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Energy, Utilities and CO2 Emission Management with AVEVA RTO at REPSOL

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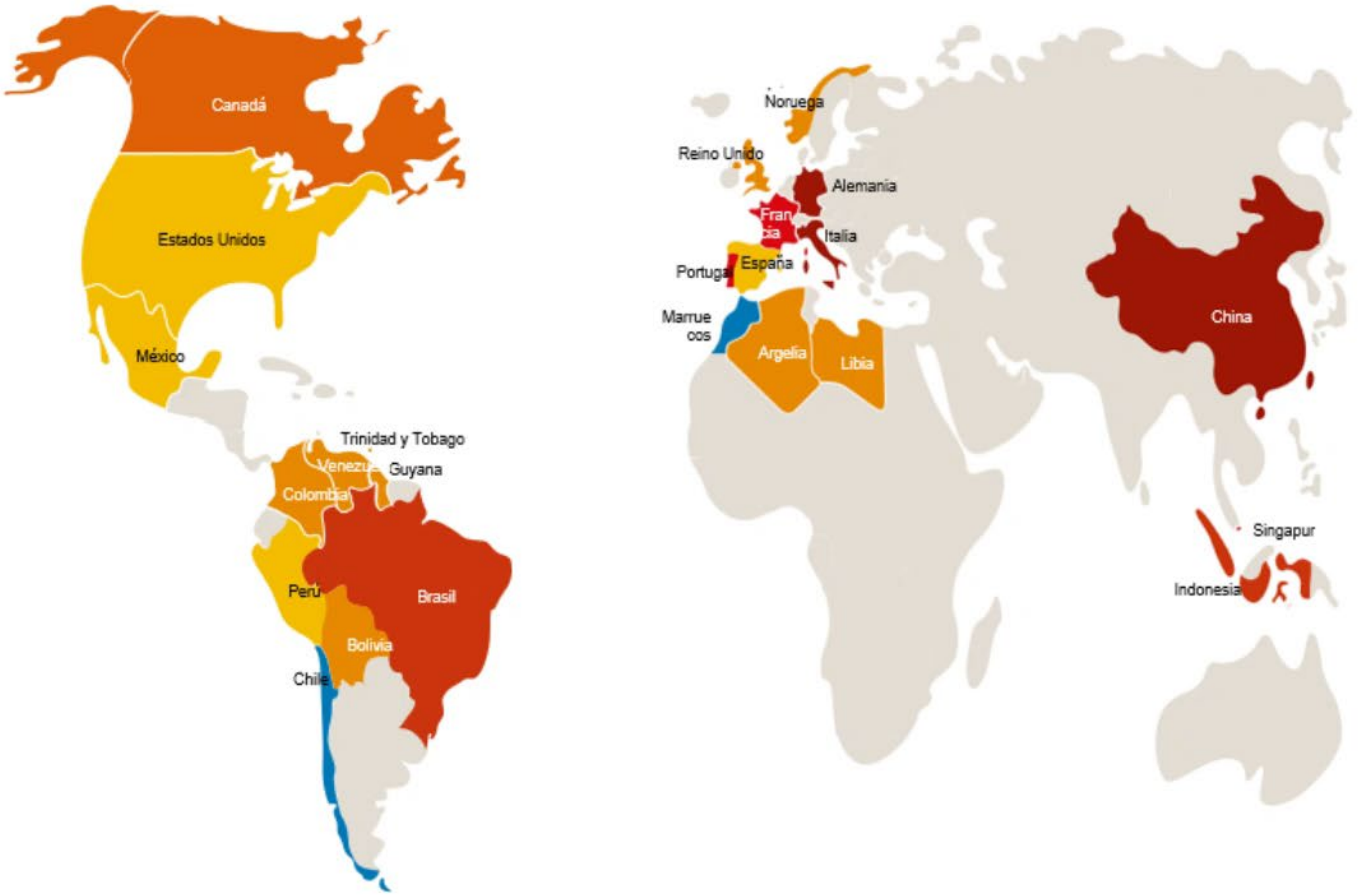
Agenda

- Introduction
- Problem Description
- Project Objectives
- Scope
- Functionality
- Solution
- Project Schedule
- Benefits
- Conclusions

Introduction

Repsol 2022



- Upstream
- Industrial
- Commercial y Renewables
- Upstream + Industrial
- Upstream + Commercial y Renewables
- Industrial + Commercial y Renewables
- All

Los datos incluidos en este mapa reflejan la presencia de Repsol en el mundo a 31 de enero de 2022

**LAAE: Lubricantes, aviación, asfaltos y especialidades*

Introduction

Repsol in the World

- Upstream
- Industrial
- Comercial y Renovables
- Upstream + Industrial
- Upstream + Comercial y Renovables
- Industrial + Comercial y Renovables
- Todos

