Energy Control & Optimization in an Oil Refinery

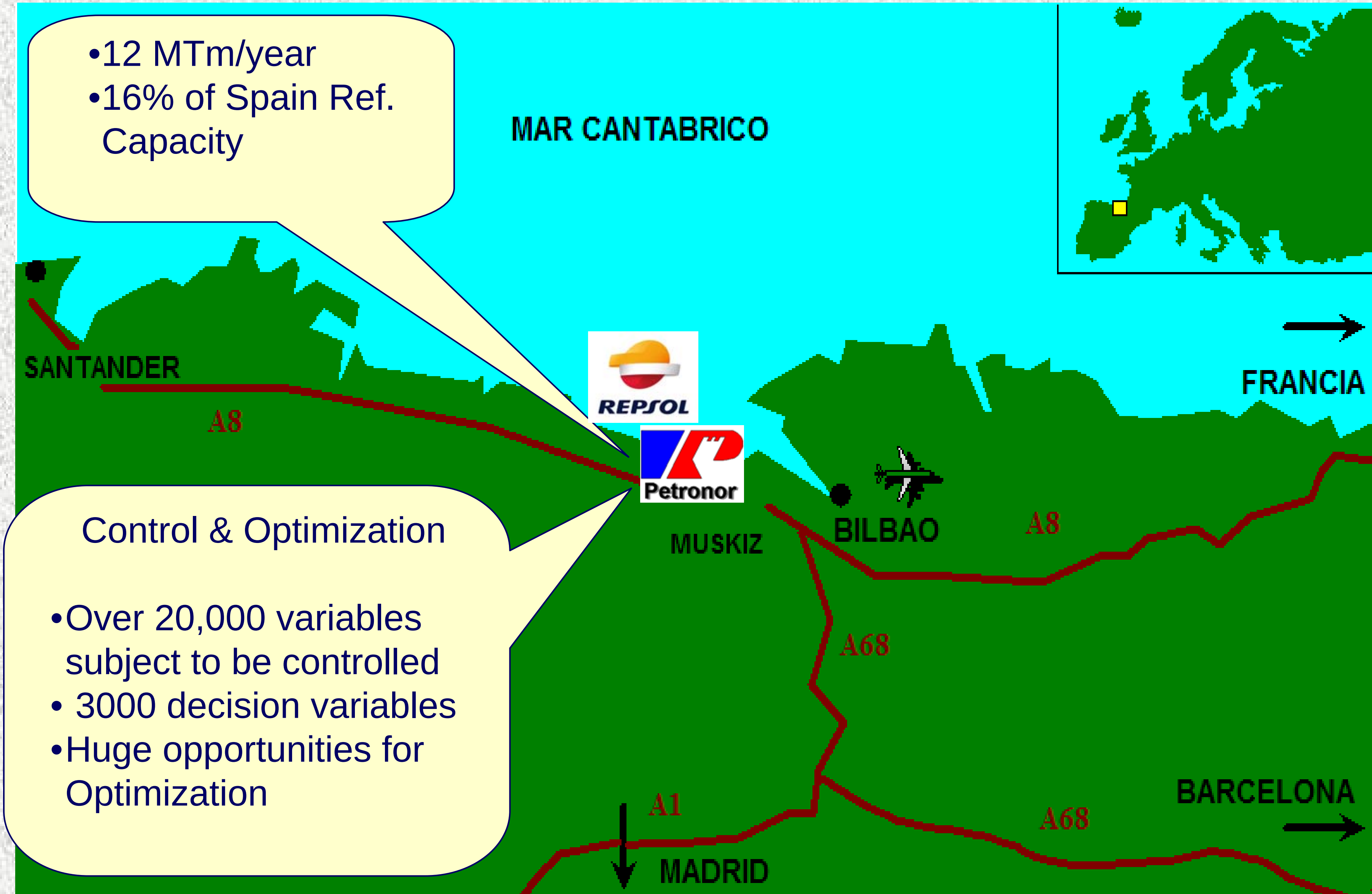
Rafael Gonzalez Martin
Control & Optimization Manager
PETRONOR
Spain

Summary

- Petronor? An oil refinery
- Where to look at? Looking for the money
- Successful stories
- New opportunities. Potential Benefits
- How to achieve it?
- Q&A

PETRONOR ? An oil refinery (1/4)

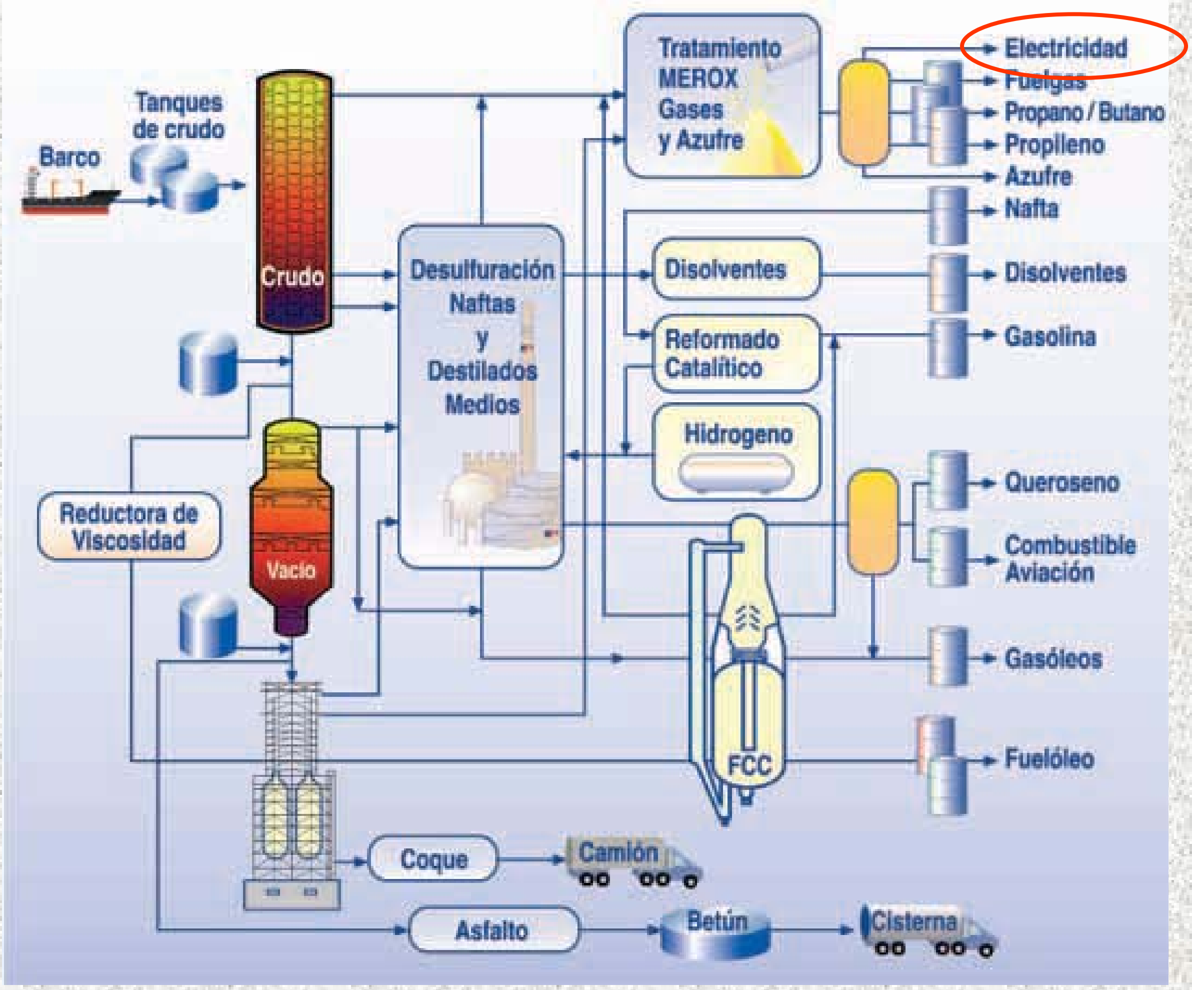
- 12 MTm/year
- 16% of Spain Ref. Capacity



