AVEVA PI WORLD

Data Management around PI System

TotalEnergies

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Agenda

About TotalEnergies

Challenge-Solution-Benefits

Details of the solution

Next Steps

About TotalEnergies

Now a Multi Energy Company

TOTAL

TotalEnergies

Our ambition is to be a major player in the energy transition.

Our activities span the entire value chain:

- from the **production** of energies,
- and their **transportation** and **transformation** into intermediate or finished products,
- to their **storage** and **distribution** to meet the needs of individual and business customers.

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OIL & GAS

Data Management for an optimal use of the PI System

Challenge

- Context: PI DA on site with local governance over the last 20 years including many specific use cases developed within PI Processbook and Excel sheets.
- How to **share** this local knowledge?
- How to **democratize** the data?
- How to **digitalize** our assets and add value to this data?
- Without forgetting **Scalability**!

Solution

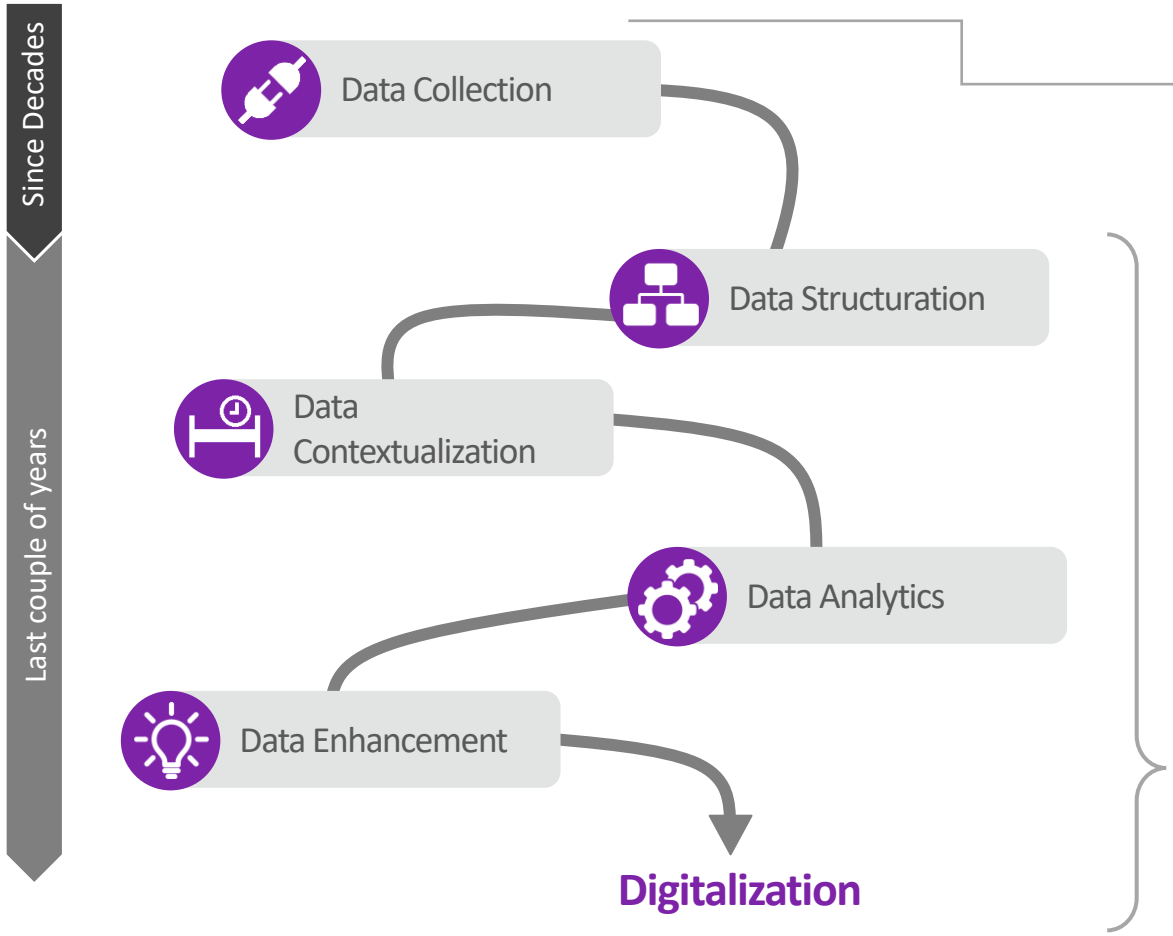
- Put in place a strong **Data Management** (and central governance) in adequacy with the AVEVA PI System products (PI AF and PI Vision).
- Creation of a **robust** Data Contextualization **platform** allowing data sharing, deployment and maintenance

Benefits

- Break business silos
- **Reusability** (new use cases are easily integrated) → increase efficiency
- **Automatic** and fast deployment → gain in term of time, **reduce** human errors and maintenance operations
- The governance and platform in place help us to put **more and more focus on use cases** and value addition to our data

Global Context

Our maturity around data…



Few years back (Before starting the project):

- One PI Data Archive running on each site
  - Efficient data collection
- However
  - Local data management
  - Many specific use-cases developed within PI ProcessBook and Excel sheets
  - Limited capitalization and sharing

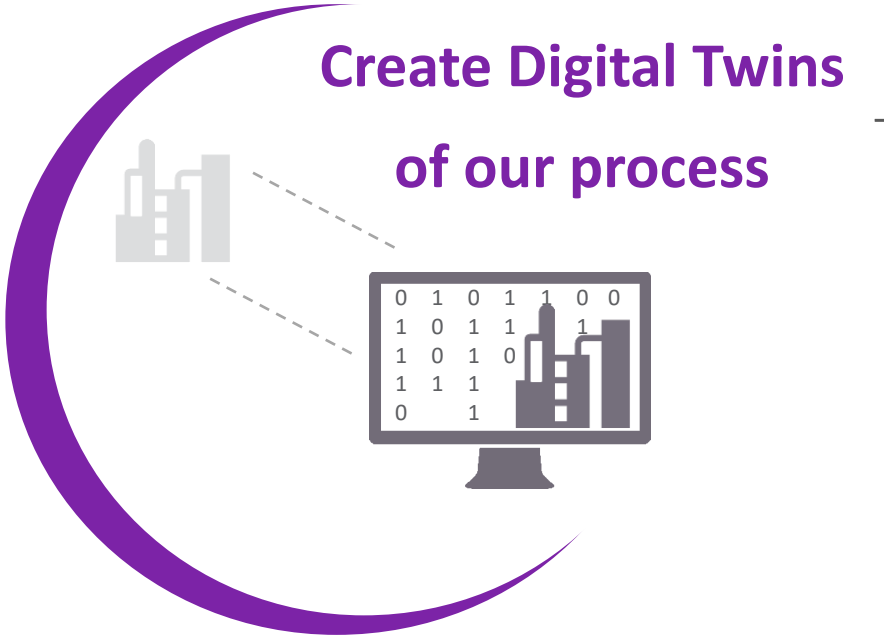
Challenges:

- How to share, democratize, add value to our data?

Scope of our project

TotalEnergies Data Digitalization

Our global vision…



- Creation of **generic templates** available for all sites (worldwide)
- Considering:

  Site-specificities such as UOM, languages, historic tag naming convention, coefficients…

  Equipment-specificities (availability of instrumentations)

TotalEnergies Data Digitalization

With known objectives…

Break Business **silos**

Only one template per equipment including all generic data to share **a single source of truth** to different business teams

Guidelines for users / developers

Standards, **Best practices**

Help **Maintenance**

Creation of generic templates and displays easy to deploy for all users, **easy to maintain** with a minimum of modifications

Fast deployment (Scalability)

Start small, but think big
Distributed AF architecture (central and local servers)
One PI Vision server to start (but this will change)
Minimize deployment costs for all sites

To achieve our goal

We cannot have this ambition without…

A well-defined

Data Management

(it is mandatory!)