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Introduction

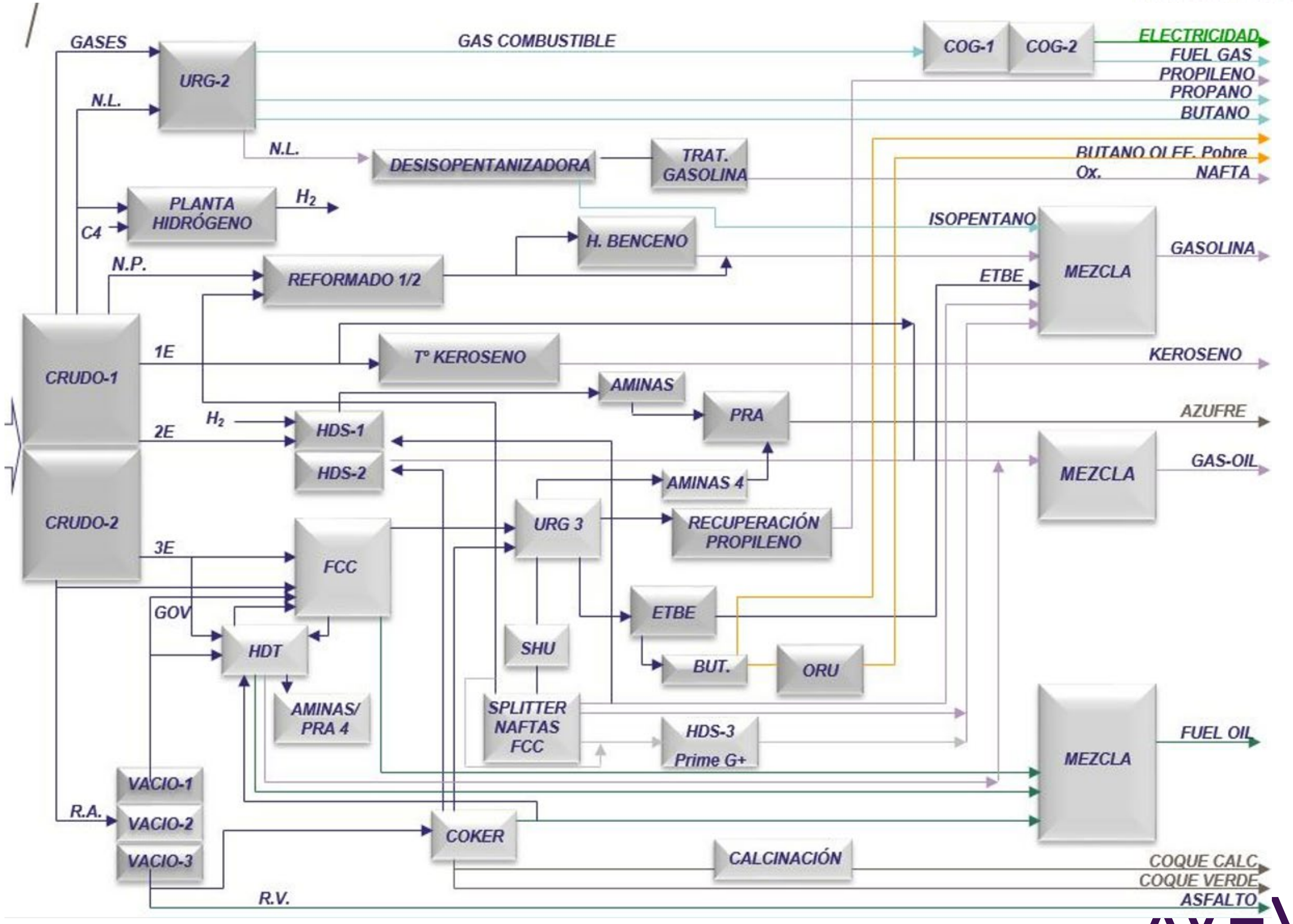
APO Installed base at Repsol

1. Cartagena (Spain) Refinery Hydrocracker Closed-Loop RTO (includes automatic LP Vector generation)
2. Tarragona (Spain) Refinery Hydrocracker Closed-Loop RTO (includes automatic LP Vector generation)
3. Tarragona (Spain) Refinery Multi-Unit CDU + VDU Closed-Loop RTO
4. Puertollano (Spain) Refinery Multi-Unit MHC + FCCU Closed-Loop RTO
5. **Coruña (Spain) overall Refinery Utilities Open-Loop RTO**
6. Coruña (Spain) Refinery Multi-Unit HDT + FCCU Closed Loop RTO
7. Petronor (Spain) Refinery Multi-Unit HDT + FCCU Closed Loop RTO
8. Pampilla (Peru) Refinery Multi-Unit CDU + VDU Closed-Loop RTO
9. Puertollano (Spain) Refinery Multi-Unit CDU-VDU Closed-Loop RTO
10. **Puertollano (Spain) overall Refinery Utilities Open-Loop RTO (in progress, commissioning Dec 2022)**

Introduction

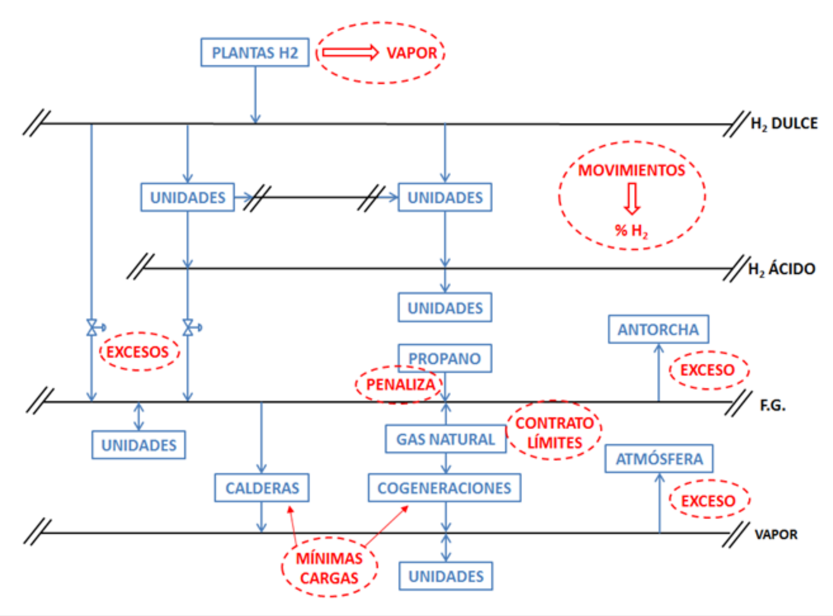
Coruña Refinery

- Location: The refinery is situated in the Bens Valley, about 3 km from the city and 5.5 from A Coruña port.
- Capacity: 5.5 million tons/annum & 120,000 bbl/day
- Refining Units
  - CDU - 120,000 bbl/day
  - VDU
  - Coker - 19,000 bbl/day
  - FCC
  - Hydrogen Plant
- Feedstocks:
  - Occasion Crudes
  - Vegetable Oils (into HDS and HDT)



Problem Description

Current Energy Management at Repsol Coruña



- Most of the changes in any utility (steam, FG, H2, electricity) impact in all the others.
- It is necessary to adjust the utilities continously in any process side changes.
- Planning and programming does not consider the utilities.

