Heat and Power Plant Optimisation

EDF R&D

Brussels

Hycon2 – September 03-04th 2012

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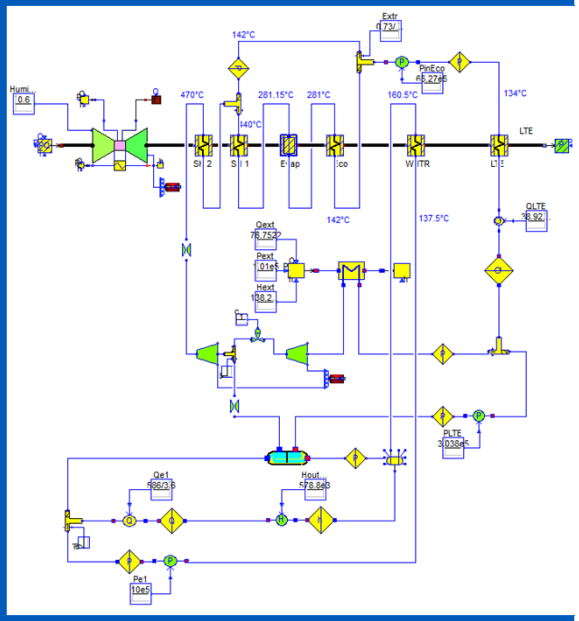
CHANGER L'ÉNERGIE ENSEMBLE