Control & Optimization

- Over 20,000 variables subject to be controlled
- 3000 decision variables
- Huge opportunities for Optimization

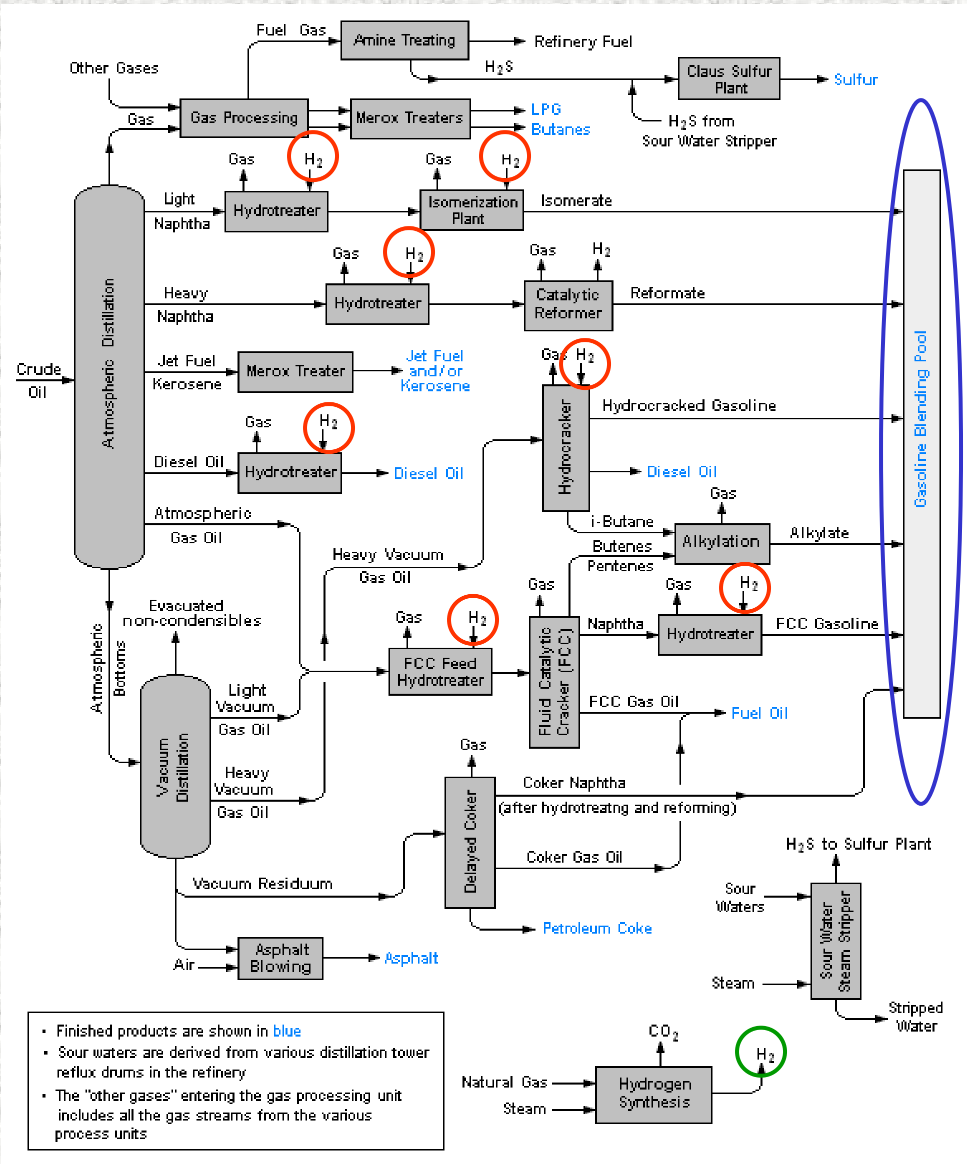
PETRONOR ? An oil refinery (2/4)



•A huge amount of energy is required (1000MWh)

• All the energy is produced in house, in fact, we export electricity (30%)

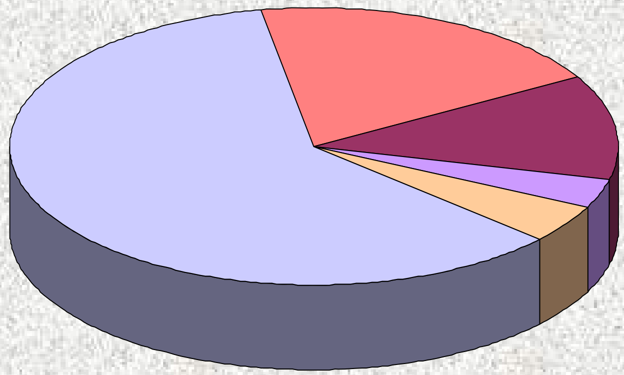
PETRONOR ? An oil refinery (3/4)