*Data management is the **creation and implementation of architectures, policies, and procedures** that manage the **full data lifecycle needs of an organization**. Having these policies and procedures in place is critical to analyze complex, big data. When data is treated as an important company asset, it needs to be managed as such.*

Common elements of data management:

- Data preparation, Data pipelines, Data extract, transform, load
- Data catalogs
- Data governance
- Data architecture
- Data security

Ref: https://www.tableau.com/learn/articles/data-management-vs-data-governance#:~:text=In%20the%20simplest%20terms%2C%20data,that%20data%20for%20decision%2Dmaking.

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Data Management

We started with…

We wrote

- **Best Practices** (AF & PI Vision)
- **Checklists** (control developments, quality check)
- **Request Forms** (formalization developments)
- **Wikis** (explain how to do a specific feature in AF, PI Vision)

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Data Governance

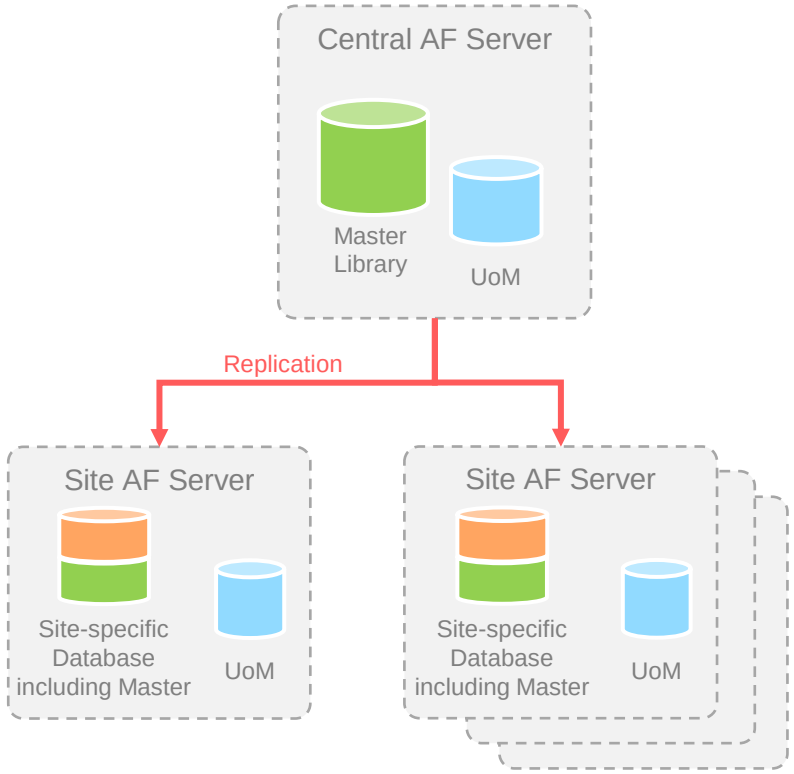
During this phase

We have thought about

- **Global** AF Hierarchy:
  - Central vs Site-specific
  - UoM Database
- Elements Structure
  - Meets industrial and automation standards requirements (ANSI/ISA-95 and 88)
- AF Security
- Naming and Structure conventions for:
  - AF objects
  - PI Vision displays
- **Replication mechanism**

Data Management - How did we proceed

Then we put our vision in place…

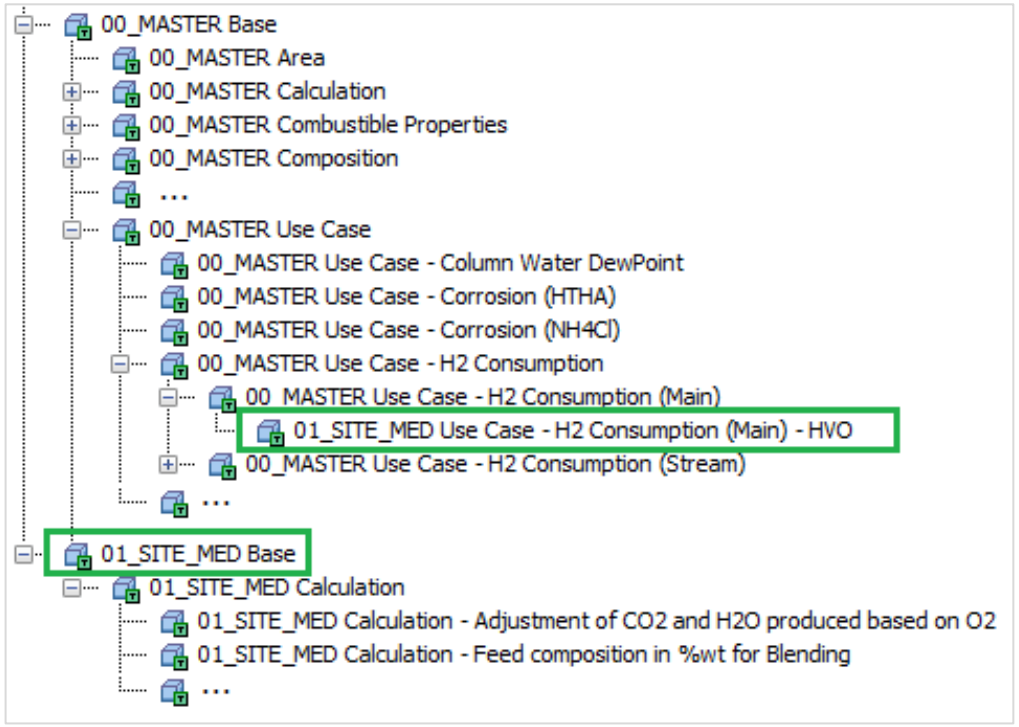


Master Library:

- **Main repository** of standard AF objects built at TotalEnergies
- Managed and stored in central system. **Cannot be modified** by site
- **Automatic replication once a day**
- All additions / editions / removals are performed using a custom **validation tool**

Data Management - How did we proceed

Then we put our vision in place…



AF Library rules:

- AF Objects (e.g., template, table, enumeration…) follow a **naming convention**
- Site can manage its own AF objects (ex: 01_SITE_DGS Template1)
  - Full control of site objects = **Autonomy**
  - Can be derived from a Master object (to add the site specific only) = **Flexibility**

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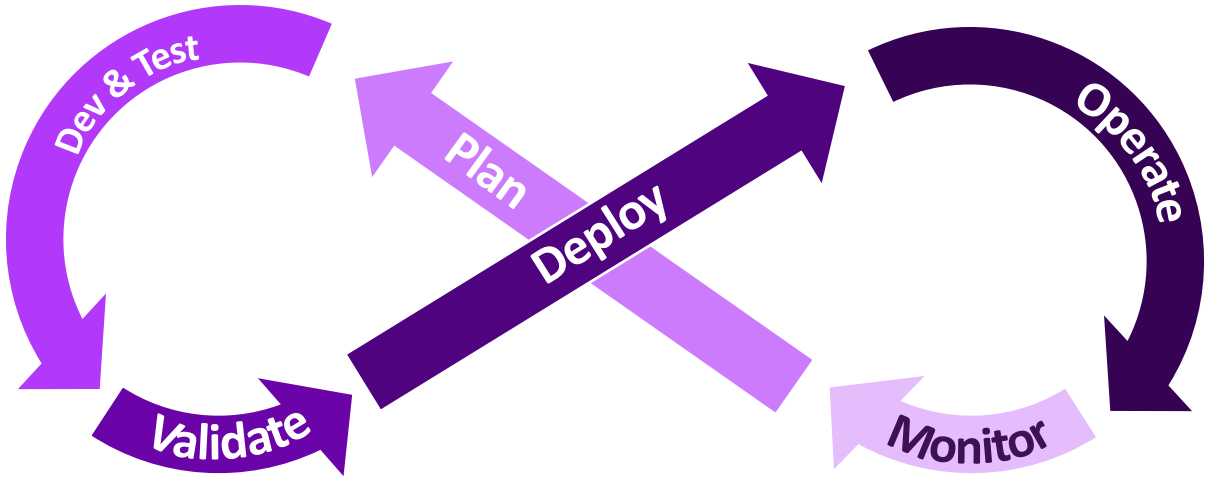
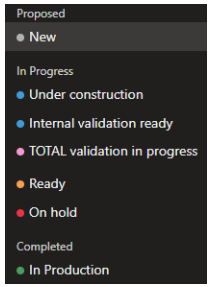
Our Development Process