H2

We normally produce more H2 than we really need
- We adjust minimum required purity
- Surplus transfer to FG
- Any increase/decrease impacts steam

Fuel gas

Punctual excesses
- FG sent to flare (on time)
- Actions are applied that usually lead to excess steam and unit de-optimizations
- Feed reduction to Platformers

Vapor

Steam venting
- There are deoptimizations to avoid venting
- If we minimize steam → we have more FG that is not consumed in boilers
- We hit minimum load in boilers or cogeneration

Project Objectives

- Monitoring and reduction of refinery's total energy and utilities costs
- Monitoring and optimization of CO_2 emissions
- Balancing various the processes, utilities and energies costs:
  - H_2
  - Natural Gas, Fuelgas, Fueloil
  - Steam
  - Electricity
  - Optimize relevant part of processes
- Generation of recommendations to the Utilities Shift Manager to reduce refinery's total energy and utilities costs at different levels of implementation
- Implementation of the "What if" tool to be used directly by the Utilities Shift Manager.

Repsol Compromiso Cero Emisiones Netas 2050

Scope

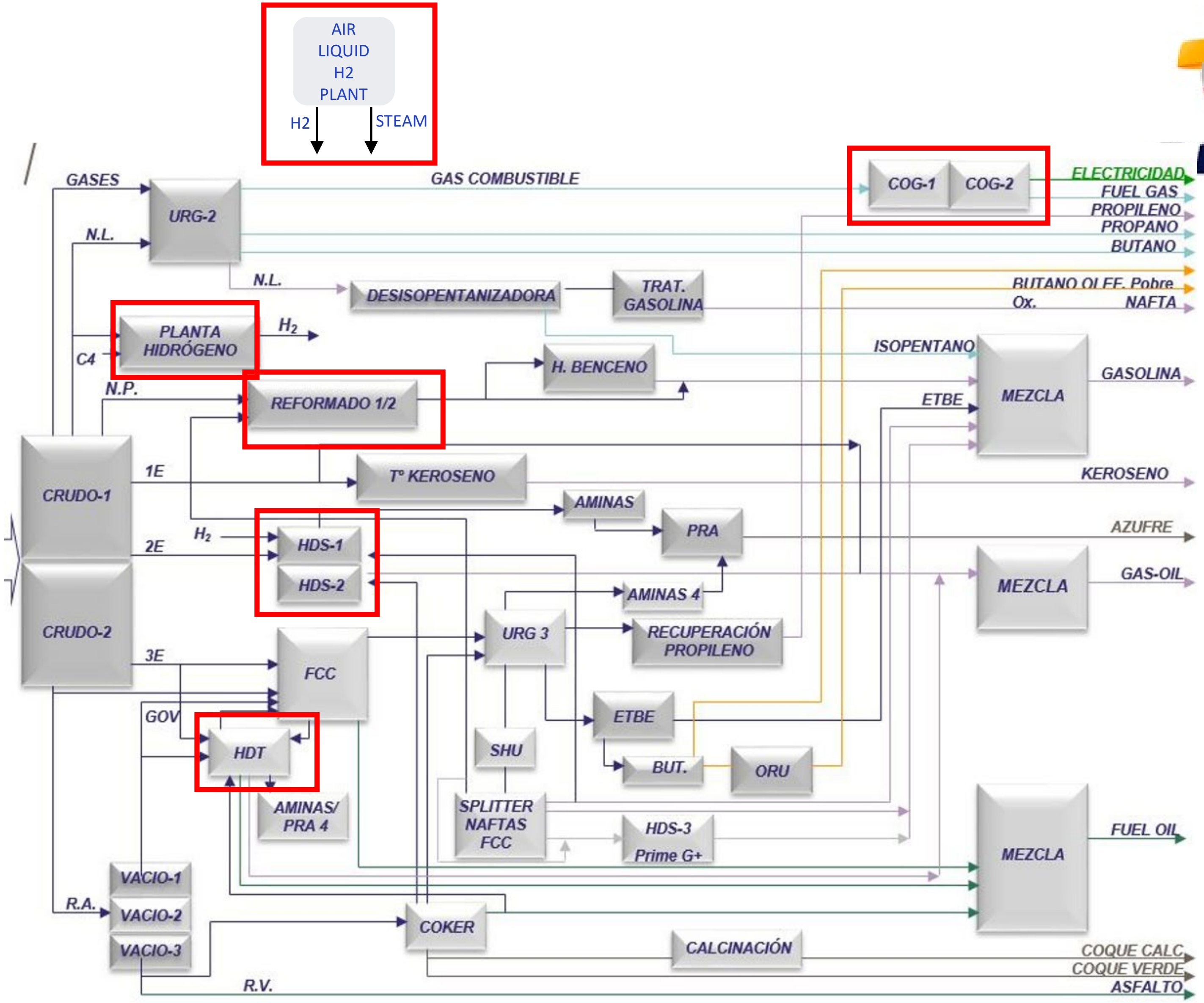
Process Units 1

- Steam and Power
  - 5 Steam Headers
  - 2 Cogen units – 1 with post combustion firing
  - 3 conventional boilers
  - Switchable electric motors / steam turbines between 4 levels
  - Steam Turbo generator
- Fuel Gas system
  - Refinery gases + NG import (pressure control) + Propane vaporizer
- H2 System
  - Import H2 & in house H2 steam reformer
  - 3 H2 headers
  - 2 Platformers
  - 3 major H2 consumers (2 HDS's and 1 HDT)
- Headers interactions:
  - Balanced FG with NG and LPG vaporization.
  - H2 bleeding to FG header
- Correlation models for HDT and Platforming
- Semi-rigorous models for HDS reactors for accurate calculation of H2 consumption and FG generation from different feedstocks.
- Simplified models of other refinery units for Fuel Gas/steam balance
  - Crude/ Vacuum Distillation units
  - FCC
  - Coker

Scope

Process side modelling

- Air Liquid H2 Plant: correlation H2 generated with steam provided to HPS.
- H2 Plant: : correlation H2 generated with steam provided to HPS and NG / FG consumed.
- HDT: correlation H2 consumed vs feed flowrate
- HDS1 & HDS2: H2 consumed vs feed composition & flowrate by means of simi-rigorous reactor model
- Platformer 2: correlation H2 & C1-C6 generation vs feed rate and output RON.