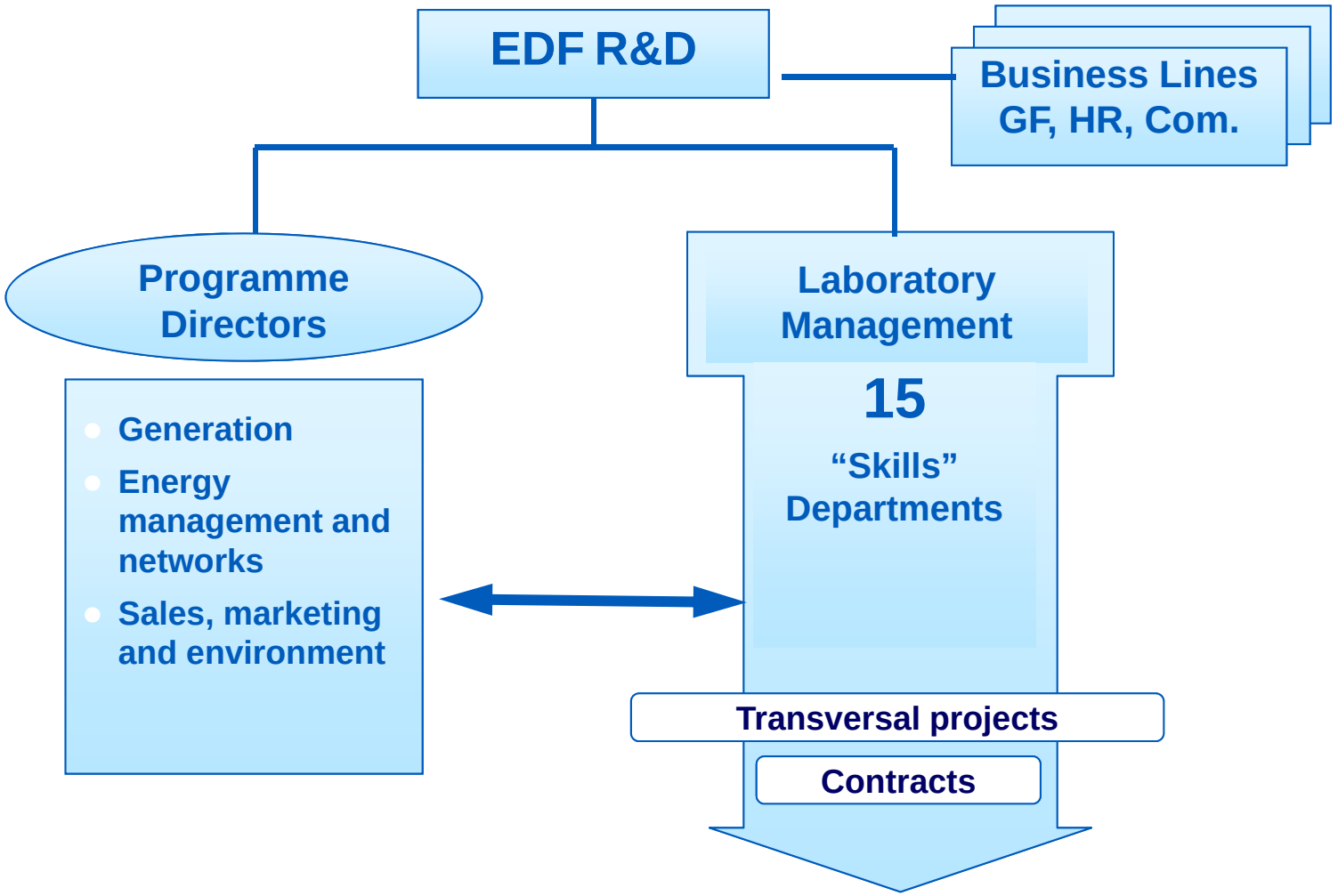
Summary

1. EDF R&D presentation
2. Context
3. Actual tools
4. Different studies
5. The needs in advanced method



Dymola Model

EDF R&D


EDF R&D
Business Lines
GF, HR, Com.
Programme Directors
Laboratory Management
15
"Skills" Departments
Generation
Energy management and networks
Sales, marketing and environment
Transversal projects
Contracts

STEP – Simulation and information TEchnologies for Power generation systems

EDF R&D - Chatou island

STEP Department

An R&D Department (130 persons staff) aimed at supporting power plant operation:

→ helping the operators better operate, monitor and maintain the facility (including meeting environmental constraints and regulation compliance)

STEP – Simulation and information TEchnologies for Power generation systems

- Relying on :
  - **academic competencies :**
    - Applied Mathematics : Dynamic Systems, Data & Image Processing
    - Applied Physics : Physical Measurement, Radiation Measurement
    - Data Processing : Knowledge Management, Safety Assessment of Computer-based and Digital Systems

  - **….and technical competencies related to power generation :**
    - Process : operation of fossil-fired and nuclear power plants
    - Equipment Monitoring Techniques
    - Radiation Protection and Management

- Aiming at providing the operator with the best possible methods/tools for an optimized operation:
  - Measurement chains
  - Control Systems
  - Information Technologies
  - Operation Aids

STEP

EDF

Advanced control for Utility

Objectives R&D

- Develop optimization tools for multi energy and multi criteria
- Transfer the optimization tools to operationnal units

Goal : optimize the process design; increase the flexibility, maximize the revenue and minimize the maintenance costs;

Partners

- **Design study :** EDF Optimal Solution, EDF Energie Nouvelle
- **Exploitation :** EDF Energy ; EDF Fenice ; EDF R&D Polska

Departments R&D

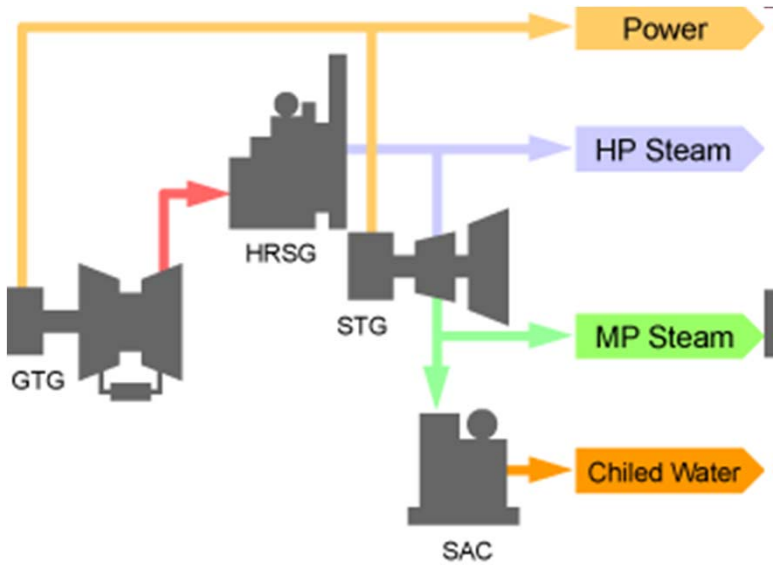
- EPI (process) ; STEP ; MFEE (weather forecast) et OSIRIS (Load forecast)

Advanced control for Utility: Multi-energies

Priority for Heat energy – profit with electricity sells

advantages…..