All generic use cases pass through a unique process



To deliver our AF use cases:

- **A dedicated team** made of process engineers and AF developers
- **Agile** approach = Quick delivery
- Use of Azure **DevOps** platform to manage our projects:
  - Easy to follow and track any changes
  - Lifecycle of AF objects / PI Vision displays



- 1 Use case = **AF templates + PI Vision displays**

Our Development Process

Our process more in details…

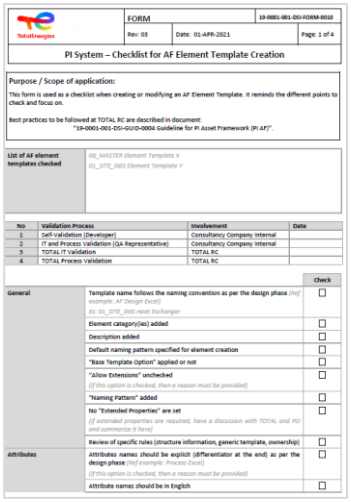
Dev / Test:

- All AF objects and PI Vision displays are **declared within DevOps**

AF Objects	Element Template	00_MASTER Calculation - Running Status - Equipment - Generic (Temperature)
AF Objects	Element Template	00_MASTER Use Case - Emissions - SO2 - Site (Period Based) - Monthly
AF Objects	Element Template	01_SITE_MED Process Unit - HDT/HDI
AF Objects	PI Vision Display	00_MASTER_Reformer_01_Home

Validate:

- **Checklists**



PI System – Checklist for AF Element Template Creation

Purpose / Scope of application:

This form is used as a checklist when creating or modifying an AF Element Template. It reminds the different points to check and focus on.

Best practices to be followed at TOTAL RC are described in document:
"19-0001-001-DSI-GUID-0004 Guideline for PI Asset Framework (PI AF)".

List of AF element templates checked

No	Validation Process	Involvement	Date
1	Self-validation (Developer)	Consultancy Company Internal	
2	IT and Process Validation (QA Representative)	Consultancy Company Internal	
3	TOTAL IT Validation	TOTAL RC	
4	TOTAL Process Validation	TOTAL RC	

		Check
General	Template name follows the naming convention as per the design phase (Ref example: AF Design Excel) Ex: 01_SITE_D00 Heat Exchanger	☐
	Element category(ies) added	☐
	Description added	☐
	Default naming pattern specified for element creation	☐
	"Base Template Option" applied or not	☐
	"Allow Extensions" unchecked (If this option is checked, then a reason must be provided)	☐
	"Naming Pattern" added	☐
	No "Extended Properties" are set (If extended properties are required, have a discussion with TOTAL and PO and summarize it here)	☐
	Review of specific rules (structure information, generic template, ownership)	☐
Attributes	Attributes names should be explicit (differentiator at the end) as per the design phase (Ref example: Process Excel) (If this option is checked, then a reason must be provided)	☐
	Attribute names should be in English	☐

Plan:

- **Close work** with central and site process teams to define the needs
- **AF Design is built at early stage**

Operate:

- Use of generic PI Vision displays part of the use cases
- **Feedback** of end users

Monitor:

- Main and critical use case outputs are monitored using our **PI System Monitoring platform**

Deploy:

- Custom tool used to manage the move to the Master Library
- **Automatic replication** on all site databases

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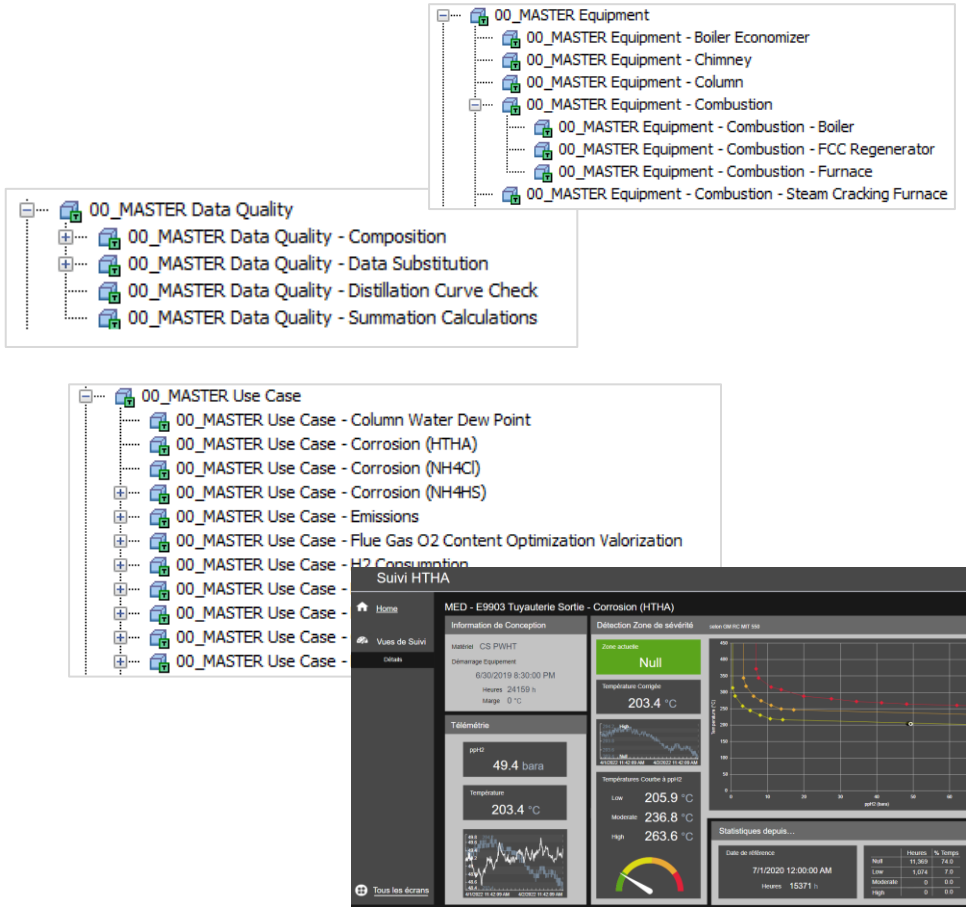
Concretely…