Scope

Features

- Steam /Electricity/Fuel (**complex contracts**)
  - Hourly electricity price, includes site electric balance and export limits
  - Natural gas price including contract penalties/ limits
- CO_2 costs included – has important impact on optimization
- Propane & Butane cost included
- Boiler Feed Water (BFW) cost included
- H_2 System
  - **Complex contract**: Import H_2 price from Air Liquide (associated with steam), includes 2 tiers (pricing regimes)
  - H_2 generation within refinery steam reforming plant included in model

- Constraints:
  - Operational constraints
  - Planning & logistic constraints

- Optimization Economic Objective function:
  - **Total utilities and energy cost = Fuels + Utilities + Electricity + CO_2 emission**
    - Fuels: Fuel Oil / Natural Gas / LPG (Propane/Butane)
    - Utilities: H_2/Steam/Water (BFW)
    - Electricity (Cogen, Turboalternator)

Functionality

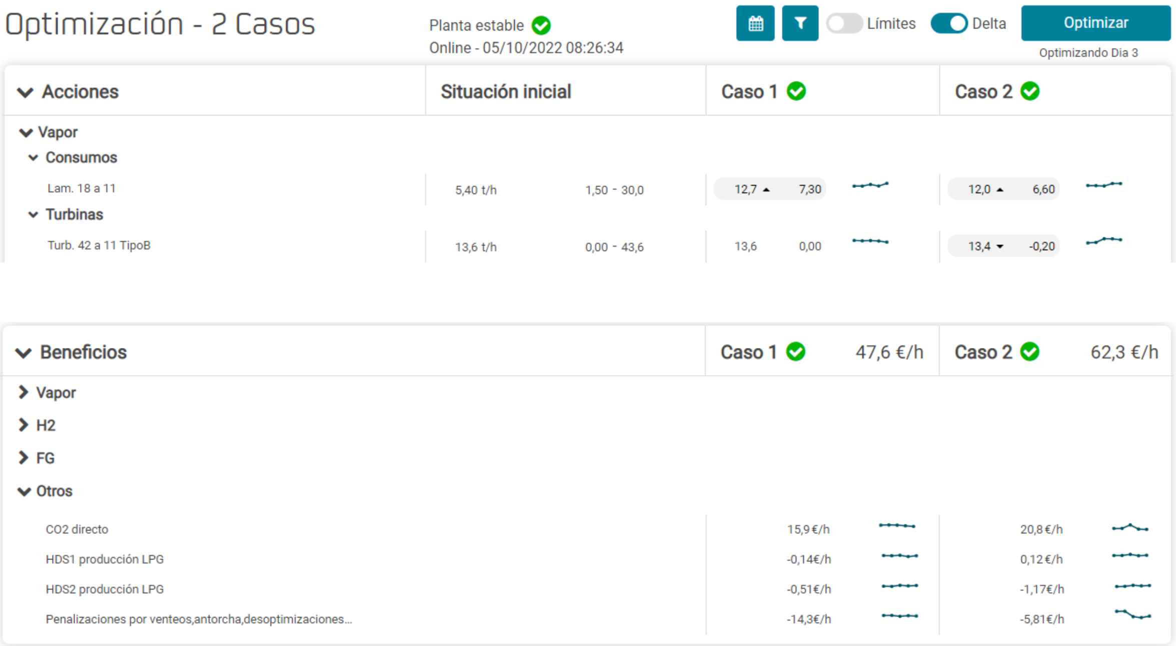
Automatic Solution cases at each run (every hour)

Model includes 2 automatic optimize cases for current operation:

- **Case 1**: Easy to change equipment (mainly valves Ops, PID SetPoints,…)

- **Case 2**: More difficult to change that require several actions from operator, less frequent changes (mainly switchable motor/turbines, H2 from Air Liquide)

It shows clear actions for the Utilities Shift Manager with the economic impact of each.



Functionality

Automatic Solution cases at each run (every hour)

- ***Two more cases are under development***:

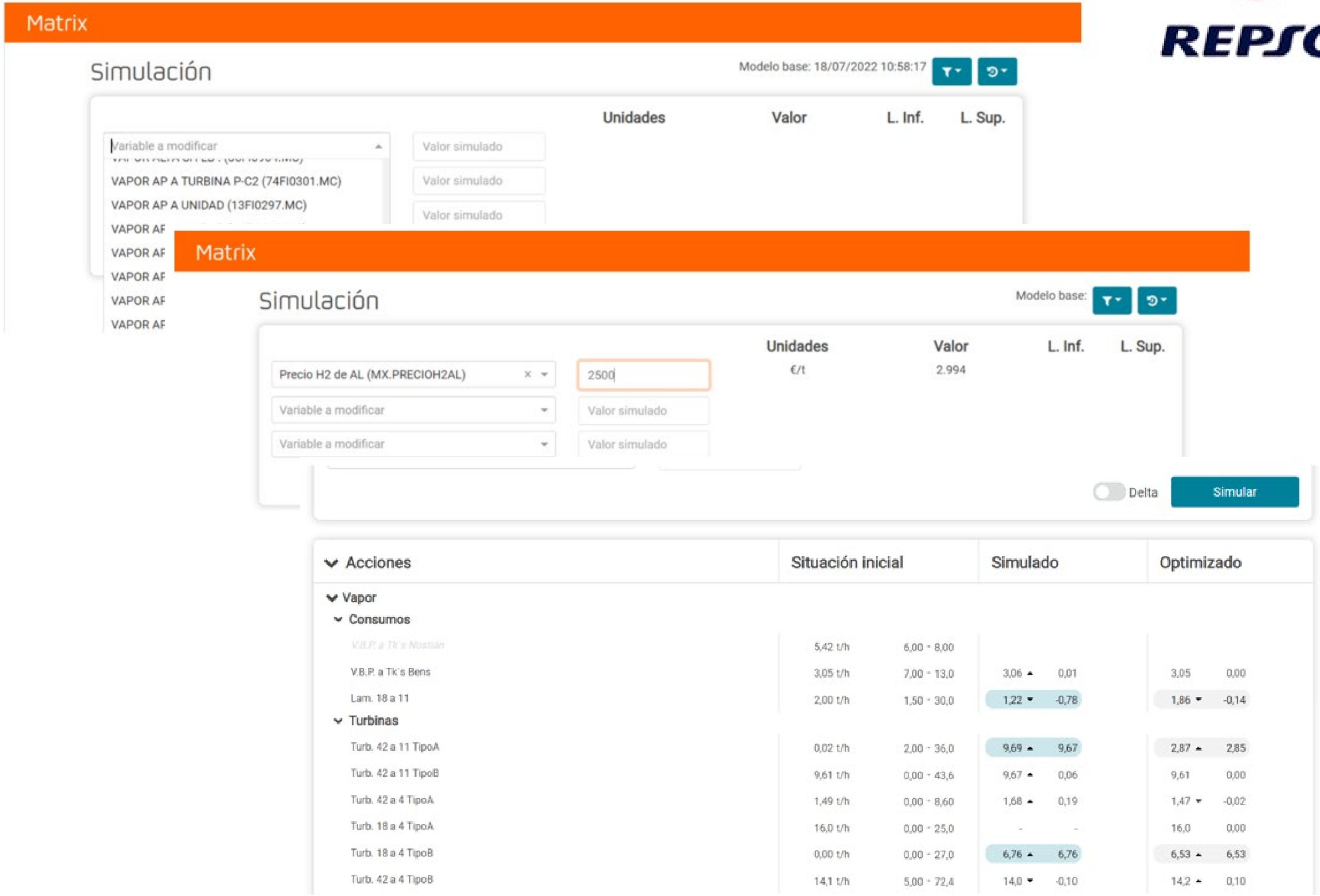
- **Operational Case 3**: It optimizes the feed rates to HDS and Platformates taking into consideration the planned following 4 days (logistic constraints)

- **Planning Case**: it optimizes the programming plan for the 4 following days taking into consideration inouts from scheduler (planned crudes, vegetable oil processing,…).
    - Purpose: future operation could be infeasible / uneconomic. Allows current operation to adjustments to help and provides a view to the future utilities operation

Functionality

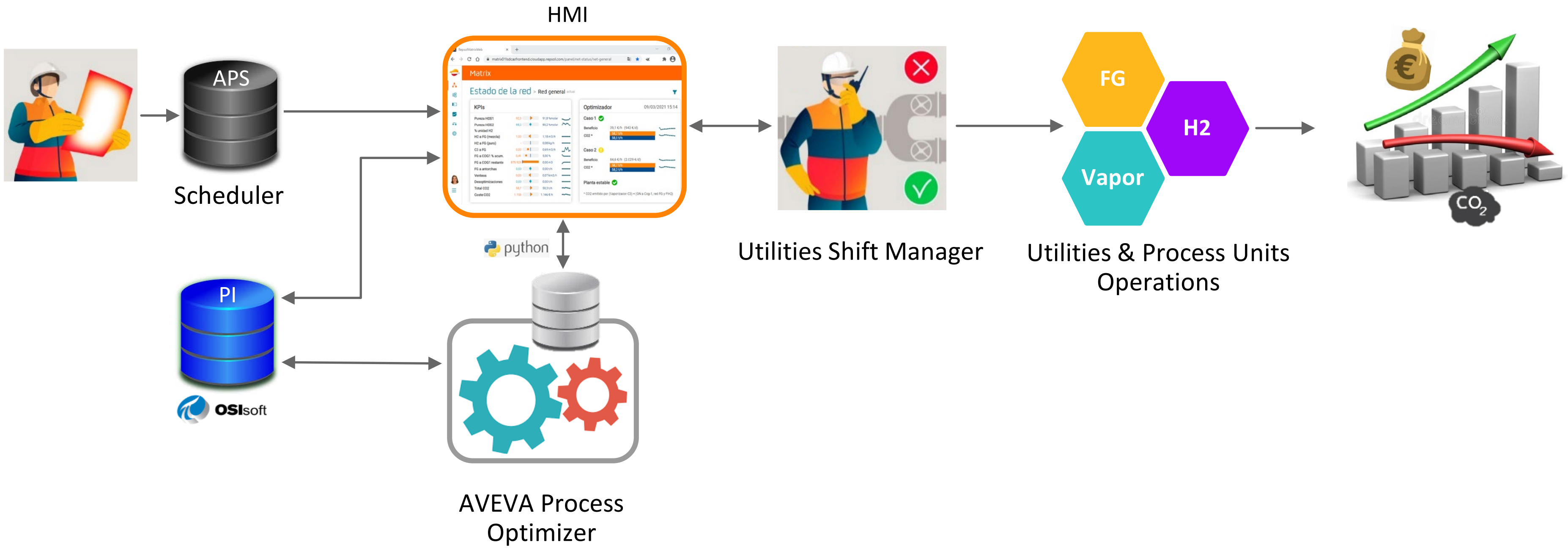
"What if cases" offline tool

- It allows the Utilities Shift Manager to run simulation "What-if" cases for planning on a Web terminal.
- System allows browsing through different datasets chronologically and select one to perform the simulation case.
- HMI allows the user to modify the model inputs for simulation.
- Examples: what if HDS units or benzene or butadiene units will be up/down in the coming days?.