- **Energy efficiency (> de 10 to 30 %)**
- **Flexibility (peak load)**
- **Distributed Generation (transportation loss)**
- **Local economy development**



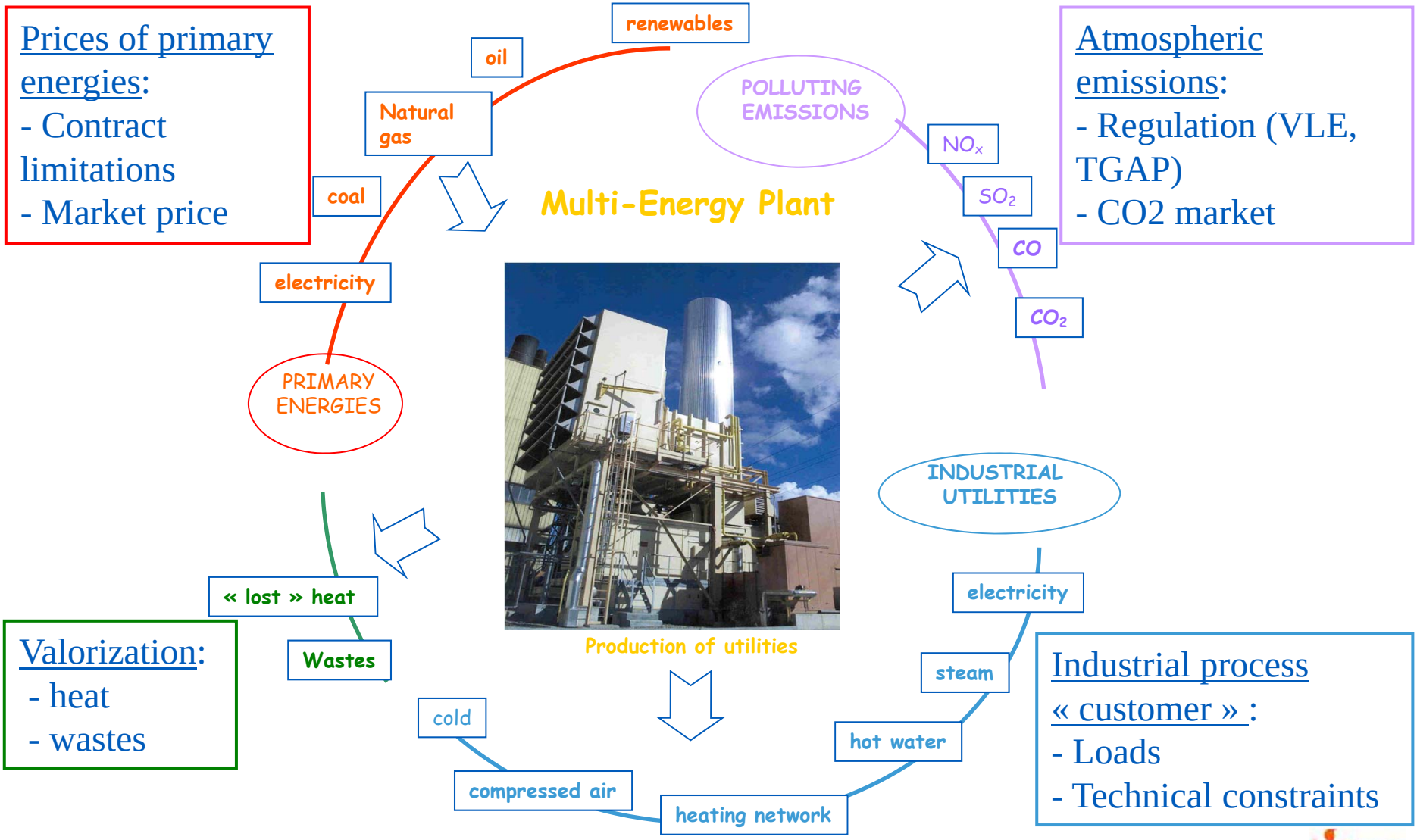
drawbacks…..

