0 or pressureDischarge=0 or pressureSuction=0 then 0 else Round(1000*(0.000103137*temperatureCooling*Flow*(pressureDischarge/pressureSuction)/PowerModel)/10)</code>	
DeltaPower	<code>if 'Motor_Power_Linear_Model[Power_Model]Inhibitor'='True' or Flow=0 or temperatureCooling=0 or pressureDischarge=0 or pressureSuction=0 then 0 else PowerReal-PowerModel</code>	

Easy
management

Testing before
deployment



Step #4: Connecting with Ecosystems: Internal Expertise

Air Liquide experts core models

Why develop a general optimization engine?

- Standardization
- Share Experience
- Build and preserve know-how
- Sustainability of solution
- Reduce technical risk
- Capitalize on past experience
- Increase collaboration
- Fast deployment
- State-of-the-art optimization technology

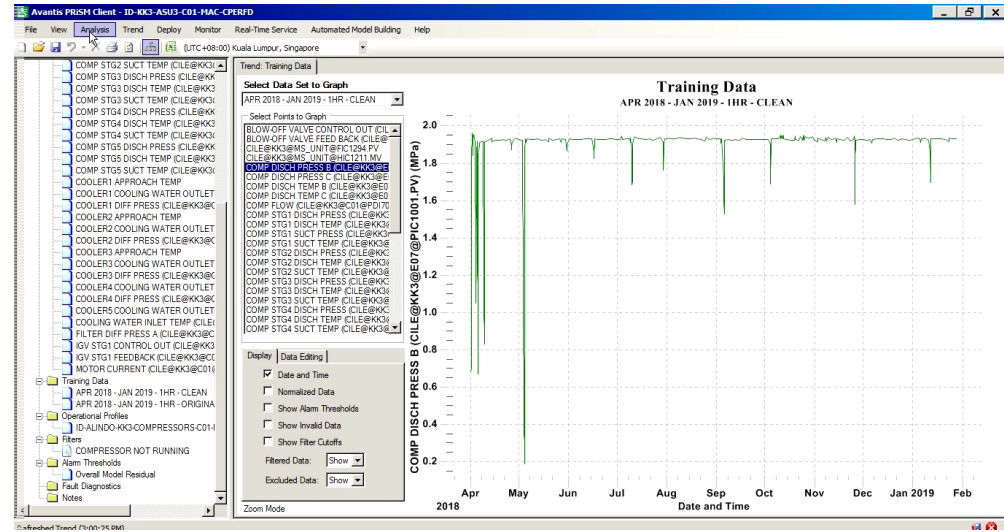
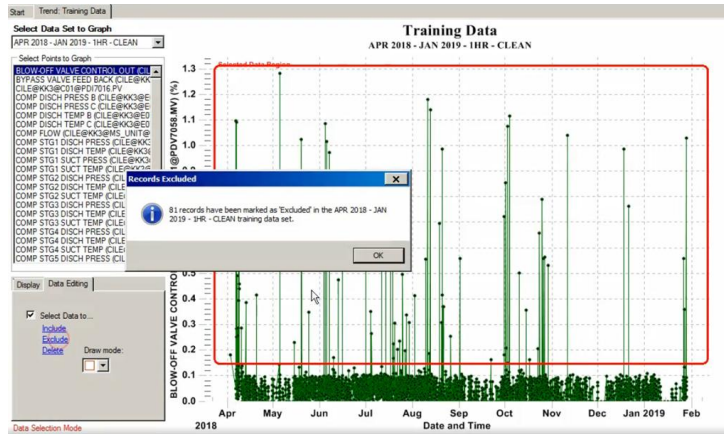


Step #4: Connecting with Ecosystems: PRiSM



PRiSM Platform

- Preferred predictive maintenance platform at Air Liquide
- User-friendly tool for data cleaning
- Linked with high fidelity, rich PI data



Step #4: Connecting with Ecosystems: Seeq



Solution -- Seeq empowers to deal with time series data in their day-to-day work, with advanced analytics

Usage :



- Search for historical periods of similar behaviour,
- look for correlations among trends taking into account time delays,
- develop monitors and alerts based on predictive models, etc.