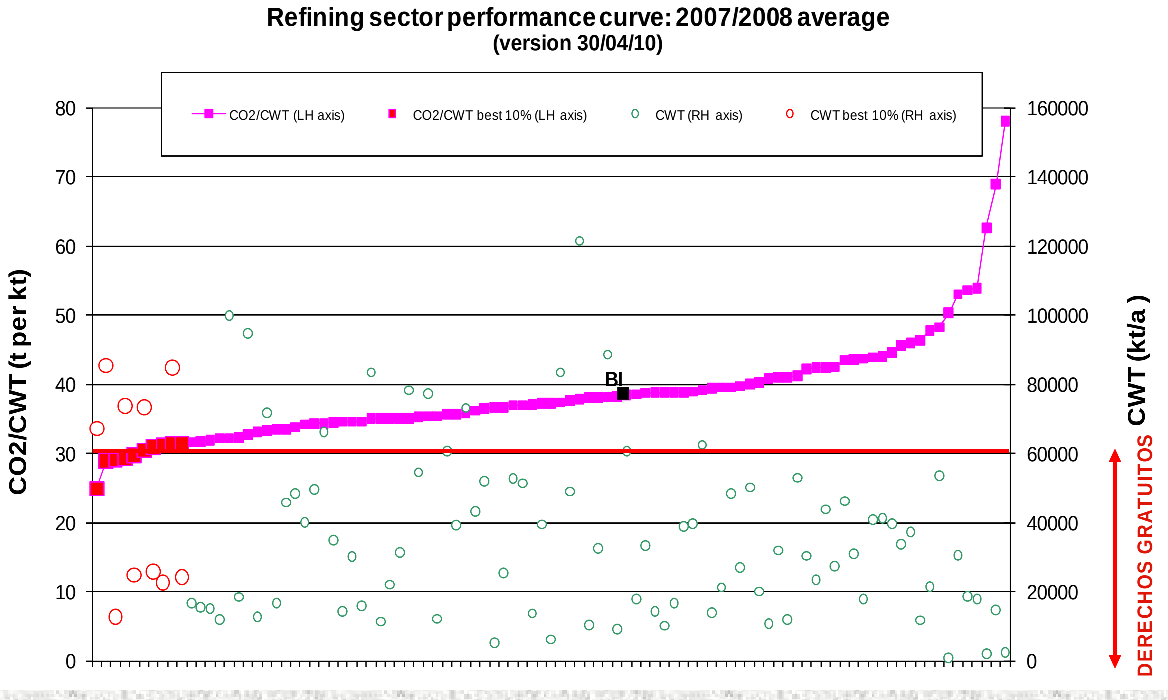


- A closer look shows that other utilities are required, H_2 is the most important one.
- H_2 is also produced in house.
- Final products are a combination (mixture) of intermediate products. Traditional recipes should be questioned to enable further optimization.
- Reaction effluents need additional treatment due to environmental regulations.
- This highly complex product and energy interconnection seems to be a perfect candidate for online optimization projects.

Competitiveness issues regarding energy: available KPIs

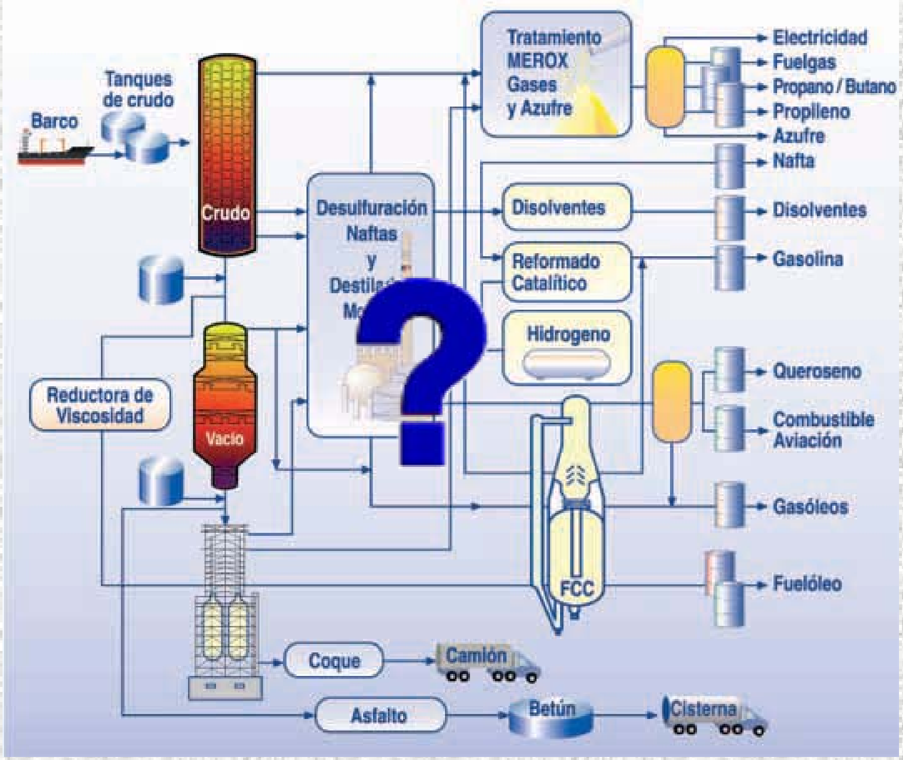
REFINERY COSTS	NWE 2010
• **Energy**	**62 %**
• Personnel	19 %
• Maintenance	12 %
• Other Fixed	3 %
• Other Variables	4 %





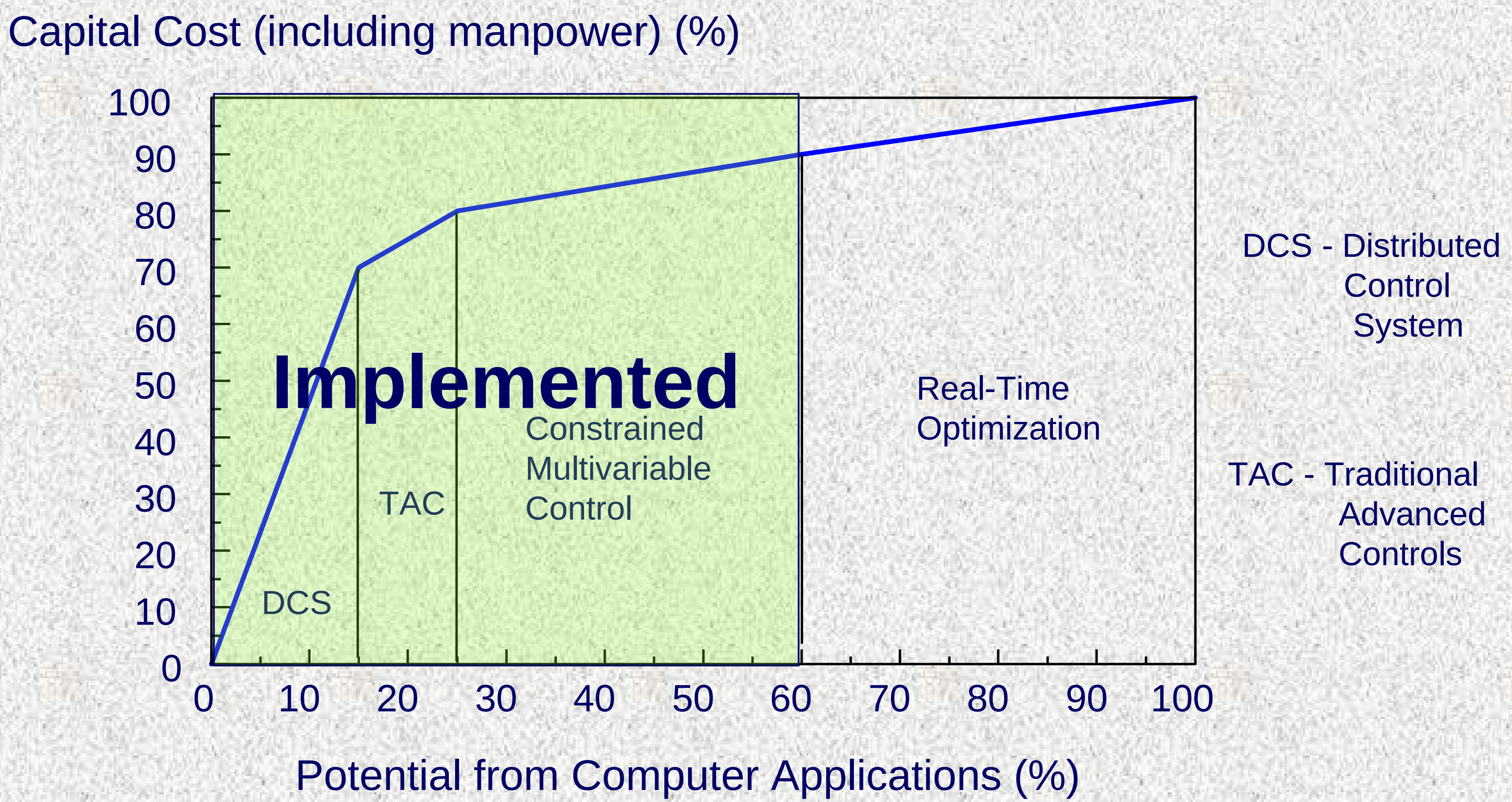
The European Union Emissions Trading System (**EU ETS**) establishes a new methodology for accounting CO2 emission rights. This method is calculated using a CWT benchmark. It will apply from January 2013 onwards.