- **O&M cost increase (gas contract, management, maintenance cost)**
- **Depends on the heat or cold demand (network, process)**

Different power stations (Cogeneration, Tri generation) : 1 MW to 1 GW

- Boiler: gas - oil- biomass
- CCPP
- Engine: gas – biogas – fuel

A global vision of the plant : *Multiple constraints to be considered*



USED TOOLS

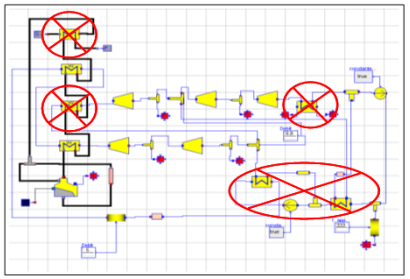
Different Tools for different use

1. First studies of optimum design (Dymola Physical model) ;
2. Commissioning of power plant (Dymola Physical model);
3. Help for exploitation: optimal functioning, estimation of losses in operation (Dymola Physical model) ;
4. Optimal power plant operation (Optimization software PILOT);
5. Predictive maintenance (Smart monitoring Tool);

Physical based modeling of utility

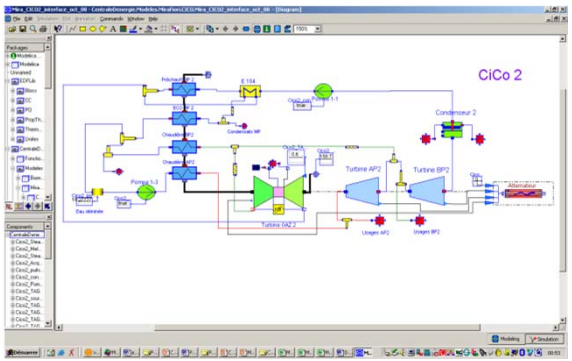
✓ Tool: DYMOLA/Modelica

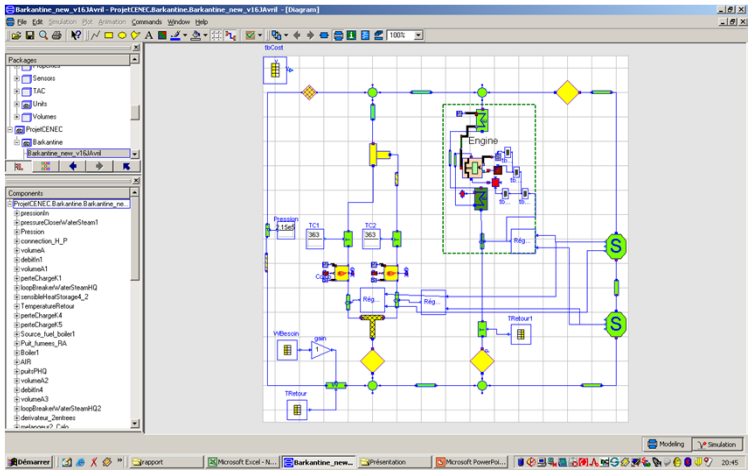
- ✓ static and dynamic simulation
- ✓ physical equation foreach module

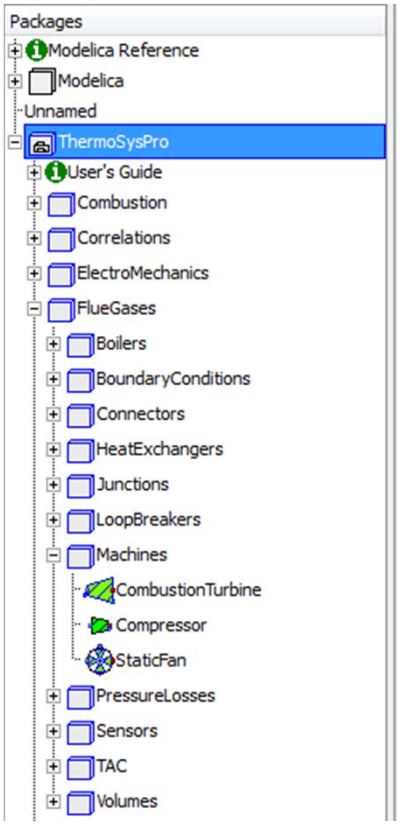


✓ ThermoSysPro Open Source Library

- ✓ All cogeneration can be modeled
- ✓ Optimize the design, assess the technical performance for new projects,…