Technology:



- High speed search engines,
- Advanced filter options and pattern recognition technology,
- Naturally connected to PI System and PI AF

Step #4: Connecting with Ecosystems: Seeq



1) Data Source

Direct connection to PI

2) Build in Data

- Cleaning
- Formula function

3) Regression

- Expanded basis, multi-variable to predict one parameter.
- Easy training window selection

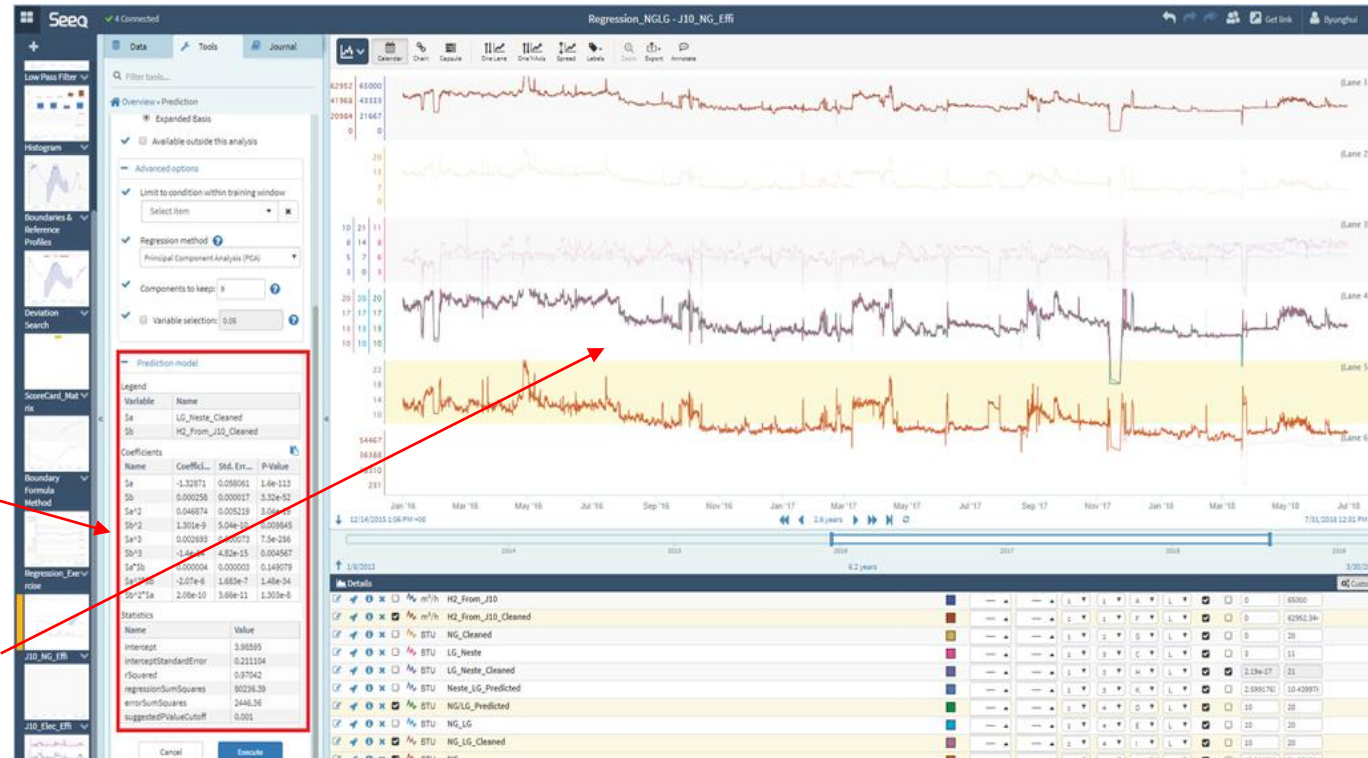


Step #4: Connecting with Ecosystems: Seeq



4) Instant display of regression result

- Select regression methods, Scale, Training window until satisfactory regression is obtained.
- Instant Display of calculated variable with regression and comparison with actual data

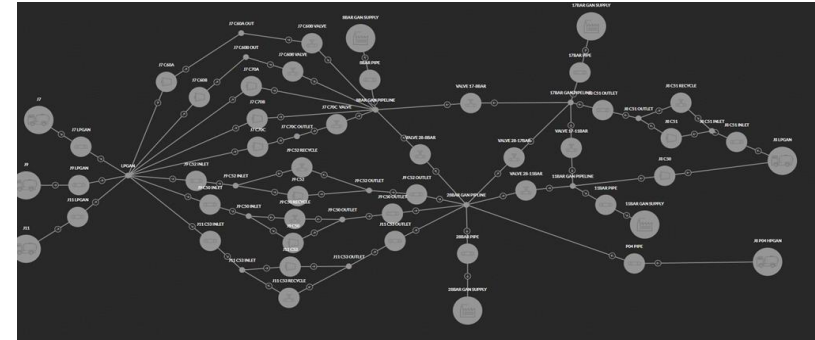


Step #4: Connecting with Ecosystems: AIMMS

AIMMS Platform



- Preferred modeling and optimization platform at Air Liquide
- User-friendly tool for non optimization experts
- Modularity and flexible user interface design
- Linked with an home made configuration wizard
- Linked with high fidelity, rich PI data
- Allows closed or open loops optimization