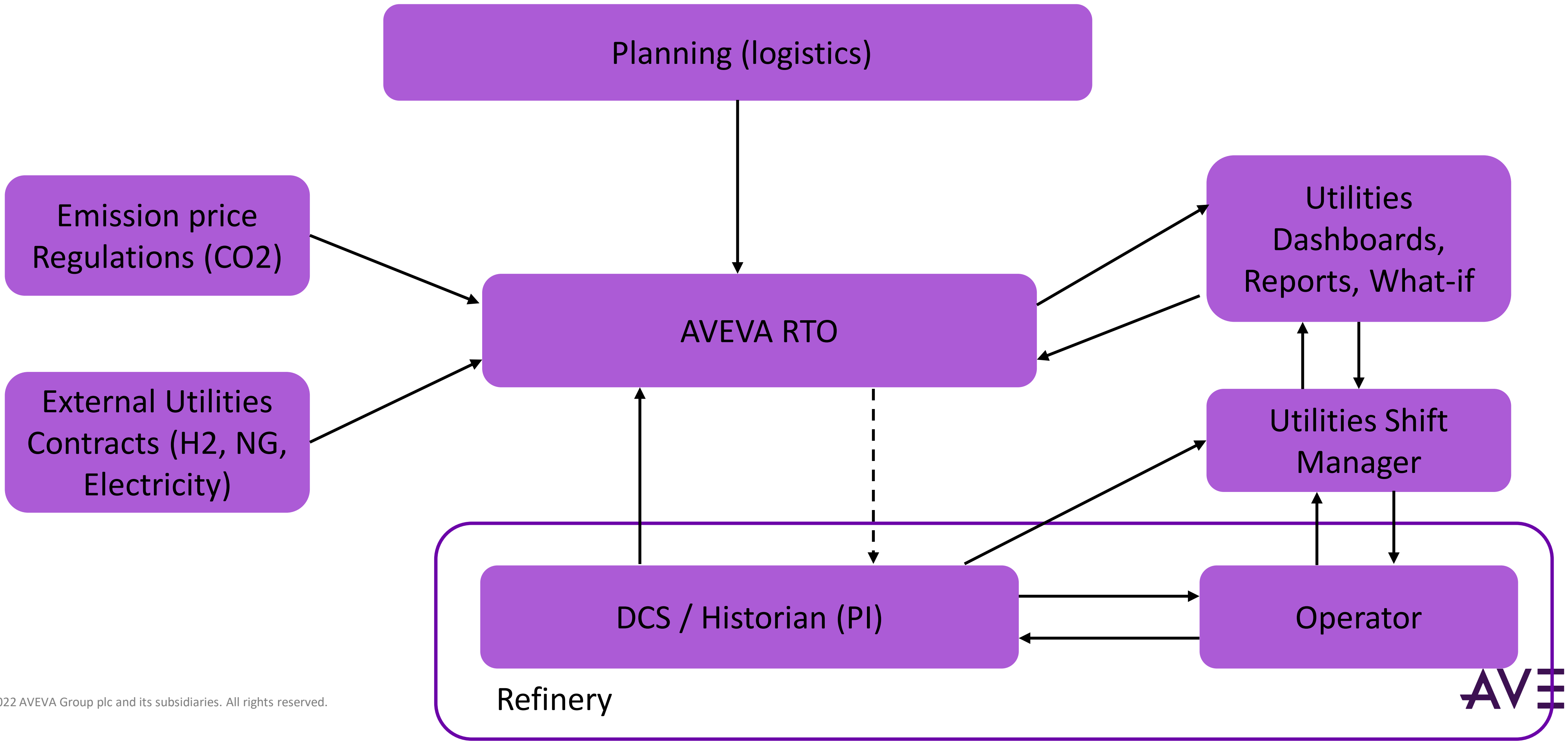
Repsol/AVEVA Solution

Open Loop Real Time Optimization



AVEVA Solution

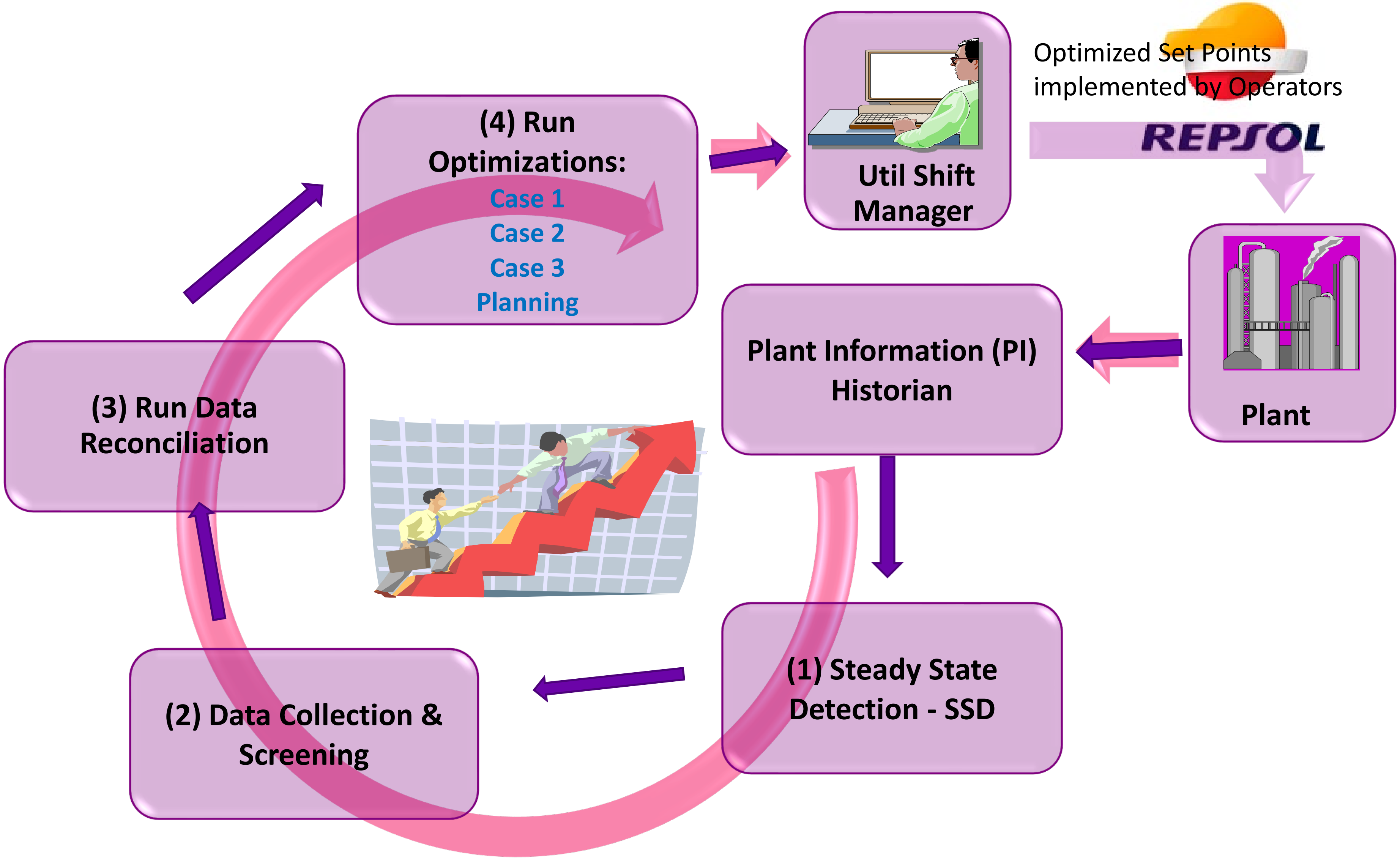
Information Flow



AVEVA Solution

Real Time System

- Open Loop – solution implemented by Utility Shift Manager.
- One solution per hour if steady state