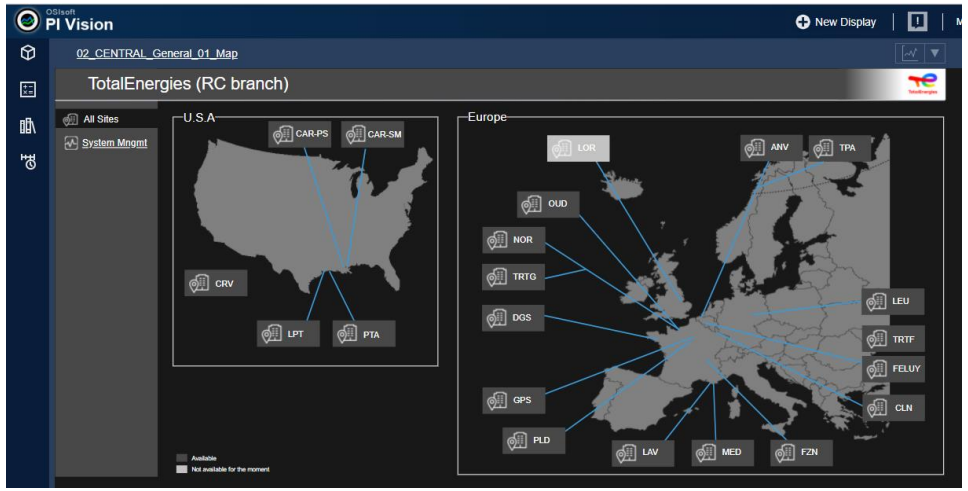
Today at TotalEnergies (RC Branch):

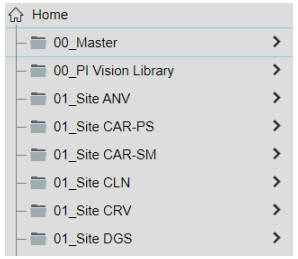
- **400 master AF element templates** covering several needs: Energy, Environment, Process, Maintenance, Data Quality…

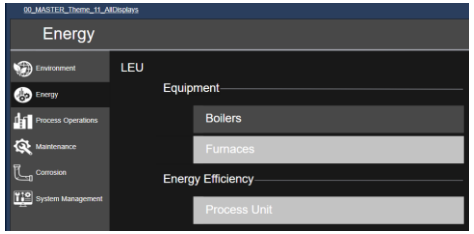
- Templates already used and **instantiated by sites**
  Ex:
  - 50 boilers / furnaces
  - 400 streams digitalized in AF
  - 7 packinox units, 3 HDS, 3 reformers

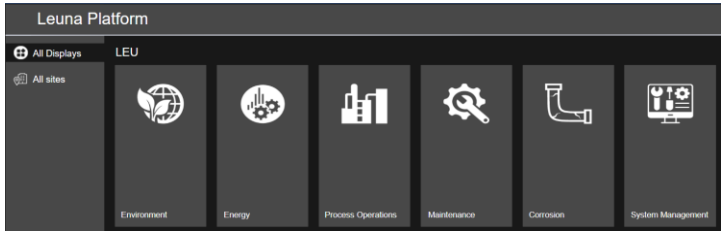
- **160 master PI Vision displays**
  - Full control of site objects = **Autonomy**

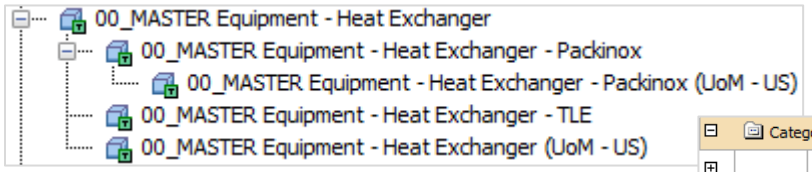
Overview of our Data Contextualization System

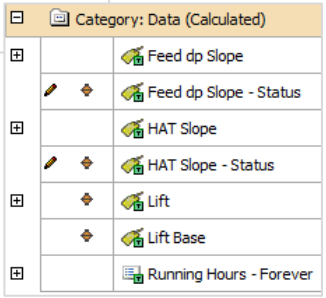


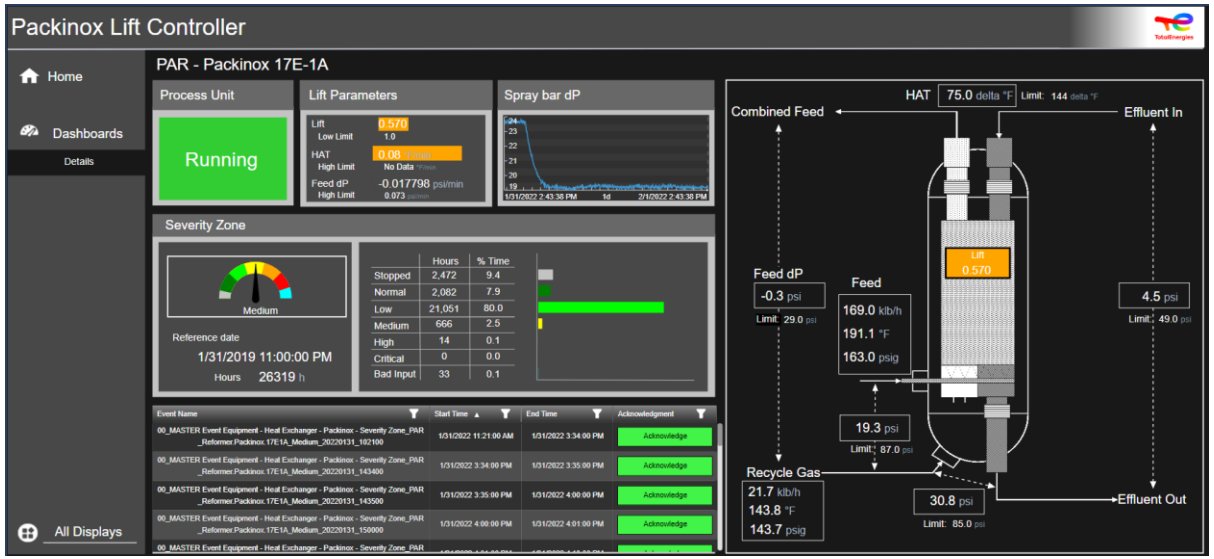






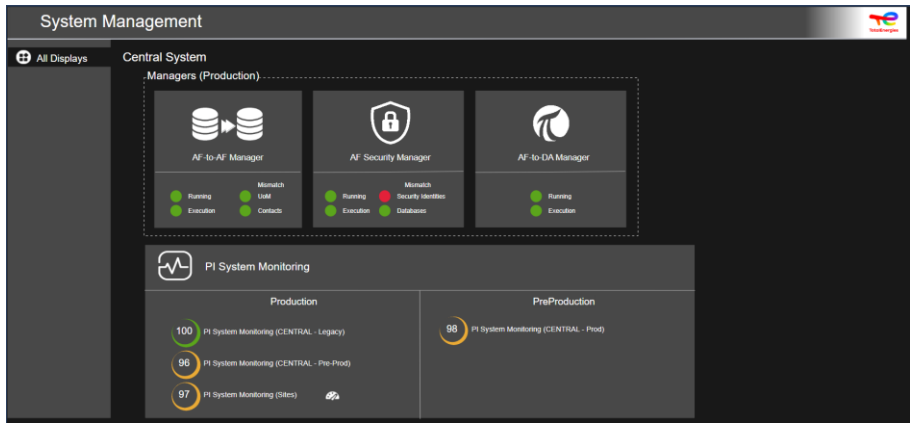


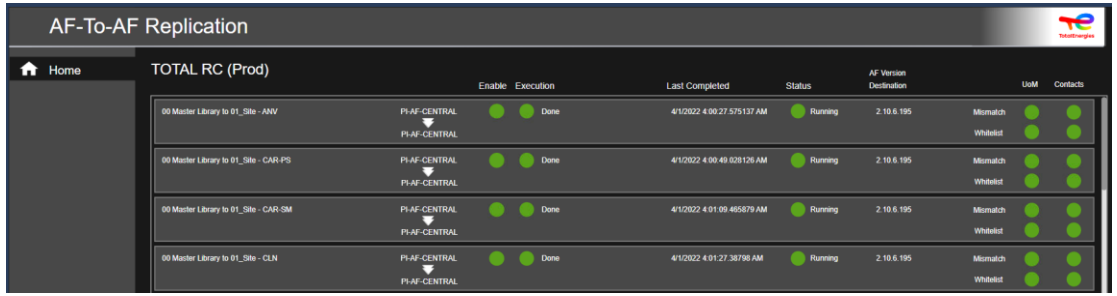




To easily maintain and deploy faster

We developed custom services & tools…





AF-to-AF Manager:

- Used to replicate:
  - Master Library objects (templates, tables, enums, categories…) to AF databases
  - Master Contacts (Delivery endpoints)
  - UoMs

Note: This is possible thanks to with our Data Governance

Regarding UoM:
We guarantee that everybody works with the same UoM conversions

- New UoM are detected and notified to central team
- Any existing UoM modified on local AF servers will be overwritten by the replication service

To easily maintain and deploy faster

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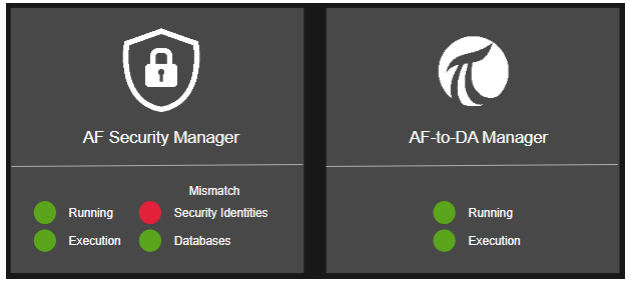

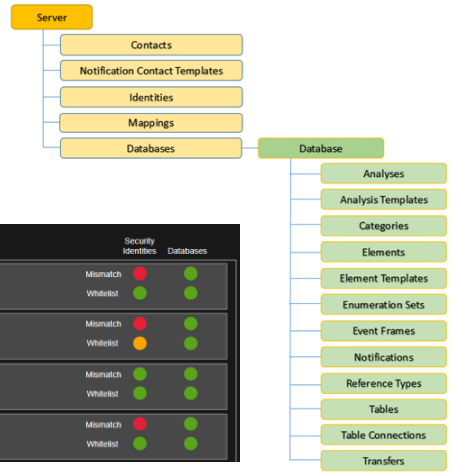

AF Security Manager:

- Creation / Edition of AF identities
- Detection of new AF identities
- Creation of AF mappings
- Propagation of AF access permissions on all AF objects (server, UoM, database objects)
  - **All our AF Servers security is managed by this service**

AF-to-DA Manager:

- Creation / Edition of AF enumeration sets into Digital sets
  - **All our DA Servers are enrolled in this service**

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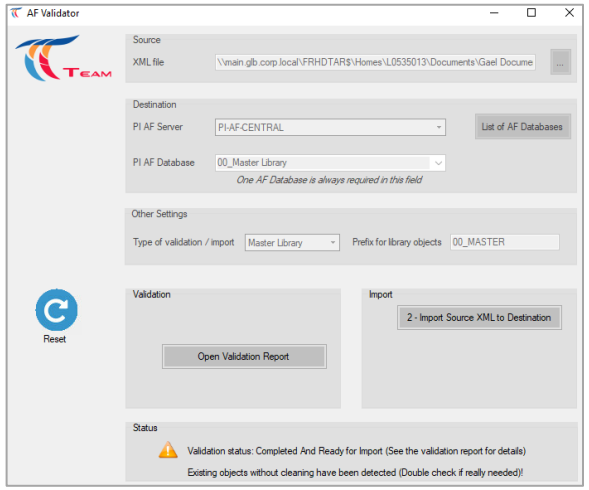

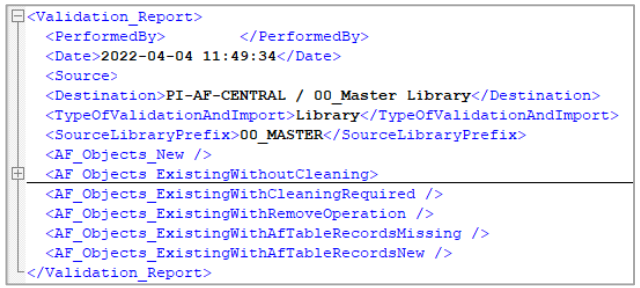

AF Validator:

- Check if the AF objects can be imported in the destination AF database
- Detect differences
  - Ex: Detect if attributes must be removed, if AF table records are missing…Creation / Edition of AF identities
- Generate a validation status to allow import or not
- This tool is used when updating the Master Library

AF Comparator:

- Detects differences between source AF objects and reference AF objects

Next Steps

Coming year(s)…

- **Adapt** our data management based on Return of Experience
- **Intensive use** of the platform to improve
- **Accelerate** the deployment to other sites
- **Close work with AVEVA** to improve their products to meet our needs

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Data Management for an optimal use of the PI System

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On the Digitalization of Molecules for Efficient Energy and Emissions monitoring

Structuration, Templatization, Replication at scale using PI AF

Pierre BERNADI – Gaël COTTET - TotalEnergies -

Focus on the new OneTech Branch

Creation of a new branch, **OneTech**, regrouping all the Central Technical Expertise, at the service of Operational branches

- 3400 engineers, researchers, technicians and support teams
- Adapt to new industrial activities
- Foster innovation
- Mobilize tech resources on strategic projects
- Provide solutions to reduce our carbon footprint
- Develop and attract talents

OIL & GAS

Efficient Energy & Emissions Monitoring

Structuration, Templatization, Replication at scale using AVEVA PI AF

Challenge

- Different Teams involved in Energy and Emissions monitoring, using same source information.
- Duplicate work, not always shared, that may lead to inconsistencies.
- Complex calculations difficult to maintain or simply not possible in Excel

Solution

- PI AF Structure of the Refineries.
- Deep structuration, considering Combustibles and Molecules as “Assets”
- From small building blocks, up to Refinery level for consolidation

Benefits

Compliance for emissions monitoring

Reuse of Assets to build parallel/connected Use Cases

Breaking silos

O_2 optimization on Heaters could save hundred of k€ per years (combustible and CO2 cost)

Who is monitoring the Refining Units ?

Same source Data, but « different » perspectives

Similar calculations are performed by Teams, often duplicated, not always shared, leading to inconsistencies and duplicate work

Process/Energy Team

- Fouling of Heat exchangers
- Efficiency of Combustion Eq.
- O_2 optimization of Comb. Eq.
- Steam cons. on reboilers, turbines…
- Energy consumption of process units
- …

Environment Team

- SO_2 emissions (Daily, Monthly, Yearly) at Chimneys
- SO2« Bubble » in mg/Nm3 (at 3%O_2 in dry flue gas)
- CO_2 emissions
- …

Performance Control Team

- Consolidation of Combustibles
- Reporting on Energy efficiency
- Reporting on losses to Flare or vents
- ….