DEMO

Inbox - guoning.zhang@airliquide x Optim Wizard - https://dh36v9opkj0b.cloudfront.net x +

https://dh36v9opkj0b.cloudfront.net

Apps Managed bookmarks ASIA IS Intranet Imported Inbox - guoning.zhang e-Expense SIO.Optim - Core Eng SIO Perform LI-WIM LIRE Report

 **OPTIM WIZARD V2.2.2**

 **Guoning ZHANG**

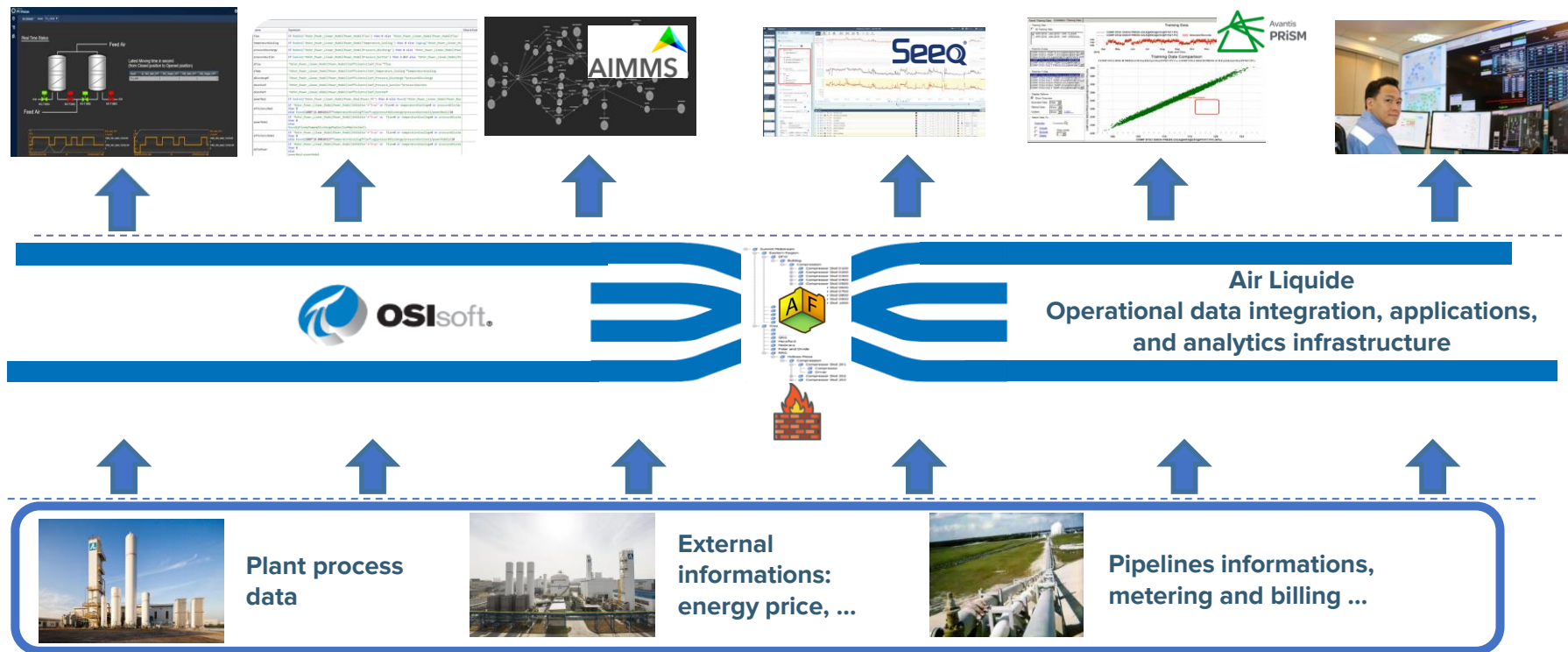
APAC SEA new project EDIT SCHEMA EDIT DATA

Create new node Create new coldbox Create new arc Save

1.3.0

EN 6:02 PM 3/6/2019

The Smart Innovative Operations Centre



Air Liquide

The Journey of the PI System at Air Liquide Operations in the 21st Century



CHALLENGE

Leverage the millions of data collected at SIO KL to improve operations in pipeline networks



SOLUTION

AF implementation & leverage:

- PI tools to model assets
- SIO.Optim tool developed by AL experts
- connecting with partners like AIMMS, PRiSM and Seeq



RESULTS

- Leading Optimization
- Customer satisfaction
- Collaboration with plant operations teams, external partners
- Unnecessary energy consumption
- CO2 emissions



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