- *Open or Closed Loop application based upon refinery policy.*
- This refinery choose open loop because:
  - Wide scope (H2/ steam/FG) therefore several consoles involved
  - Mixed slow and fast dynamics



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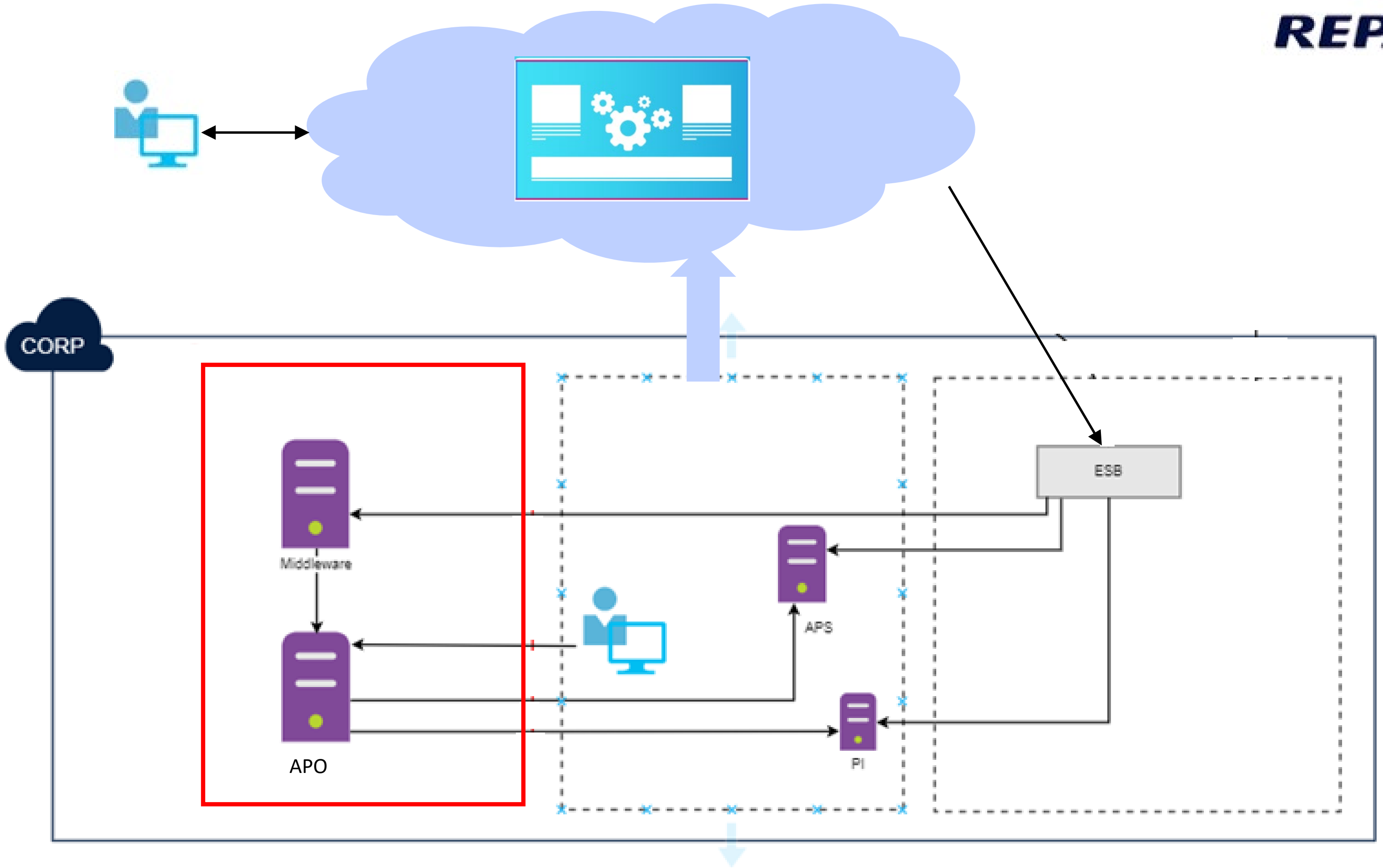
AVEVA Solution

