EINSTEIN USER & DEVELOPPER DAY

Energy Integration of a French cheese factory using Einstein 2.1

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Bruxelles – May 30th 2012

EDF Group

- A leading player in the energy market, active in **all areas** of electricity from **generation** to **trading** and **network management.**
- **Balance** between regulated and deregulated activities.
- Expertise in **engineering** and **operating** generation plants and networks.
- Expertise in the design and promotion of **energy eco-efficiency solutions**.
- Leader in the **French and UK** electricity markets, solid positions in **Italy** and numerous other European countries; industrial operations in **Asia** and the **United States.**

37 million
customers worldwide

630,4 TWh
electricity generation worldwide

108.9g of CO_2
per kWh generated
(CO_2 emissions from EDF Group electricity and heat generation)

158,842
employees worldwide

€65.2 billion
in sales

Consolidated data at 12.31.2010.

EDF R&D: shortening the time between innovation & market

A competitive edge in a changing landscape

- Two new international centers in Poland and the UK.
- Patent filings within the Group and external support for start-ups.
- Recognized expertise, top-rate experimental and scientific tools including
  the most powerful computer available in industry.

Four priorities:

- Low-carbon generation mix:
  - Renewable energies, carbon capture and storage for fossil-fired generation, etc.
- Helping customers manage their consumption:
  - Energy efficiency, distributed renewable generation, smart buildings and smart cities.
- Smart power systems.
- Partnerships that are a window to the world:
  - 12 joint laboratories worldwide
  - participation in collaborative EU projects.

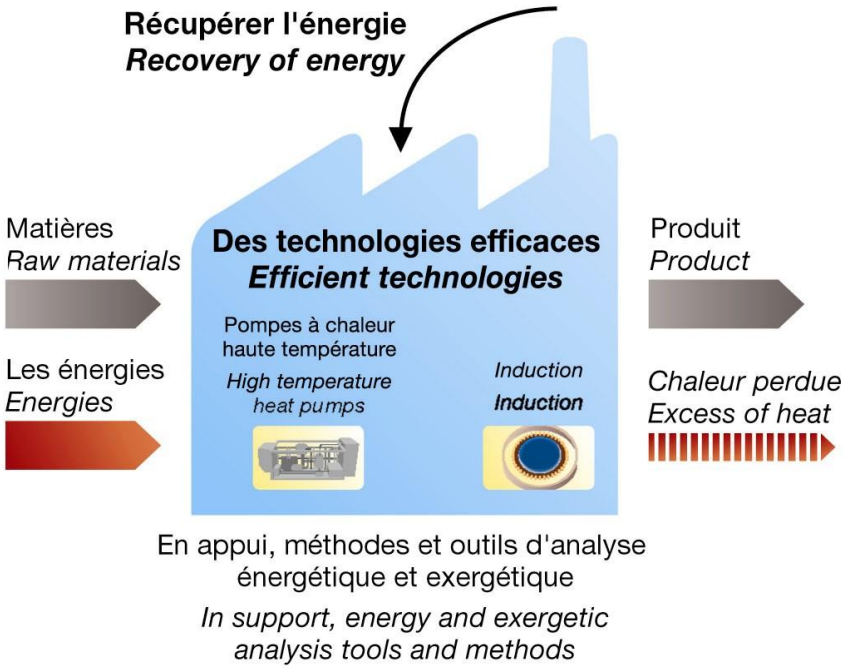
Budget = €486 million

+ than 2,000 employ.

Eco-efficiency & Industrial Processes Department

- **~100 people**
- **Sub-divided into 5 « groups »**
  - Expertise and statistical analysis of industrial sectors
  - Long-term energy demand forecasting
  - Environmental analysis of industrial sites
  - Industrial utilities expertise
  - **Industrial processes optimization**