- Energy control & optimization plays a key role in refining sustainability. The question is: Where and how?



The traditional approach is looking at individual processes, we call them units, control applications and optimization is performed at local level.

Vendor’s profit expectation (1990’s)



Where to look at? Looking for the money (3/4)

- At unit level we will look for opportunities based on process knowledge and “common sense”
- Let’s have a look at the simplified “money equation”:

$$\text{Profit} = +\ \text{PROD}_{(\text{@ target specs.})} * \$_{\text{PROD}}$$
$$-\ \text{Raw Materials} * \$_{\text{RM}}$$
$$-\ \text{Production cost (only variable costs)}$$
$$-\ \text{Investment}$$

- The only two degrees of freedom available to Control & Opt. online are:
  - PROD(@ target specs.)
  - Production Cost (energy & other utilities cost)

Where to look at? Looking for the money (4/4)

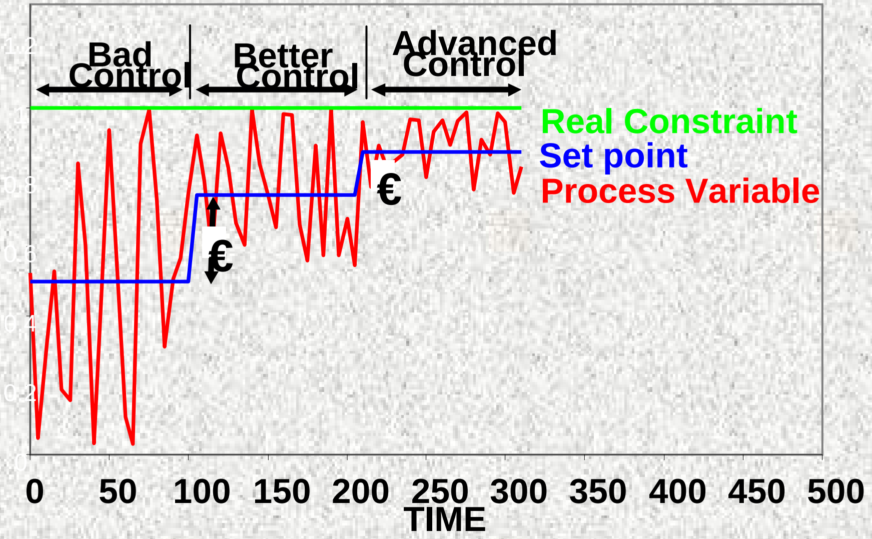
Profit = + PROD$_{(@\ target\ specs.)}$ * $\$_{PROD}$

- Raw Materials * $\$_{RM}$

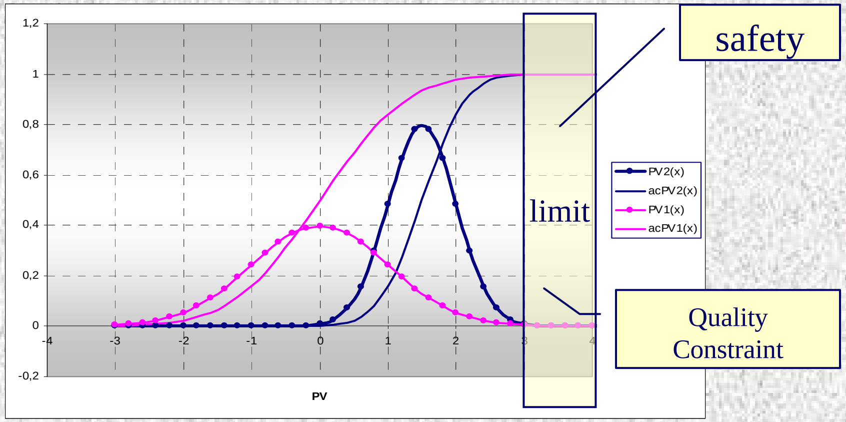
- Production cost (only variable)