Architecture

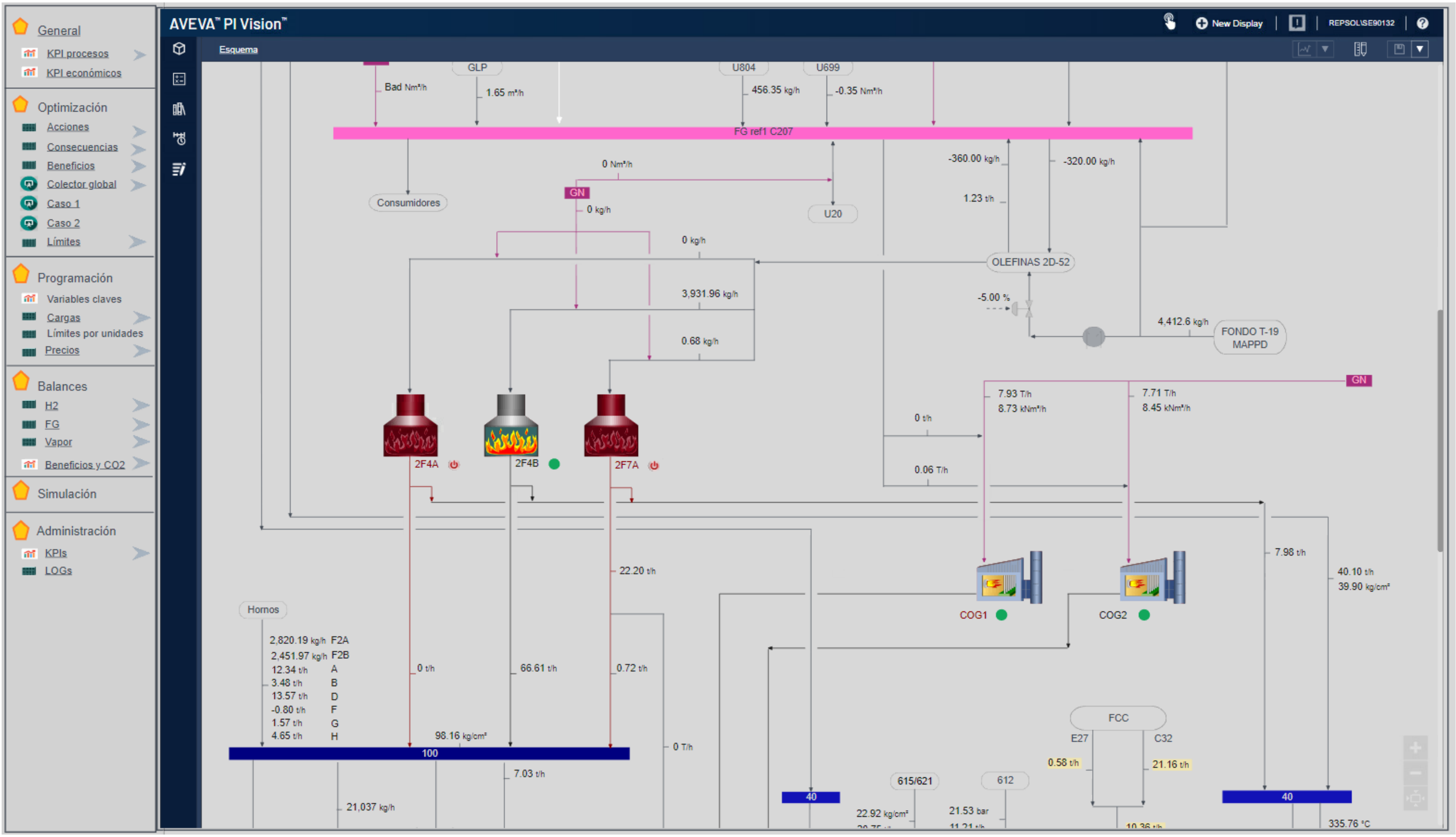
- APO running on premises in virtual environment.
- Visualization via Cloud in a Web terminal.
- Web terminal shows online results dashboards
- Web terminal includes HMI to use the offline "What if" cases tool.



AVEVA Solution

PI Vision Visualization - Puertollano Refinery Deployment – FG & Steam interaction

- Comprehensive visualization of data from process (PI), planning, scheduler and optimizer from a Web terminal developed in **PI Vision**.
- User access authentication required
- Different levels of user access.



Project Execution Strategy

Requirements Gathering and Design → Execution and Deployment → Warranty & Support

Phase-1 (1 month)
- Gathering Details
- Project Scope
- Functional Design
- Benefit Estimation

Phase-2 (9 months)
- Model Build
- Deployment at site
- Model validation
- Performance evaluation
- Commissioning

Phase-3 (1 Year)
- Continuous support
  - Model Convergence
  - Troubleshooting
  - Solution Analysis
- Enhancements/Modifications

Benefits

- Benefits of ROI less than 6 months.
- In 2021, 20% of the annual CO_2 emission reduction due to all Repsol CO_2 reduction technologies applied in Coruña Refinery was due to APO application.
- Benefit mechanisms:
  1. Reduce power generation during low electric price periods
  2. Reducing Letdown flows via better use of switchable turbines and demands
  3. Best use of discretionary steam production from process units
  4. Best use of Propane/Butane vs NG as marginal fuel
  5. Optimum dumping of H_2 streams to Fuel Gas
  6. Optimum processing of high H_2 consumption feeds
- Other benefits:
  - Learning of beneficial operations never thought about before by Utilities Shift Manager.
  - Accurate prediction of changes of energy, utilities and emissions (**CO_2**) generated by the RTO
    - Evaluate of different operational strategies
    - Validation of the improvement of the refinery carbon footprint
  - Possibility to evaluate capital investment opportunities
  - Possibility to re-evaluate your utility contracts due to the agility provided by the tool.

Conclusions

- The close and continuous collaboration between Repsol Site and AVEVA team (as a single team) has guaranteed success delivering large carbon footprint reduction and large energy/utilities savings.

- Combination of AVEVA RTO and a comprehensive visualization tool (OsiSoft PI Vision) provides an efficient tool for optimal energy/utilities site operation.

- AVEVA RTO contributes greatly to achieve companies net-zero emission objectives.

Questions?

Please wait for the microphone.

State your name and company.

Please remember to...

Navigate to this session in the mobile app to complete the survey.

Thank you!

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