➢ **Pinch Analysis**
➢ **Watch on existing & developping tools**



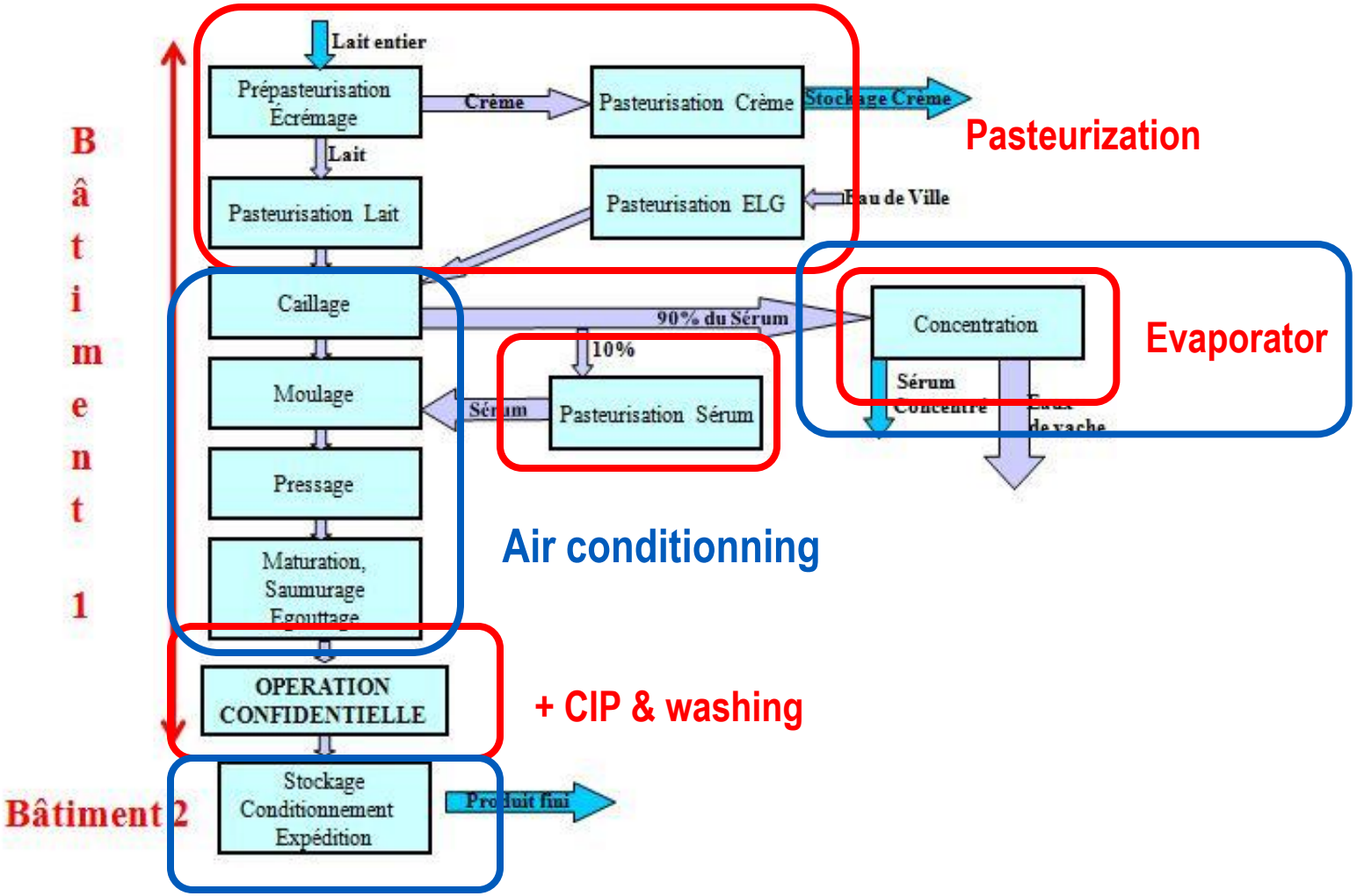
The Cheese Factory (1)

Case-study previously used for comparison of different pinch tools

- 2 days auditing → many available data
  - flowsheets, temperature & steam sensors, process schedule
- Data « reconciliation »
  - Detailed modeling (pasteurization) → Bottom-Up approach
  - Black-box modeling (evaporator) → Top-Down approach
- 6 months-study : pinch analysis using different tools **including Einstein I**

