Assessment of a combined cooling, heat and power plant using EINSTEIN

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Public Research Centre Henri Tudor, Luxembourg

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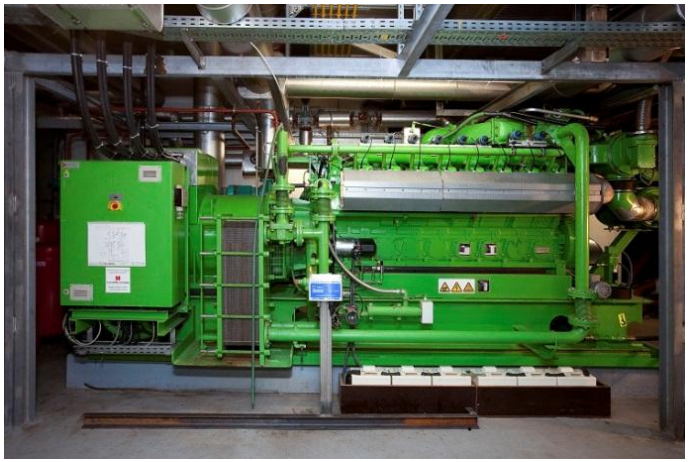
EINSTEIN II final conference

Presentation structure

1. Presentation of CRP Henri Tudor/CRTE
2. Project description
3. Modelling in EINSTEIN
4. Outcomes



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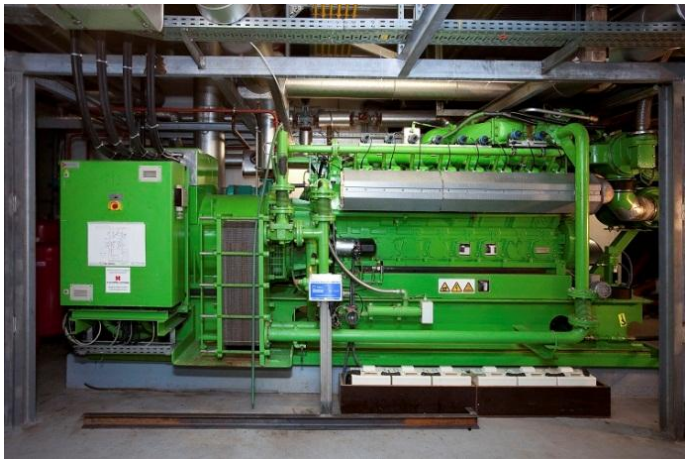

TUDOR – three objectives

CRP Henri Tudor - an autonomous Luxembourgish institution for applied research

- Research: Contribute through scientific excellence to the production and transfer of knowledge and to the international recognition of the scientific community in Luxembourg.
- Innovation: Sustainably strengthen the innovation capacity of companies and public organisations.
- Policy support: Support through research and innovation the definition, implementation and evaluation of national public policies.

Resource Centre for Environmental Technologies (CRTE)

Objective

- Foster eco-innovation and support the implementation of ecotechnologies by adopting an integrated and pro-active approach

Key Competences & RDI topics:

- Multi-criteria assessment and environmental management
  - Analysis and management of material and energy flows
  - Life cycle assessment of products, processes and services, eco-design
  - Assessment and management of environmental risks
- Clean technologies and process engineering
  - Instrumentation, control and automation
  - Process optimization through modeling and simulation
- Environmental modeling
  - Integrated modeling and meta-modeling
  - Analysis and management of spatial data

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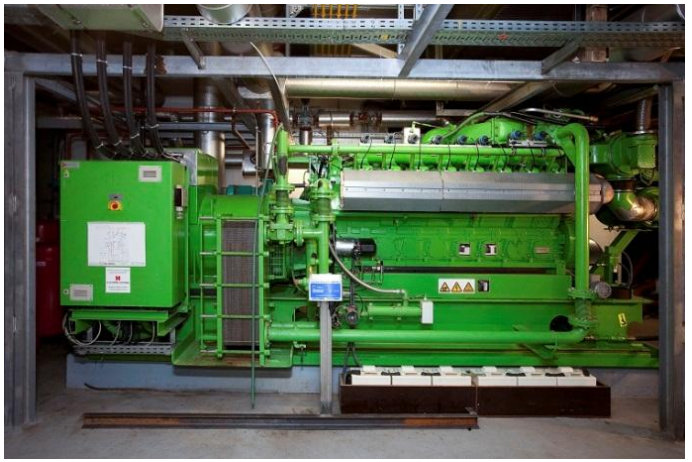