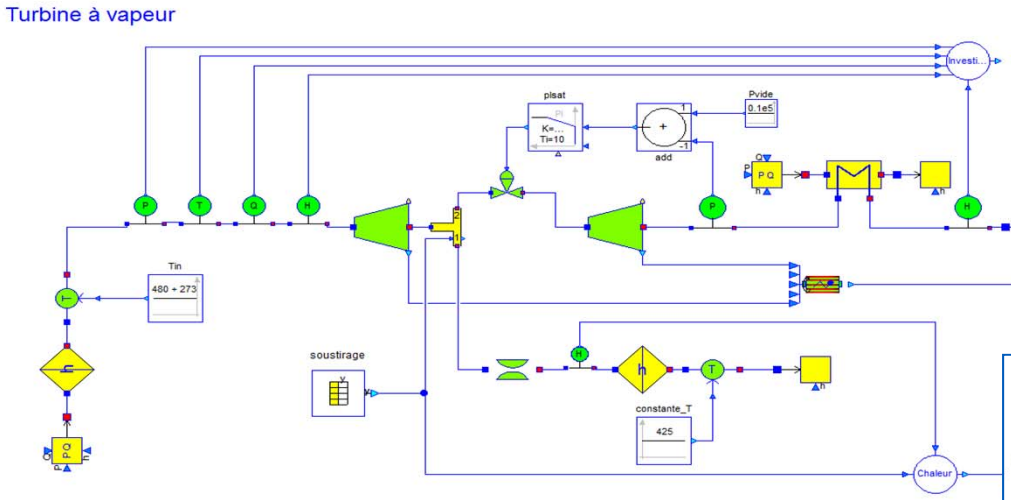


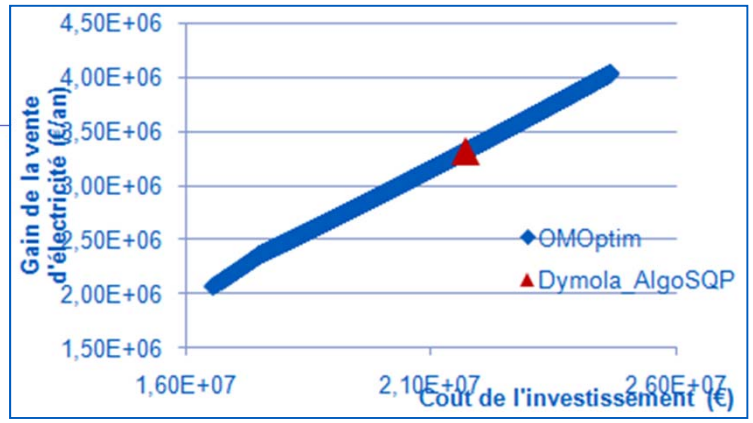
ThermoSysPro library

Process design optimization

Tools: OMOptim (Open Source) et Dymola (option)

Ex : Sizing of a biomass cogeneration





Optimization :

- Minimize investment cost
- Maximize profits (electricity sales)