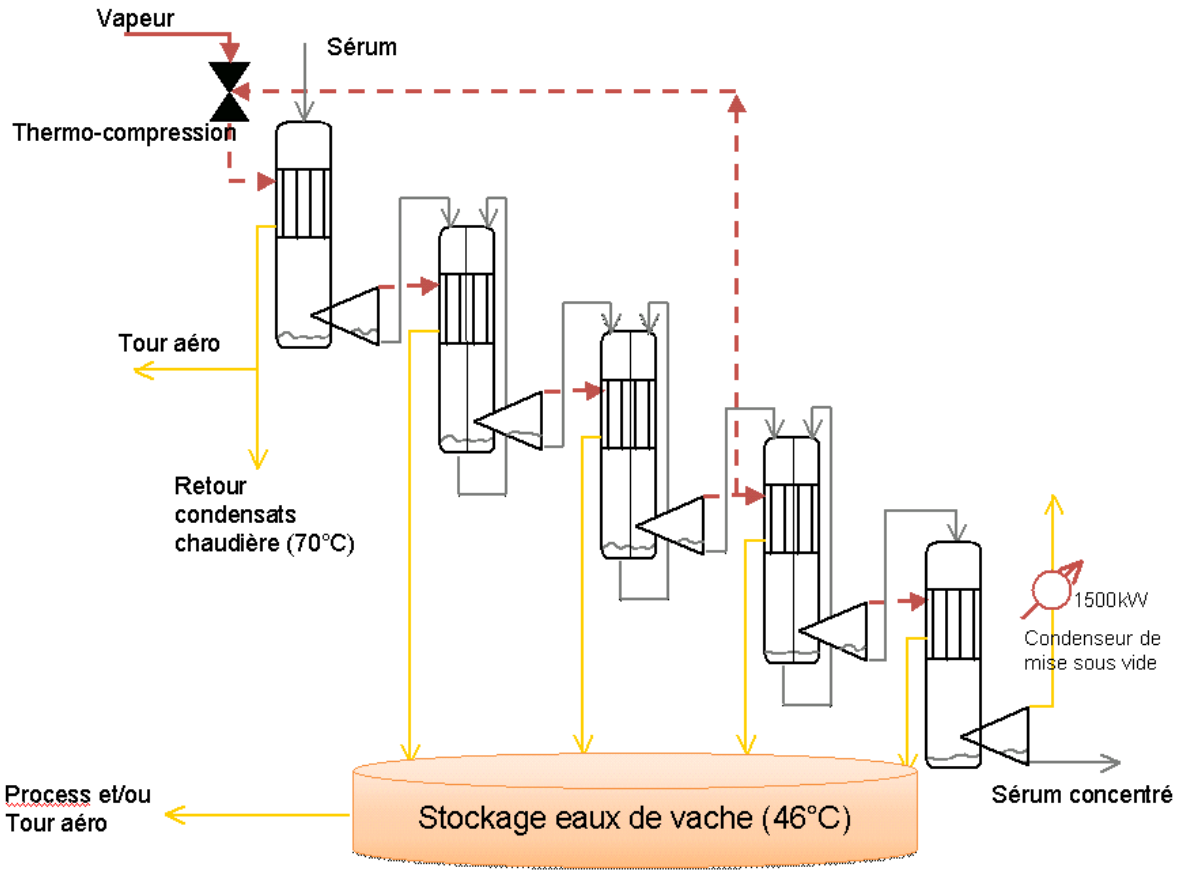
The Cheese Factory (2)

Main heating and cooling needs



The Cheese Factory (3) : modeling of the evaporator

Evaporator : 5 effects & 1 thermo-compression



3 flows:

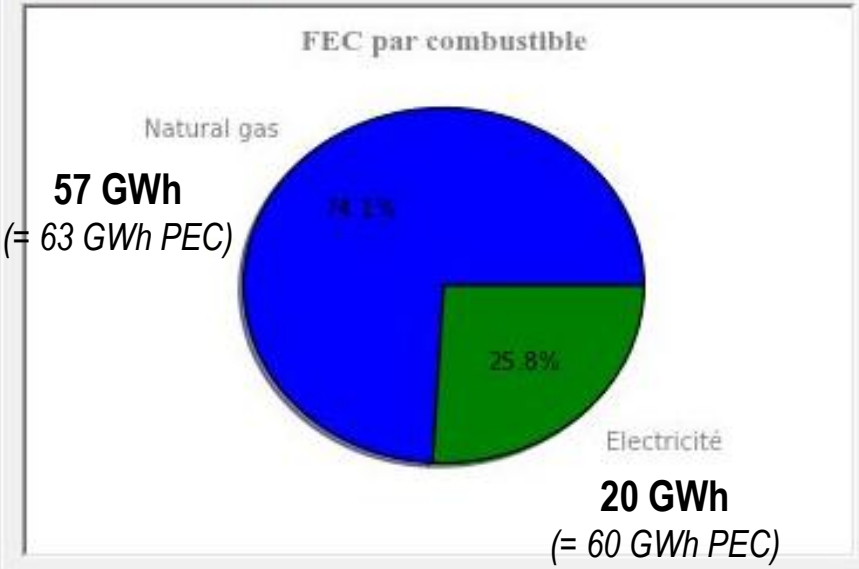
- 1 cold flow
  - Maintenance energy at 140°C for steam consumption
- 2 hot flows
  - Wastewater flows at 46°C
  - Latent heat at the last effect condensor at 43°C