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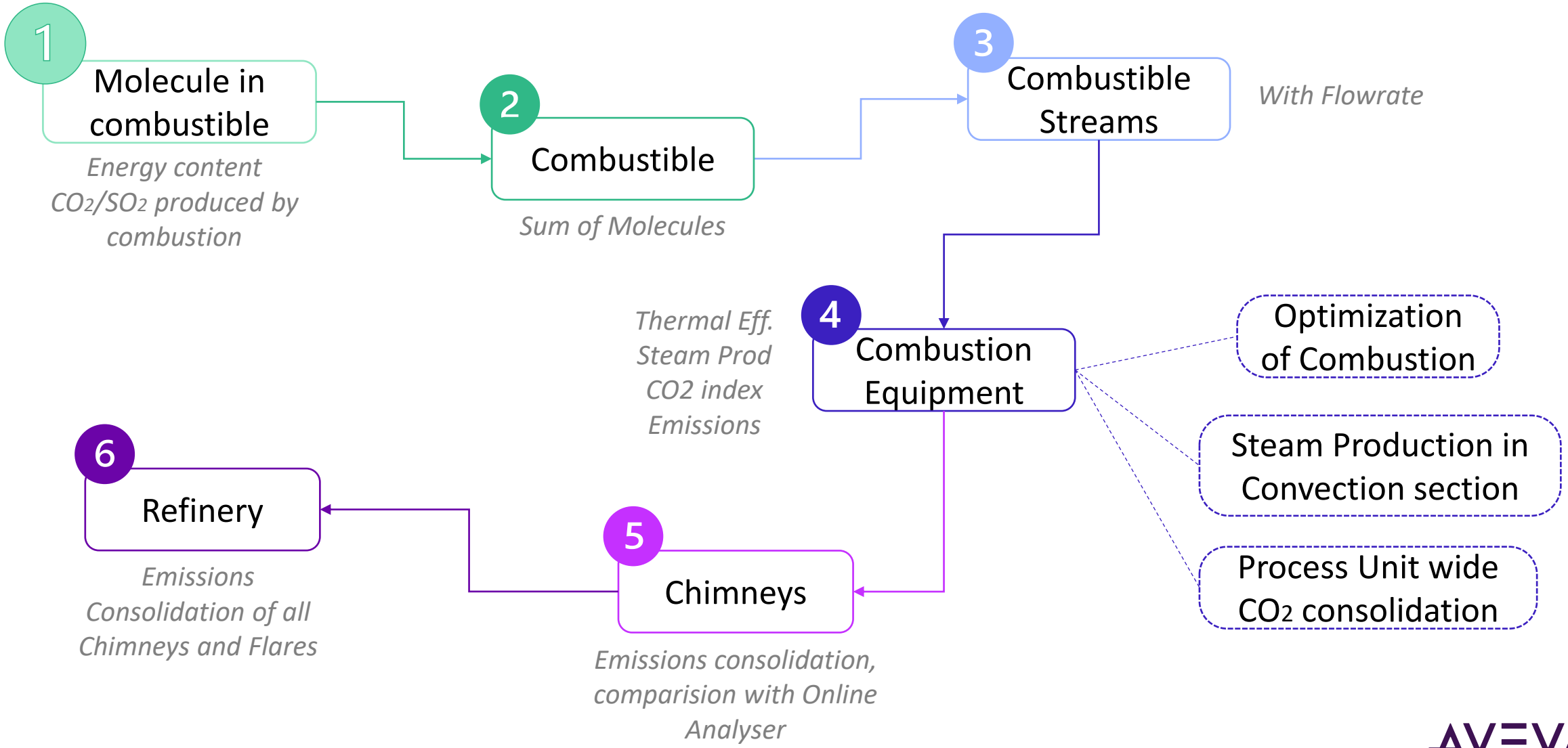
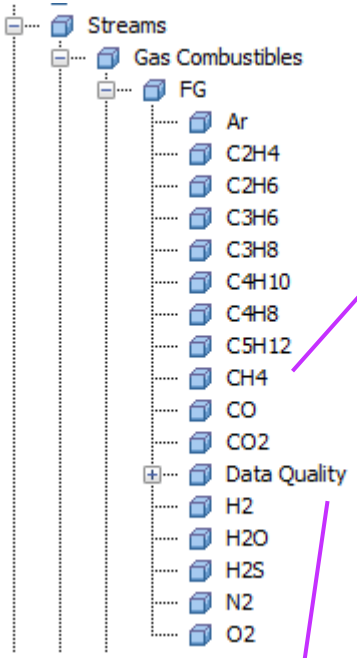
Molecules in Combustible : primary source of info



Molecule as starting point



Data Quality on composition + Normalization to 100%

Intrinsic Properties of the Molecule : « Master » template

CH4

General | Child Elements | Attributes | Ports | Analyses | Notification Rules | Version

Filter

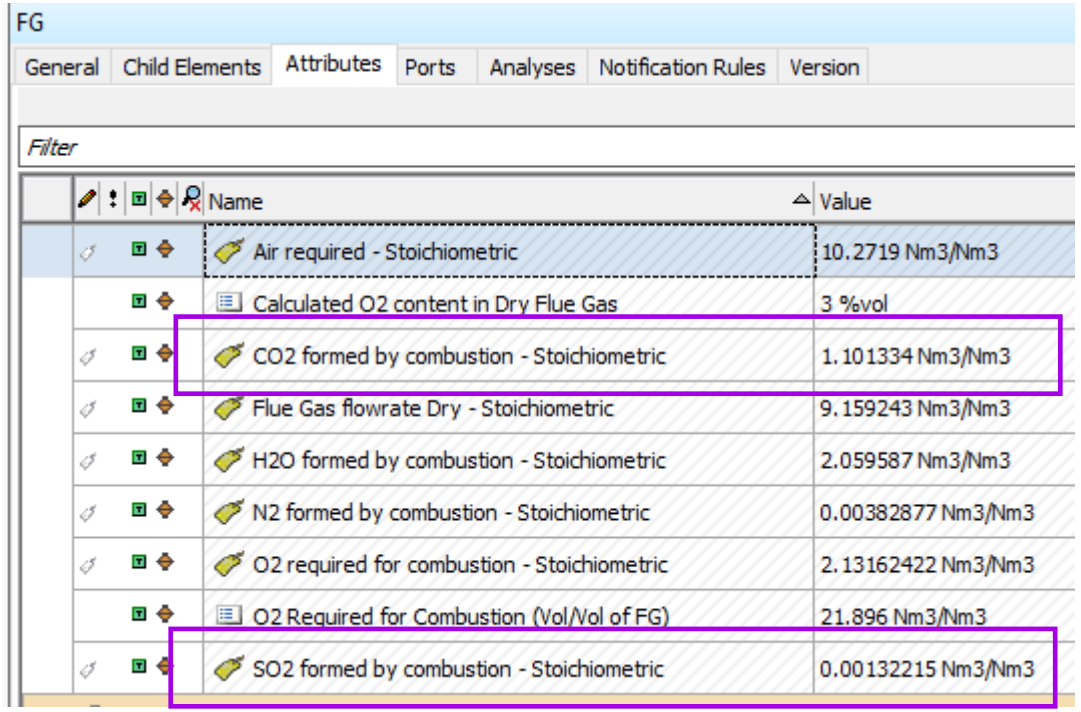
Name	Value
Category: Combustion	
CO2 formed (Vol/Vol of FG)	0.27838 Nm3/Nm3
H2O formed (Vol/Vol of FG)	0.55677 Nm3/Nm3
N2 formed (Vol/Vol of FG)	0 Nm3/Nm3
O2 Requirement (Vol/Vol of FG)	0.55677 Nm3/Nm3
SO2 formed (Vol/Vol of FG)	0 Nm3/Nm3
Category: Data (Calculated)	
Molar Weight Fraction	4.4658 kg/kmol
Normalized % Volume	27.83846 %vol
Category: Data (Constant)	
Specific Heat Constant	
Molar Mass Constant	16.042 g/mol
Category: Efficiency	
CP - Average Temperature	9.6932 J/(mol °C)
CP - Reference Temperature	-20940 J/mol
Fuel Enthalpy (Ref Temperature)	8038.4 J/mol
HHV	0.556769192 kJ/Nm3
LHV	9970.90137 kJ/Nm3