Utility operation optimization

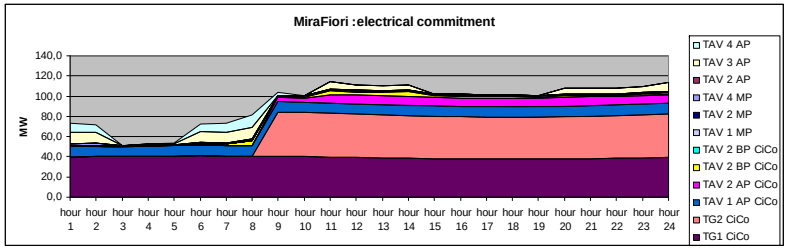
Minimize the variable operation cost

=

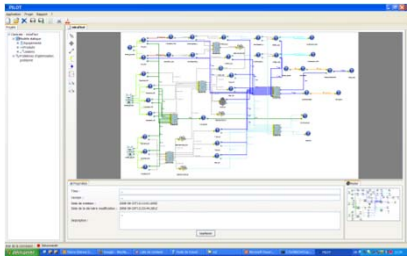
Fuel consumption

+ maintenance cost

– electricity sales



- **Forecast of needs**
- **Model of the plant**
- **Prices of energy**



Unforecasted need

PiLoT

Planification optimale

Boiler failure

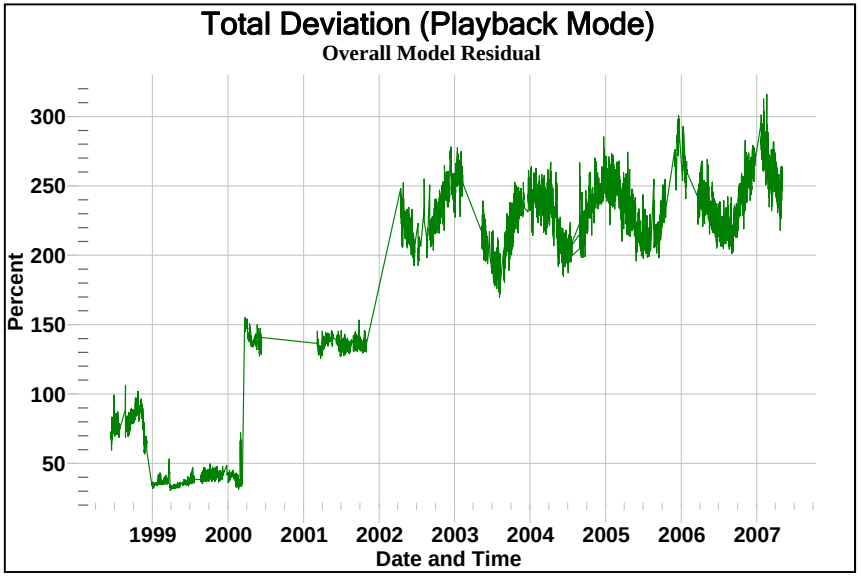
optimal plannings

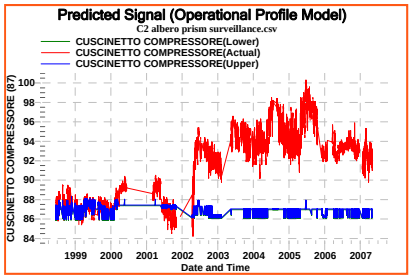
- **For each equipment**
- **For each time-step**
- **On/Off**
- **Levels of generation**
- **<u>-> Optimal cost</u>**

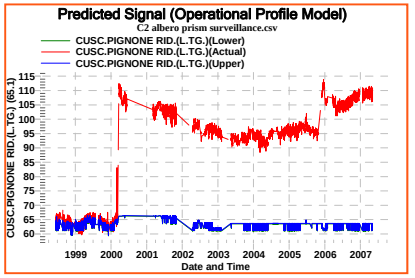
Utility monitoring

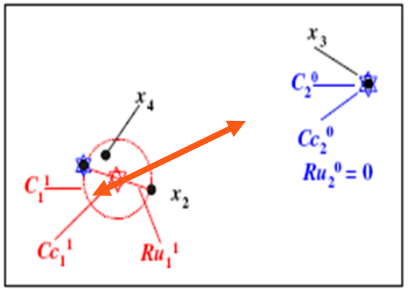
Tool Smart monitoring

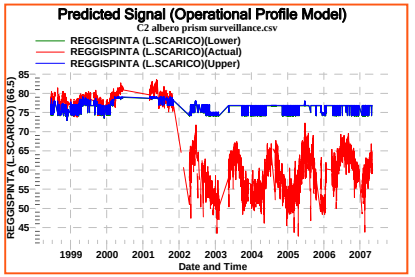
- **Principe**
- Normal behavior model by learning.
- **To ?**
- Detect anormal signals early before the alarms, the trip or damage of components