The Cheese Factory (4)

Utilities

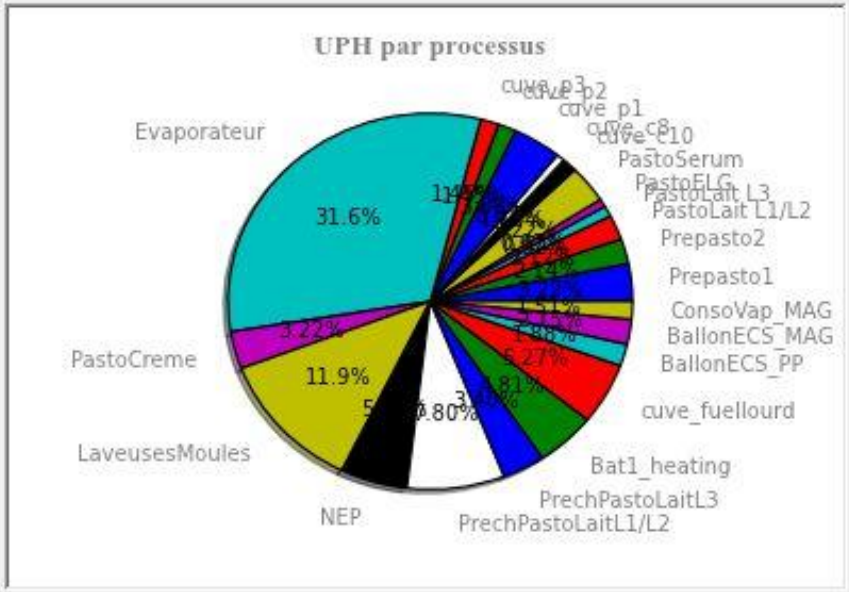
- Steam boilers : « Steinfasel » & « Babcock »
- Hot water boiler : « Thermigaz »
- Chillers for Building 1 (« Mycom ») & for building 2 (« York »)
- Cooling tower

Final Energy Consumption / Useful Process Heat



57 GWh
(= 63 GWh PEC)

20 GWh
(= 60 GWh PEC)



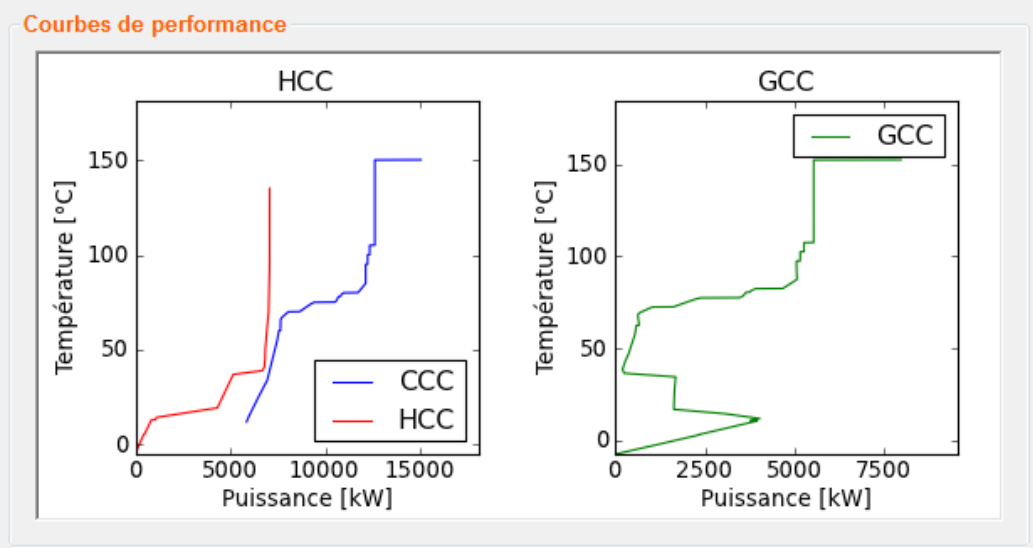
Study of alternatives

- Reference = checked site with utilities simulation
- Marginal improvement : suppression of heavy fuel tank
- Heat recovery : mix of automatic & manual design
- Heat recovery + heat pump on evaporator latent heat
- Heat recovery + Solar thermal : maximum available area versus realistic investiment