- Investment

Operate process closer to real constraints

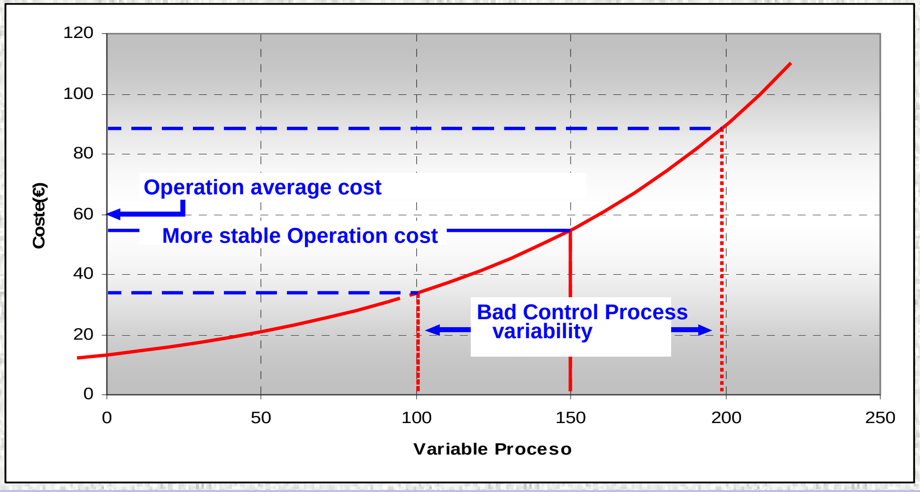


Same percentage rule

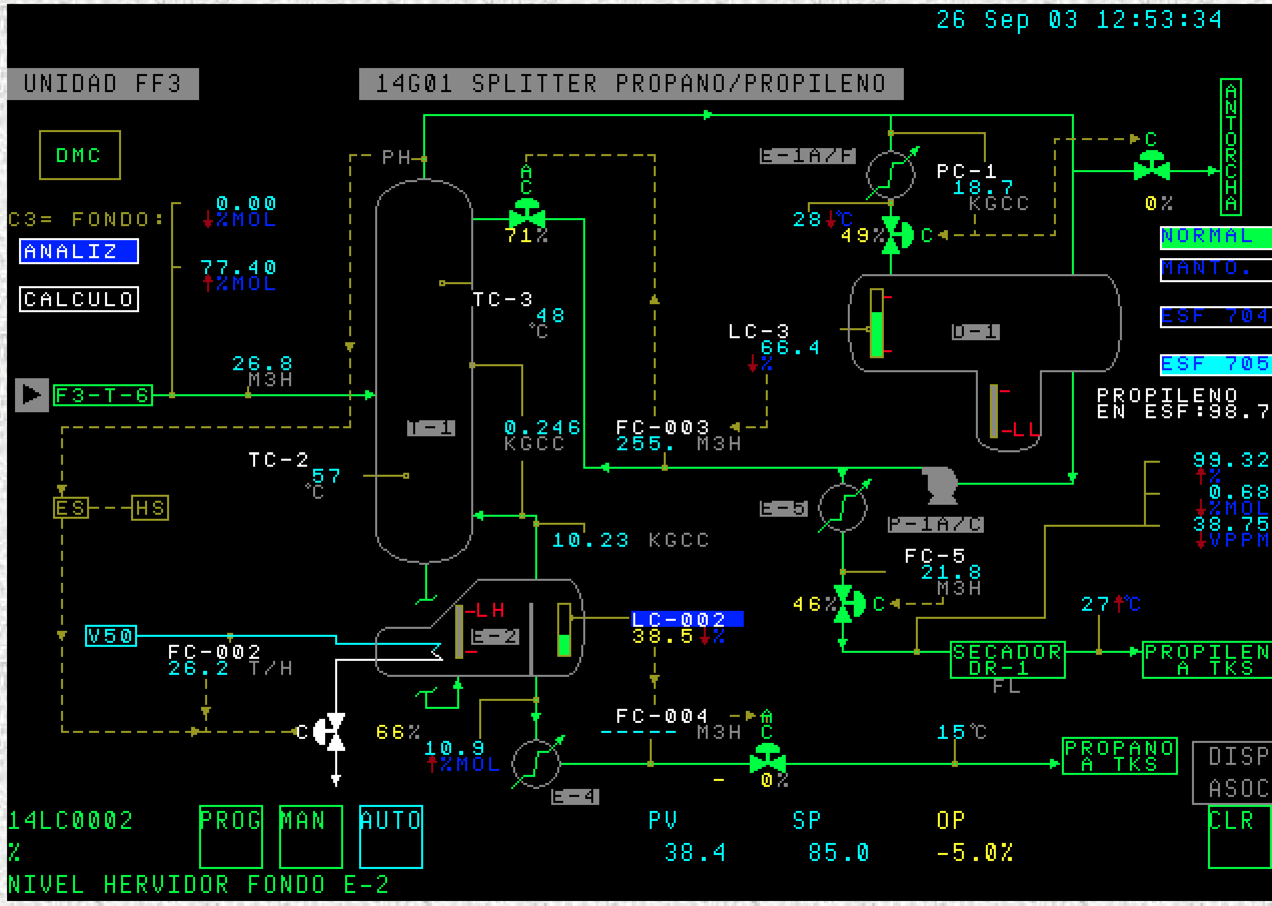


$$\left.\begin{aligned}\overline{pv_1} + 3\sigma_1 &= pv_{\max}\\ \overline{pv_2} + 3\sigma_2 &= pv_{\max}\end{aligned}\right\}\overline{pv_2} - \overline{pv_1} = \Delta SP = 3(\sigma_1 - \sigma_2)$$

Process energy required not linear



Successful stories (1/3)



Main operating values:

- Feed rate: 20-30 m3/h
- Feed composition : 70-85 % de C3$^{=}$, rest C3 & C2 residual
- Top C3$^{=}$ composition : 97-99.5%
- Bottom C3= Composition: minimum

Before:

- C3$^{=}$(%) **avg.=98,5**; **std=0,5**
- Av. Flow-rate 20 m3/h

After:

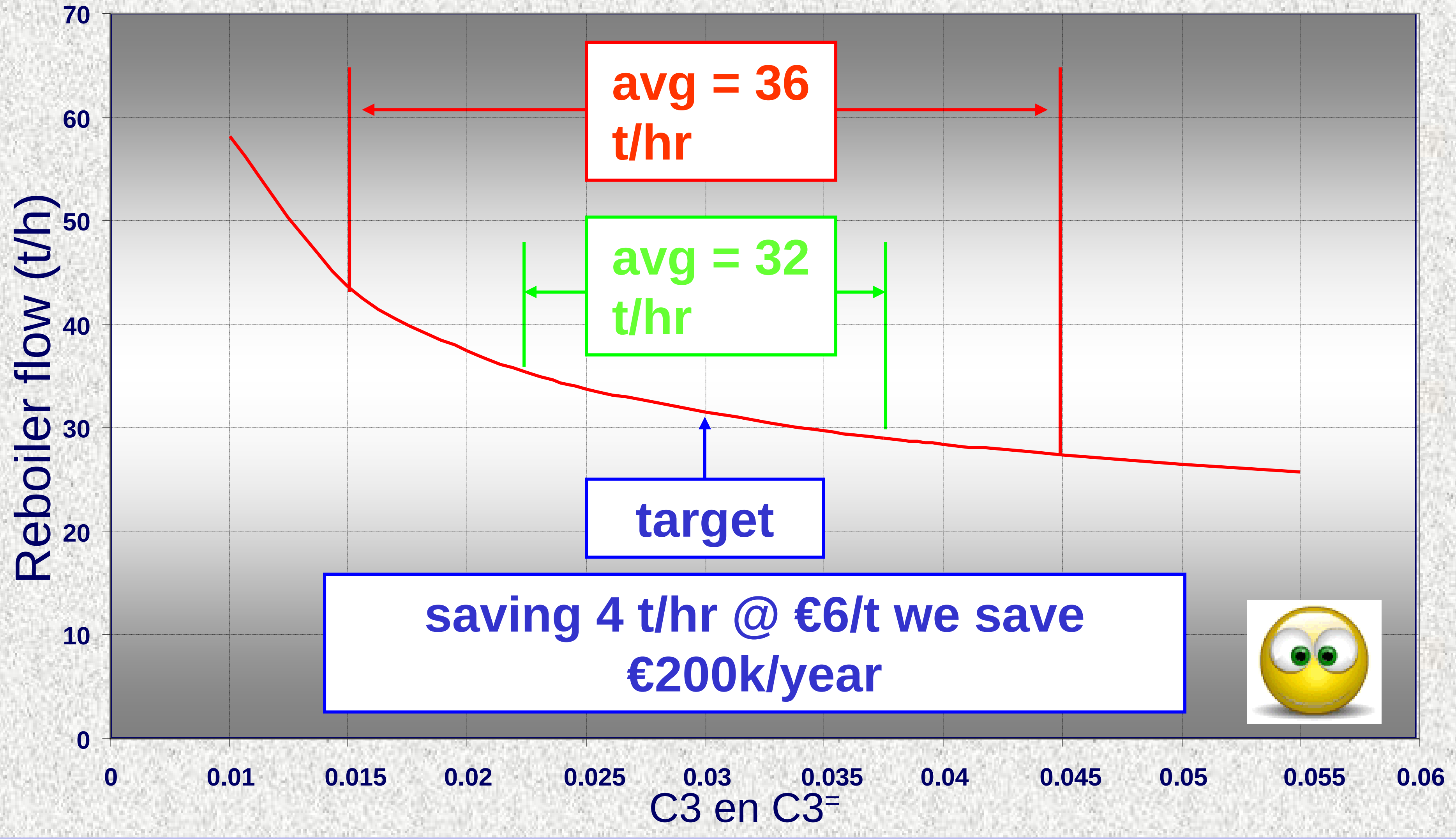
- C3$^{=}$(%) std=**0,1**
- ΔSP=3(0,5-0,1)= **1,2** %
- C3$^{=}$(%) avg. **97,3**%

Profit:

- 1,2/100*20*24*365 = 2100 m3/year
- 2100 * 0,7 T/m3h = 1471 T/year
- difference C3/C3$^{=}$=500\$/T