« Intrinsic » means : properties per Nm3 of gas

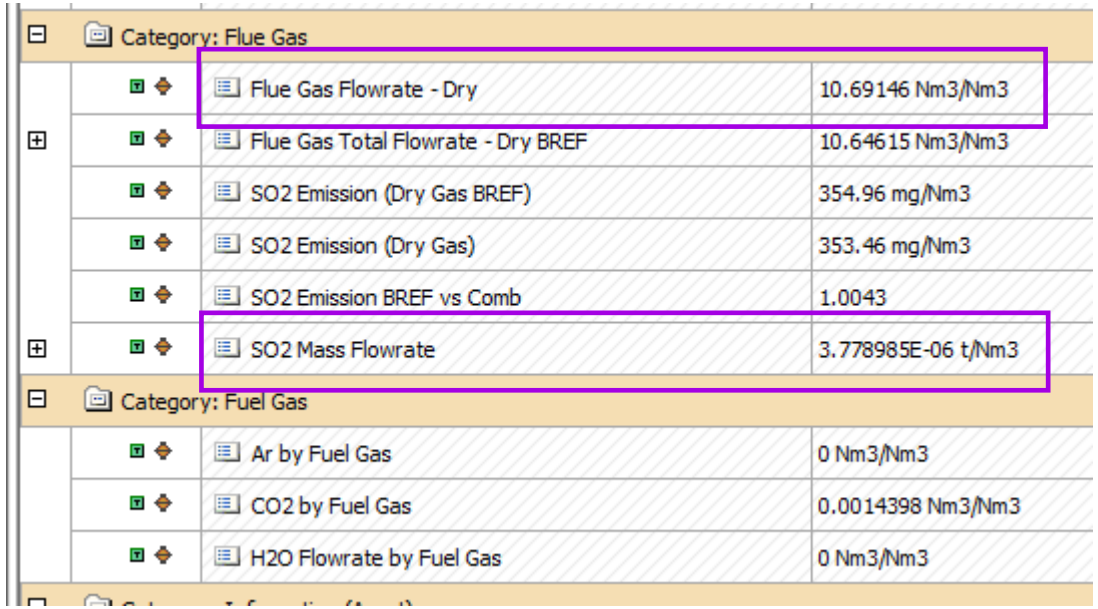
Emissions

Thermodynamics

Combustibles : roll-up of Molecules



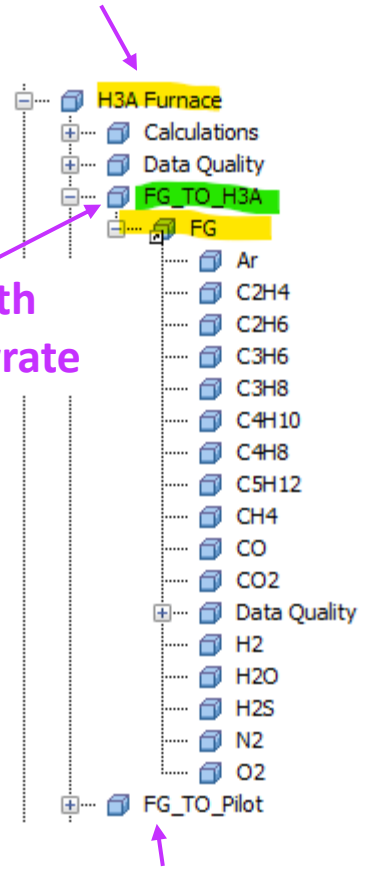
Intrinsic Properties of the Combustible



Not yet a stream feeding a particular Combustion Equipment.
The same Combustible (same quality) can feed several Combustion Equipment

Combustible(s) under Equipment

Heater / Boiler



With Flowrate

Second combustible (may be different)

Thermal Efficiency and Emissions at Heater level

H3A Furnace

General | Child Elements

Filter

Name	Value
Category: Efficiency	
Air Sensible Heat Duty - Air Temperature	33.393 kW
Duty Absorbed in Convection	2.2057 MW
Duty Absorbed in Radiation	6.2545 MW
Efficiency - Advanced Correlation	83.64 %
Flue Gas Sensible Heat Duty - BWT	3716.8064 kW
Flue Gas Sensible Heat Duty - Stack Temperature	1409.885 kW
Fuel Combustion Duty	10.085 MW
Fuel efficiency at BWT	62.02 %
Fuel efficiency at Stack	83.9 %
Fuel Sensible Heat Duty	4.862 kW
Furnace Losses	2.5 %
Thermal efficiency at BWT	61.78 %
Thermal efficiency at Stack	83.57 %
Total Thermal Input	10123 kW

Category: Emissions - CO2 Consolidation	
CO2 Mass Flowrate	1.997 t/h
Category: Flue Gas	
Acid Dew Point	131.31 °C
CO2 Mass Flowrate	1.997 t/h
Flue Gas Composition - Wet	
Flue Gas Flowrate (3% O2) - Dry	9840.4561 Nm3/h
Flue Gas Flowrate (3% O2) - Dry BREF	9798.7481 Nm3/h
Flue Gas Flowrate Actual - Dry	13615.97 Nm3/h
Flue Gas Flowrate Actual - Wet	15638.79 Nm3/h
Flue Gas Flowrate Stoichiometric - Wet	10407.72 Nm3/h
SO2 Emission	353.46 mg/Nm3
SO2 Emission BREF	354.96 mg/Nm3
SO2 Emission BREF vs Calc	1.0043
SO2 Mass Flowrate	0.0034782 t/h

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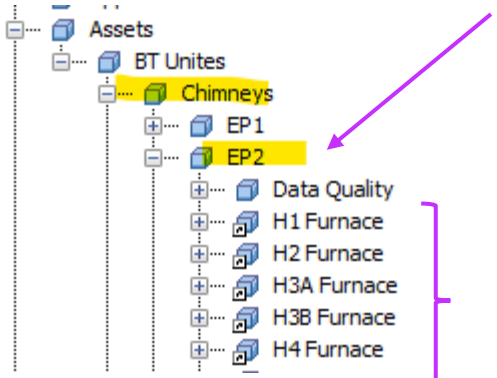
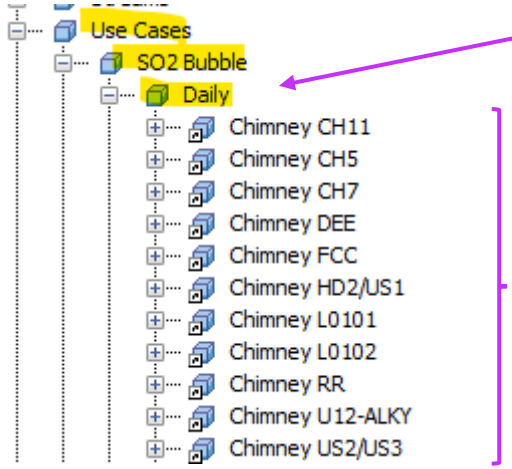
Consolidation at Chimney level & and Refinery Level