« Marginal improvement » alternative

- **Heavy fuel tank : constant maintenance energy at 65°C**
- **Used once every 4 years → useful ?**
- **Savings potential:**
  - 3200 MWh/yr
  - 47 k€/yr
  - Suppression of Babcock boiler during summer
- **Alternatives ?**
  - Substitution of Heavy fuel with Domestic fuel (! Adaptation of gas burner !)
  - Change of contractual conditions for gas supply
  - Insulation of the tank

« Heat recovery » alternative



- **2 heat exchangers proposed by Einstein II:**
  - Evaporator wastewater → pasteurization production line 3 (320 kW)
  - CIP wastewater → process hot water needs (113 kW)

- **3 heat exchangers designed manually:**
  - Evaporator wastewater → pasteurization production lines 1 & 2 (300 kW)
  - Heat from Air Compressors → process hot water needs (91 & 41 kW)

  → *Suppression of « Thermigaz » boiler*

« Heat recovery + heat pump » alternative

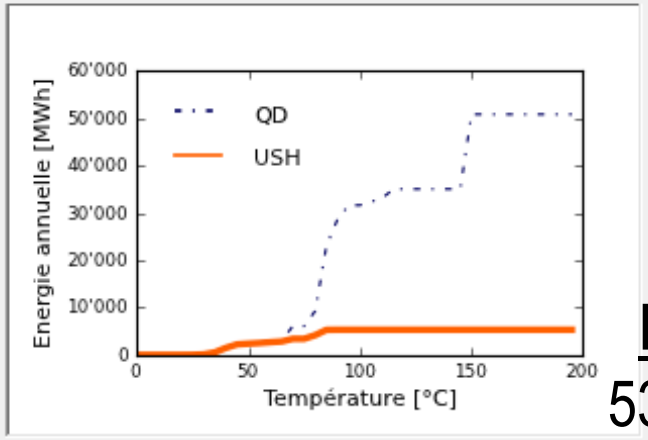
- **Grand Composite Curve → Heat pump potential**
- **Cold source = latent heat condensed at the 5th effect of evaporator**
  - Global potential = 1500 kW at 43°C, working 22h/d
- **Hot source = several hot needs at 70-80°C (washing machines, pasteurization, etc.)**
- **COP ~4**
- **Einstein sizing of heat pump :**
  - 500 kW thermal (hot side) → does not use the whole potential
  - Supplies 4500 MWh thermal = 8,7% thermal needs
  - Consumes 1125 MWh electricity

« Heat recovery + solar thermal » alternative

Solar thermal integration (evacuated tubes):

- maximal potential = 10000 m2 evacuated tubes (left)
- Realistic investment = 1000 kW (right)

Demande en chaleur et contribution solaire



Performance du système

Surface brute adaptée à une installation [10000.00
Capacité thermique solaire potentielle ma:6363.64

Fraction solaire (jusqu'à 200°C) [%] 10.43
Rendement énergétique annuel [kWh/kW.333.53
Rendement moyen du système [%] 26.41
Température moyenne d'exploitation (coll.78.51]

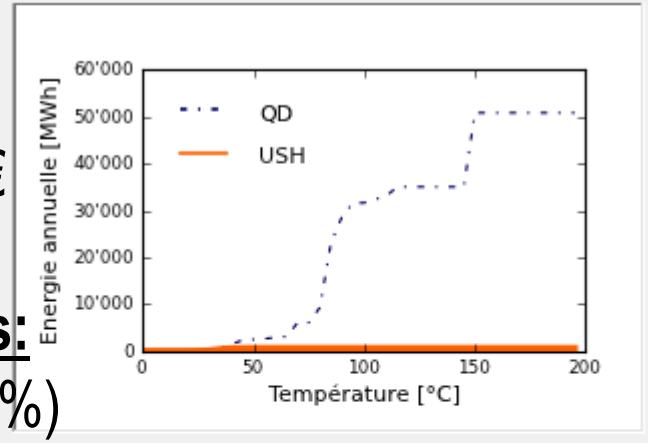
Investment:

6 M€ vs 600 k€

Energy savings:

5300 MWh/yr (10%)
vs. 600 MWh/yr (1%)

Demande en chaleur et contribution solaire



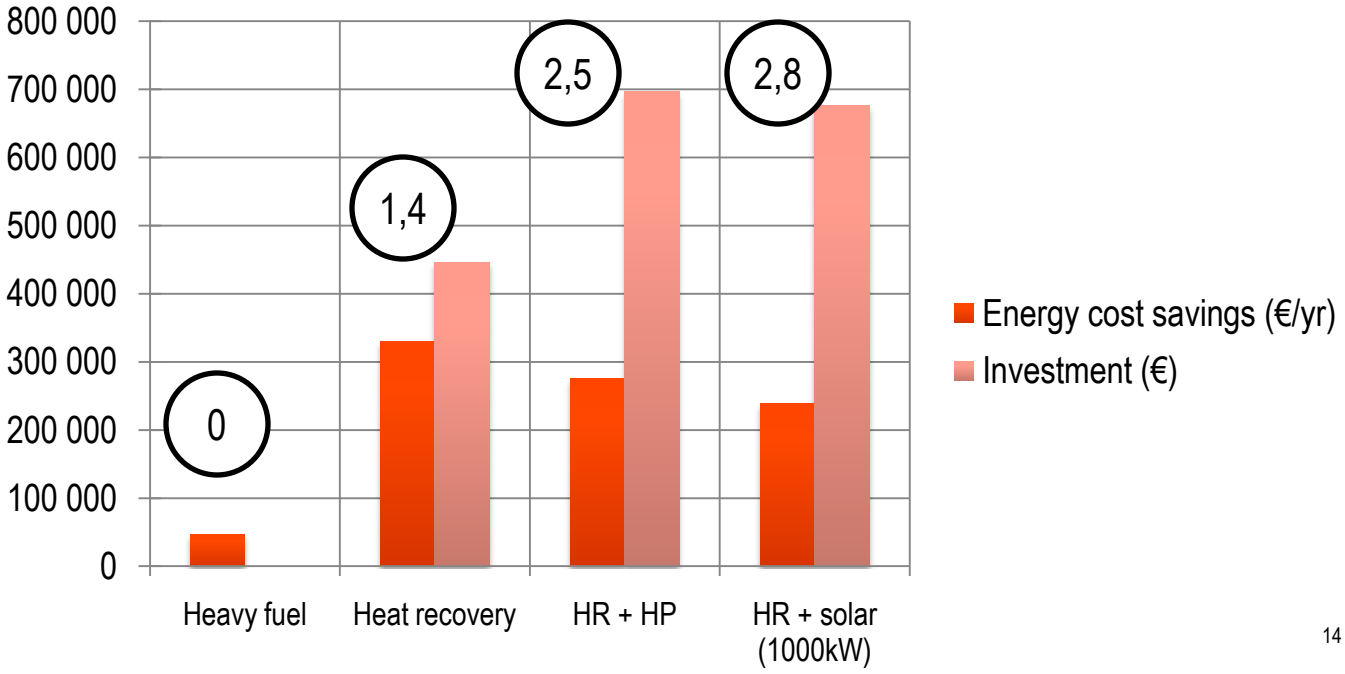
Performance du système

Surface brute adaptée à une installation [10000.00
Capacité thermique solaire potentielle ma:6363.64

Fraction solaire (jusqu'à 200°C) [%] 1.19
Rendement énergétique annuel [kWh/kW.604.65
Rendement moyen du système [%] 47.87
Température moyenne d'exploitation (coll.43.49]

Conclusion (1) : comparison of alternatives

	PEC savings (MWh)	Energy cost savings (€/yr)	Investment (€)	***Payback (yr)***
Heavy fuel	3 192	47 177	0	***0,0***
Heat recovery	**8 784**	330 120	446 320	***1,4***
HR + HP	4 870	275 148	696 320	***2,5***
HR + solar (1000kW)	6 355	239 029	675 754	***2,8***
HR + solar (max)	**11 521**	435 439	**6 014 050**	**13,8**



Conclusion (2) : about this project & Einstein II

◎ ++++++++++

- Lots of improvement compared with Einstein I
- Easy to compare alternatives
- Possibility of designing high-temperature heat pumps ☺
- Evaluation of solar thermal potential

◎ ~~~~~~~~~~~

- Complex case study → missing data (pb with autorun)
- Consistency check : !! Redundant data !!
- Site already studied before → already an idea of the solutions
- Difficulties with heat pump, some HX not proposed
- Cannot propose MVR