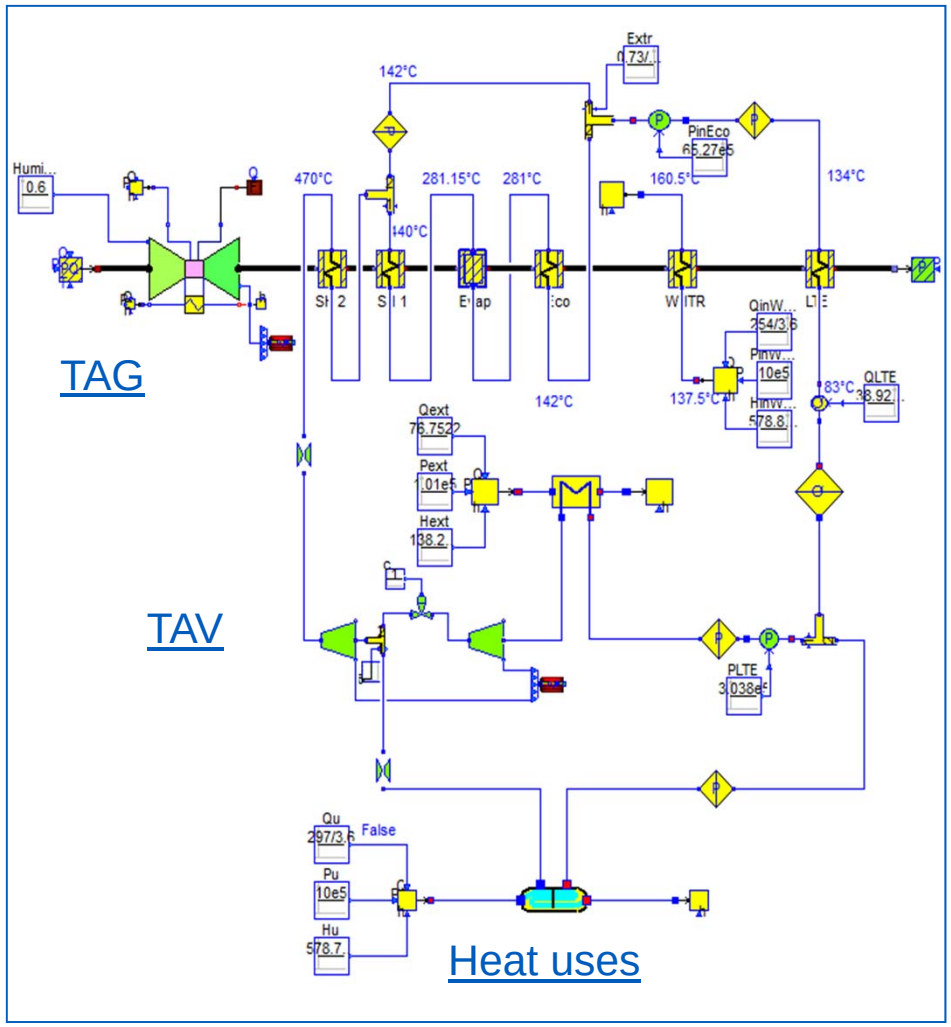






SOME EXAMPLE OF STUDIES

Barilla power plant with FENICE

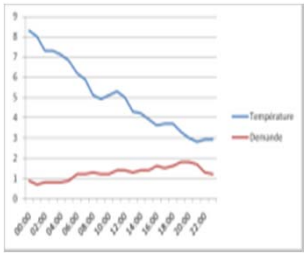


Combined cycle of Barilla

- Engineering (Technical economic)
- Power plant control
- Exploitation help

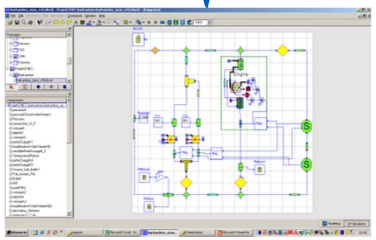
Barkantine with EDF Energy

Forecast



PILOT

Dymola



Barkantine

PC operator

Heat and power plant optimisation

- Driving with model
- Exploitation help
- Maintenance help

NEEDS IN ADVANCED TOOLS

Needs of actual tools

Used of detail thermo-hydraulic physical model for real-time optimization

- Model simplification (linearization, interpolation) , using physical model, usable by mixed integer linear optimization tools like PILOT
- Use homotopie method included in Modelica library
- Use of new non linear optimization methods for complex physical model

Integrated the influence of the control for realistic optimization

- Allow to respect the fidelity of the model with installation behavior

Global optimization of the process design (sizing and control)

THANK YOU VERY MUCH