700.000 $/year

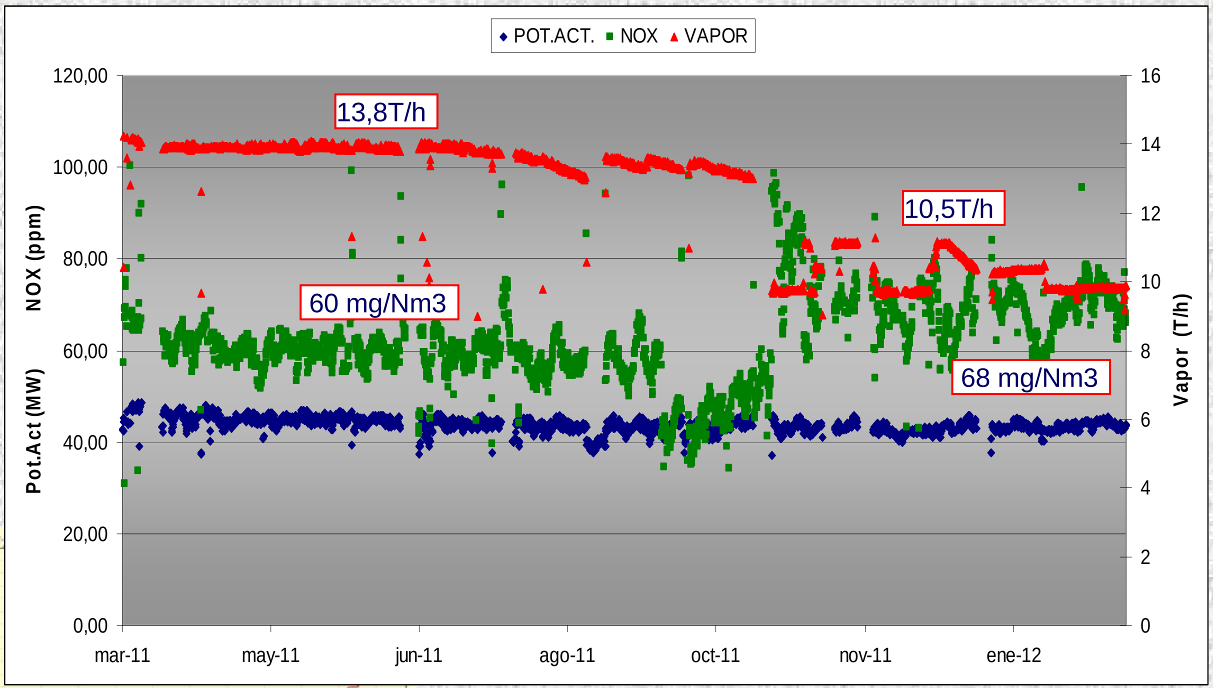
What about the energy?



Successful stories (3/3)

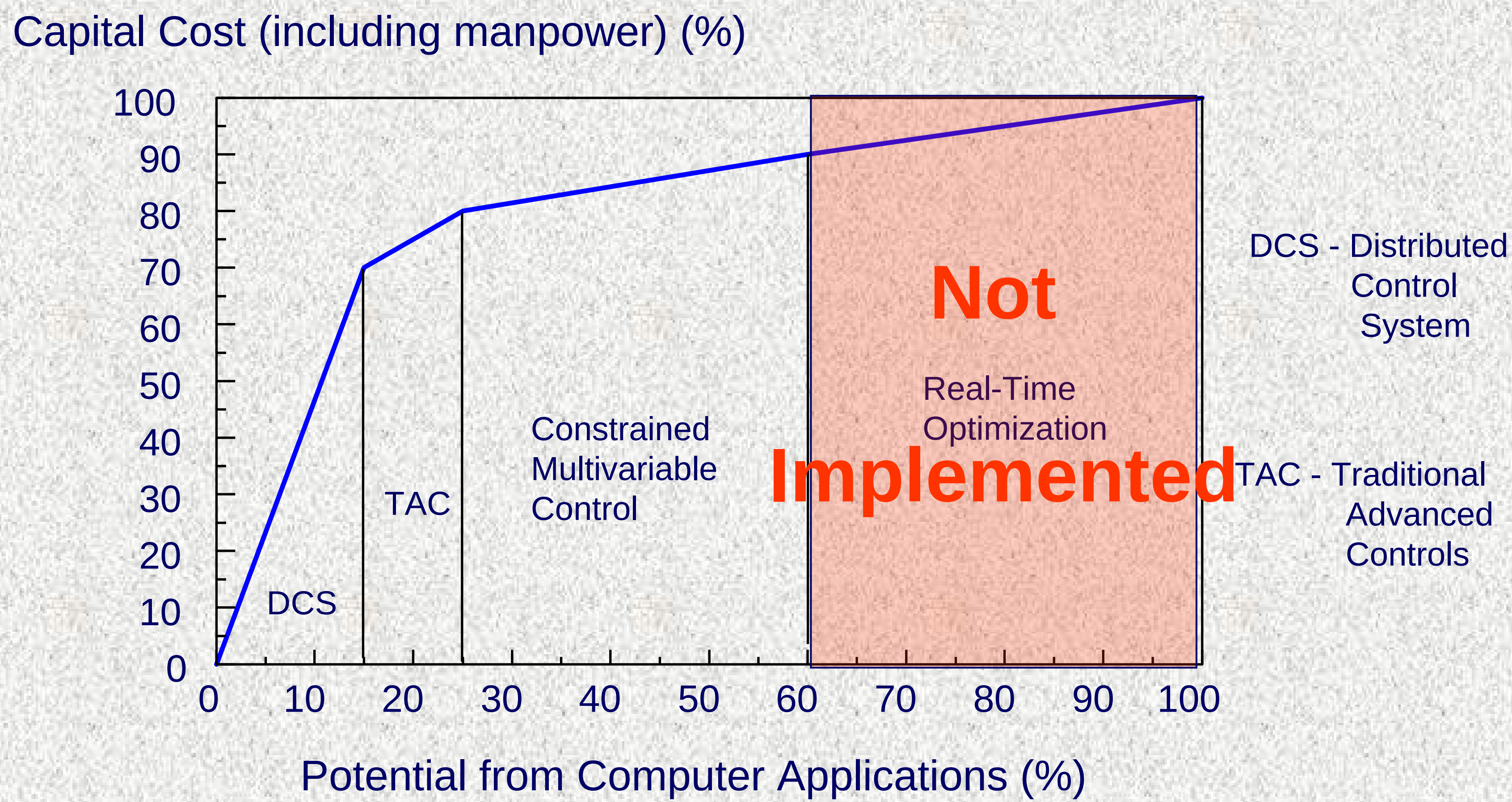
Environmental regulations : Emissions Control

- NOx control requires steam consumption to be controlled
- The upper limit allowed by law is 80 mg/Nm3.
- We save 600# steam.