Building on top of lower level Elements



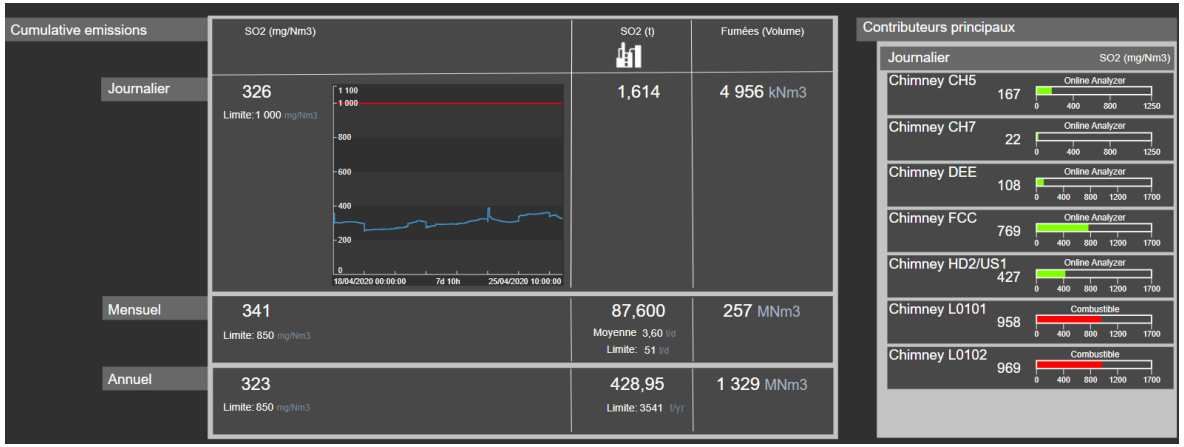
Chimney : grouping several Heaters

Roll-up of Heaters in Chimney



Refinery Use Case

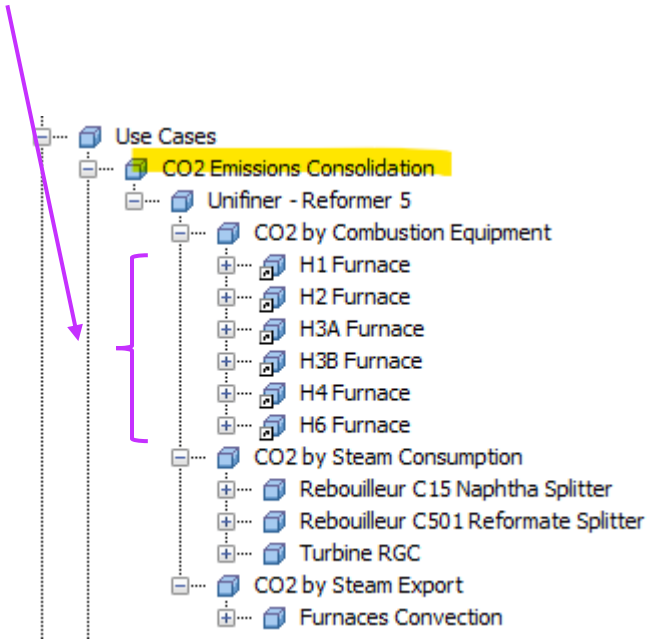
Roll-up of Chimneys and others at Refinery level



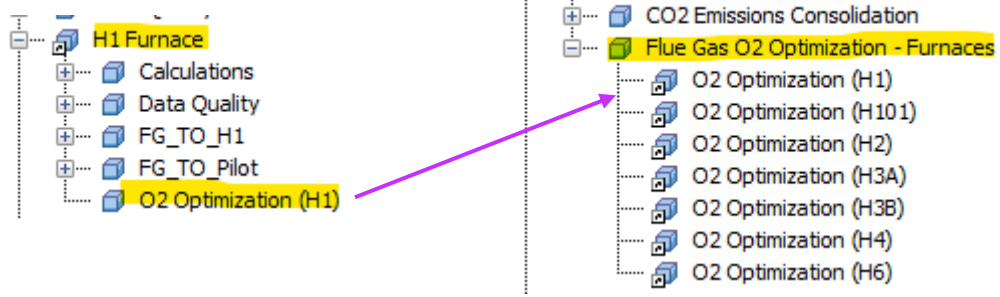
Re-Using the information for other purposes

CO_2 consolidation and Furnace Optimization

Roll-up of Furnaces for CO2 consolidation at Process Unit level



Flue Gas O2 optimization at Furnace level & Consolidation at Refinery level



Economie potentielle

Combustible	CO2	Total
92,0 t/month	278,1 t/month	
78 k€/month	22 k€/month	100 k€/month

Prix CO2

80 €/t

Economie potentielle - Équipement

Equipement	Unité	Statut	Temp Fumées	Tirage	O2 Mesuré	O2 Cible	Prix Combustible	Economie potentielle Combustible		Economie potentielle CO2		Economie potentielle Total
O2 Optimization (H1)		Running	350,9 °C	-8,5 mmH2O	3,7 %	3,0 %	850 €/t	2,7 t/month	2,3 k€/month	8,5 t/month	0,7 k€/month	3,0 k€/month
O2 Optimization (H101)		Running	155,4 °C	-4,6 mmH2O	5,6 %	3,0 %	850 €/t	4,0 t/month	3,4 k€/month	11,6 t/month	0,9 k€/month	4,4 k€/month
O2 Optimization (H2)		Running	303,0 °C	-3,8 mmH2O	6,3 %	3,0 %	850 €/t	15,4 t/month	13,1 k€/month	46,0 t/month	3,7 k€/month	16,8 k€/month
O2 Optimization (H3A)		Running	264,9 °C	-8,3 mmH2O	5,7 %	3,0 %	850 €/t	14,8 t/month	12,6 k€/month	43,2 t/month	3,5 k€/month	16,0 k€/month
O2 Optimization (H3B)		Running	264,9 °C	-8,3 mmH2O	6,3 %	3,0 %	850 €/t	16,4 t/month	13,9 k€/month	48,0 t/month	3,8 k€/month	17,8 k€/month
O2 Optimization (H4)		Running	272,3 °C	-3,6 mmH2O	5,4 %	3,0 %	850 €/t	22,0 t/month	18,7 k€/month	70,3 t/month	5,6 k€/month	24,3 k€/month
O2 Optimization (H6)		Running	240,2 °C	-8,0 mmH2O	6,5 %	3,0 %	850 €/t	16,6 t/month	14,1 k€/month	50,5 t/month	4,0 k€/month	18,2 k€/month

Key Takeaways and Observations

- **Few templates required** for efficient Emissions/Energy monitoring
- **Emissions** and **Energy** monitoring are based on **same information**
- Templates are **generic and fully scalable** : easy and fast replication on several refineries
  - Already deployed at 4 refineries (more than 45 combustion equipment)
- Results are stored in PI Tags : **consistent information available to Teams in the Refinery** and to Central Support Teams
- **Optimization Use Cases** can be built on top of Monitoring Use Cases
- **Data Quality** elements can be used to « secure » online calculations
- Future / Next Steps:
  - **Extend** to the detailed **CO_2 allocation in Steam Networks**
  - More and more Energy use cases

AVEVA

OIL & GAS

Efficient Energy & Emissions Monitoring

Structuration, Templatization, Replication at scale using AVEVA PI AF

Challenge

- Different Teams involved in Energy and Emissions monitoring, using same source information.
- Duplicate work, not always shared, that may lead to inconsistencies.
- Complex calculations difficult to maintain or simply not possible in Excel

Solution

- PI AF Structure of the Refineries.
- Deep structuration, considering Combustibles and Molecules as “Assets”
- From small building blocks, up to Refinery level for consolidation

Benefits

Compliance for emissions monitoring

Reuse of Assets to build parallel/connected Use Cases

Breaking silos

O_2 optimization on Heaters could save hundred of k€ per years (combustible and CO2 cost)

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