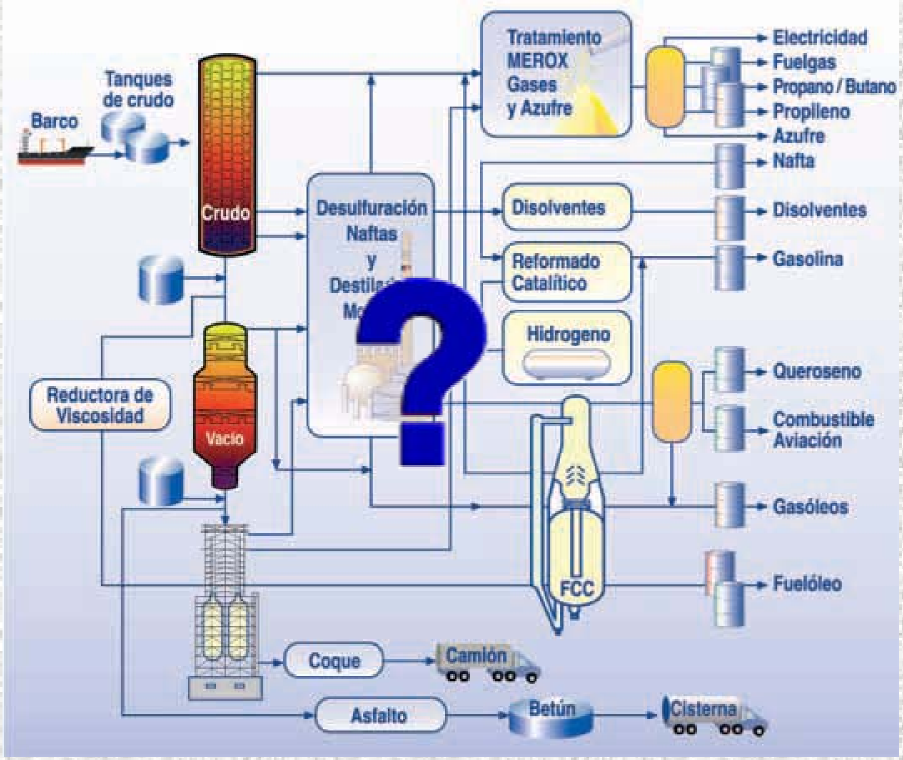


Estimated savings
~ 850.000 €/año
Reduction 3.800 T/año FOE
Reduction 11.600 T/año CO_2

- Many other successful (and others too) stories are available.
- We report every year to the General Management the contribution to the profit due to Advanced Control & Optimization applications. “€” is common language. Doing a project profitable is good, but keeping being profitable is better.
- Where are now the new opportunities?



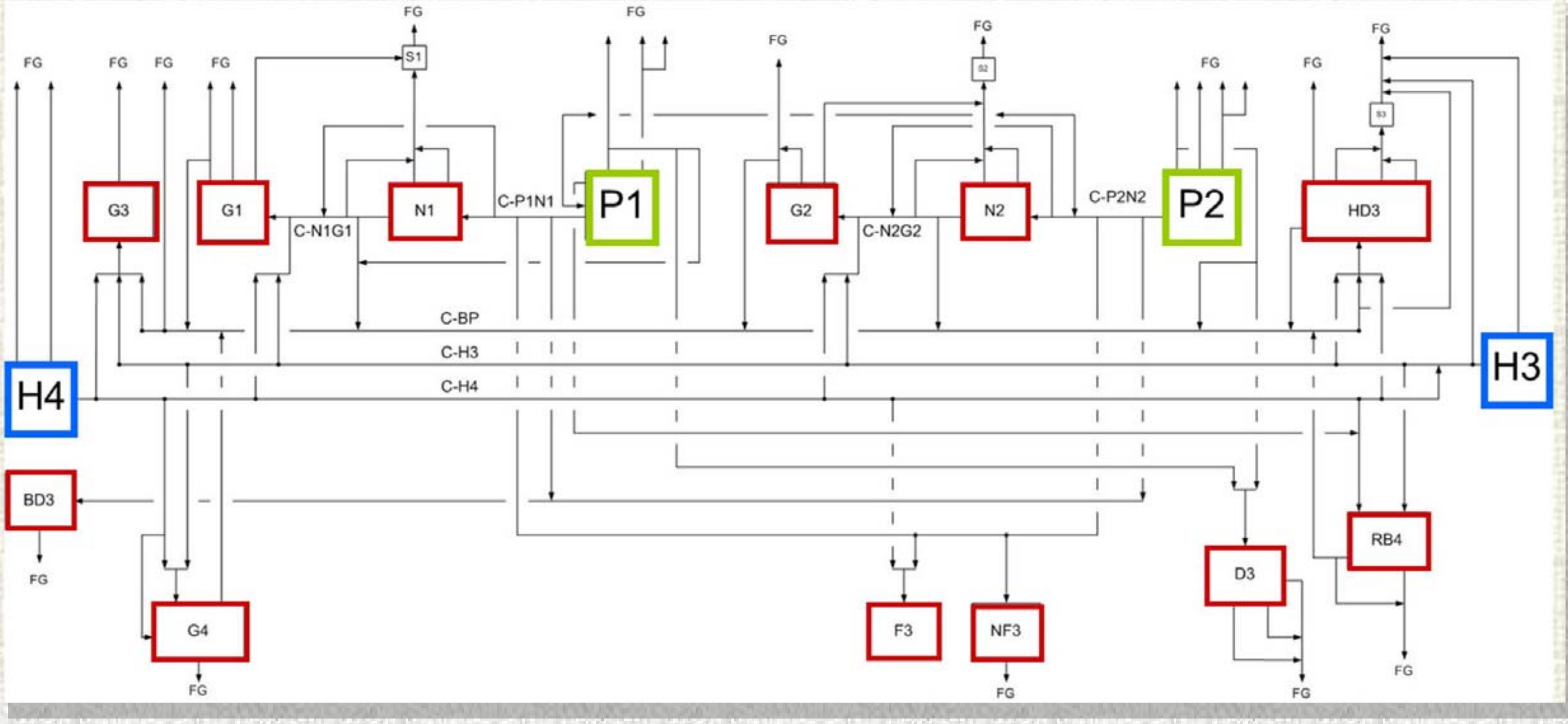
- We need to see the plant as a one process. Unit optimization is required but not enough, local vs. global optimization.



- Consider unit connections as part of the process.
- Optimize product and energy distribution.
- Define KPIs to supervise all the process. Continuous improvements should be made.

New opportunities. Potential benefits (3/5)

H2 network optimization

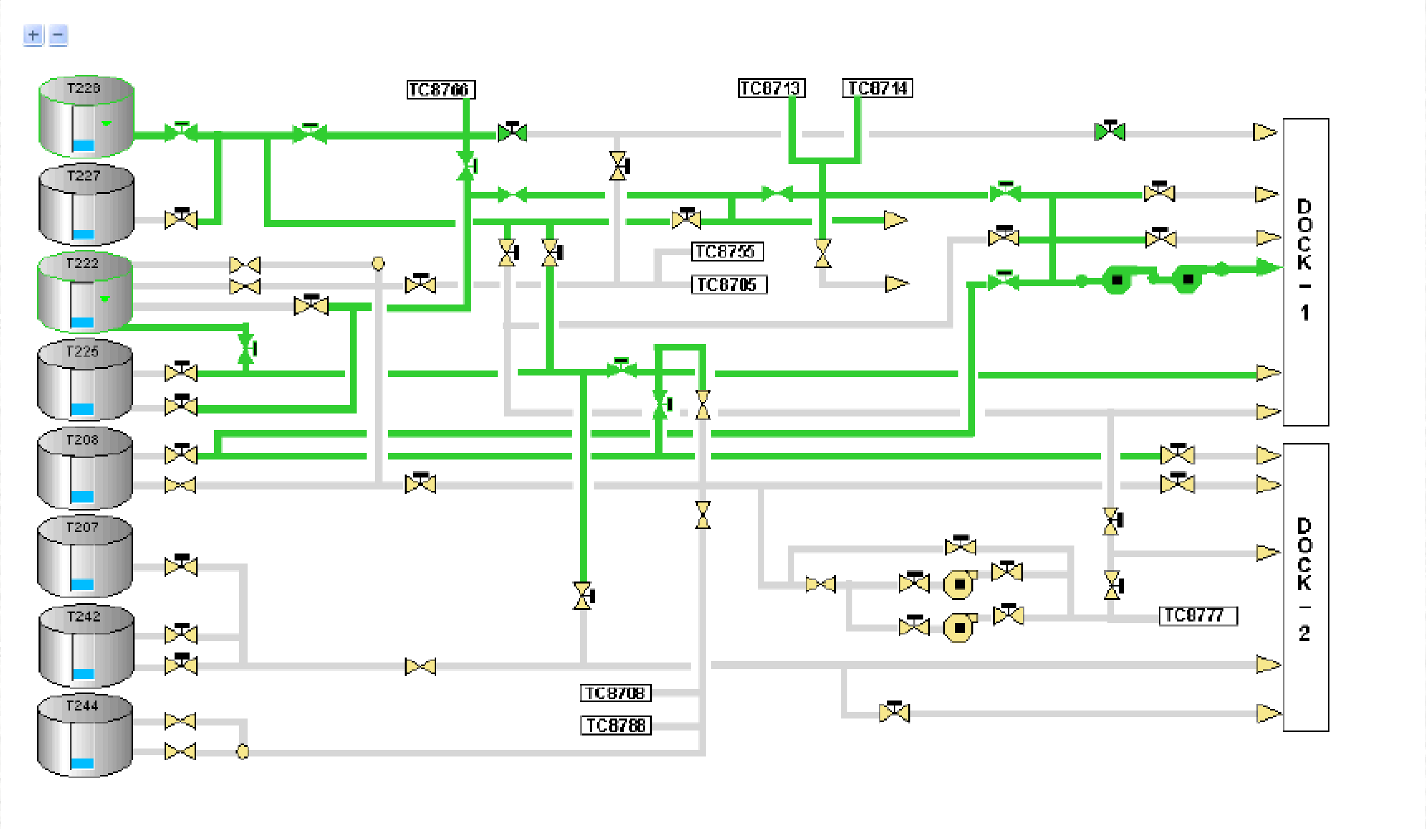


• Objectives: Estimate correct and balanced flow rates. Distribute H_2 to minimize an economic cost function while maintaining offer and demand.

•This project is being doing under the Hycon2 framework with University of Valladolid. Achieving results right now.

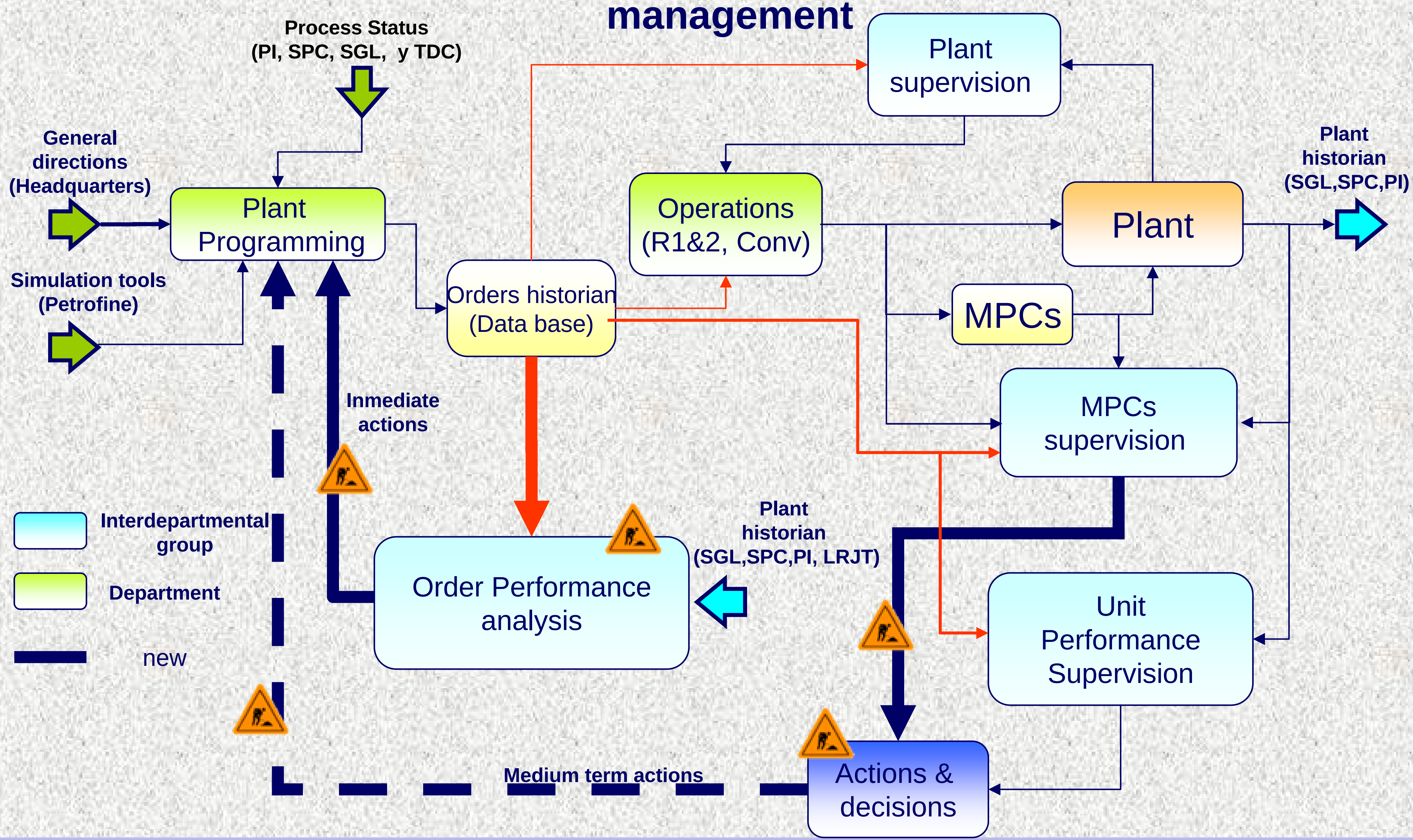
•Next step is adding a new degree of freedom: H_2 production

Tank farm movements and blending optimization



- Objectives: Automate all product movements. Avoid product contamination due to bad operations. Minimize time requirements per move.
- This project is on the way. We estimate 5M€ /year benefits.

Key Process Indicators (KPI) development to enhance overall process management



How to achieve it? (1/1)

- Technological innovation is required. Currently there is not available commercial solutions for issues like: uncertainty, hybrid systems, large scale problems, etc. Safe and functional new solutions could have a potential business.
- Industry need to have stable agreements with R&D groups. A **medium term** partnership is required.
- Industrial implementation is required, therefore a professional implementer is mandatory. The implementer needs to be a partner from the first beginning. They should take care of the business side.
- Stable project funding required. High potential projects are identified, but quite often they do not step forward due to a lack of financial support.
- Thanks for your attention.

Q&A