Project description

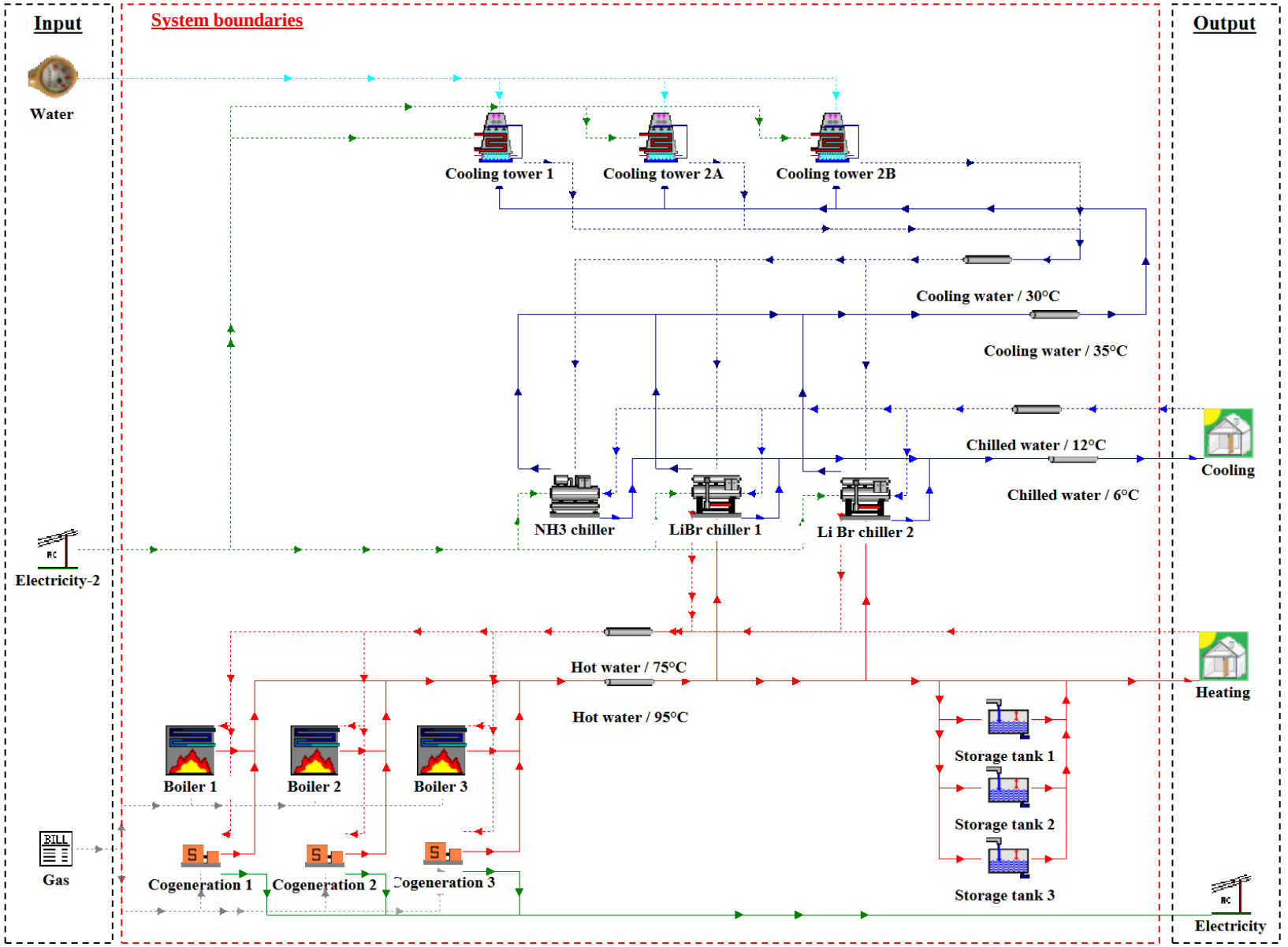
- Country: Luxembourg
- Site: hospital
- System assessed: combined cooling, heat and power plant (trigeneration)
- Energy data (2009):
  - Natural gas consumption: 2 713 994 Nm3
  - Cooling production: 2 679 MWh
  - Heat production: 16 843 MWh
  - Electricity production: 7 817 MWh

Audit objectives

Particularity: main energy users already monitored – focus instead on the CCHP plant:

- Assessment of the CCHP plant under ideal working conditions
- Assessment of replacement of absorption chillers with mechanical chillers
- Assessment of heat recovery on boilers and NH_3 chiller

CCHP plant


Input
System boundaries
Output
Water
Cooling tower 1
Cooling tower 2A
Cooling tower 2B
Cooling water / 30°C
Cooling water / 35°C
Chilled water / 12°C
Chilled water / 6°C
Cooling
NH3 chiller
LiBr chiller 1
Li Br chiller 2
Electricity-2
Hot water / 75°C
Hot water / 95°C
Heating
Boiler 1
Boiler 2
Boiler 3
Storage tank 1
Storage tank 2
Storage tank 3
Gas
Cogeneration 1
Cogeneration 2
Cogeneration 3
Electricity

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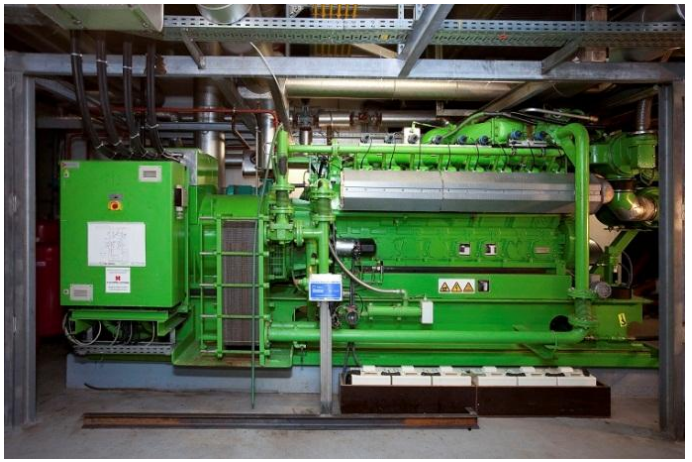
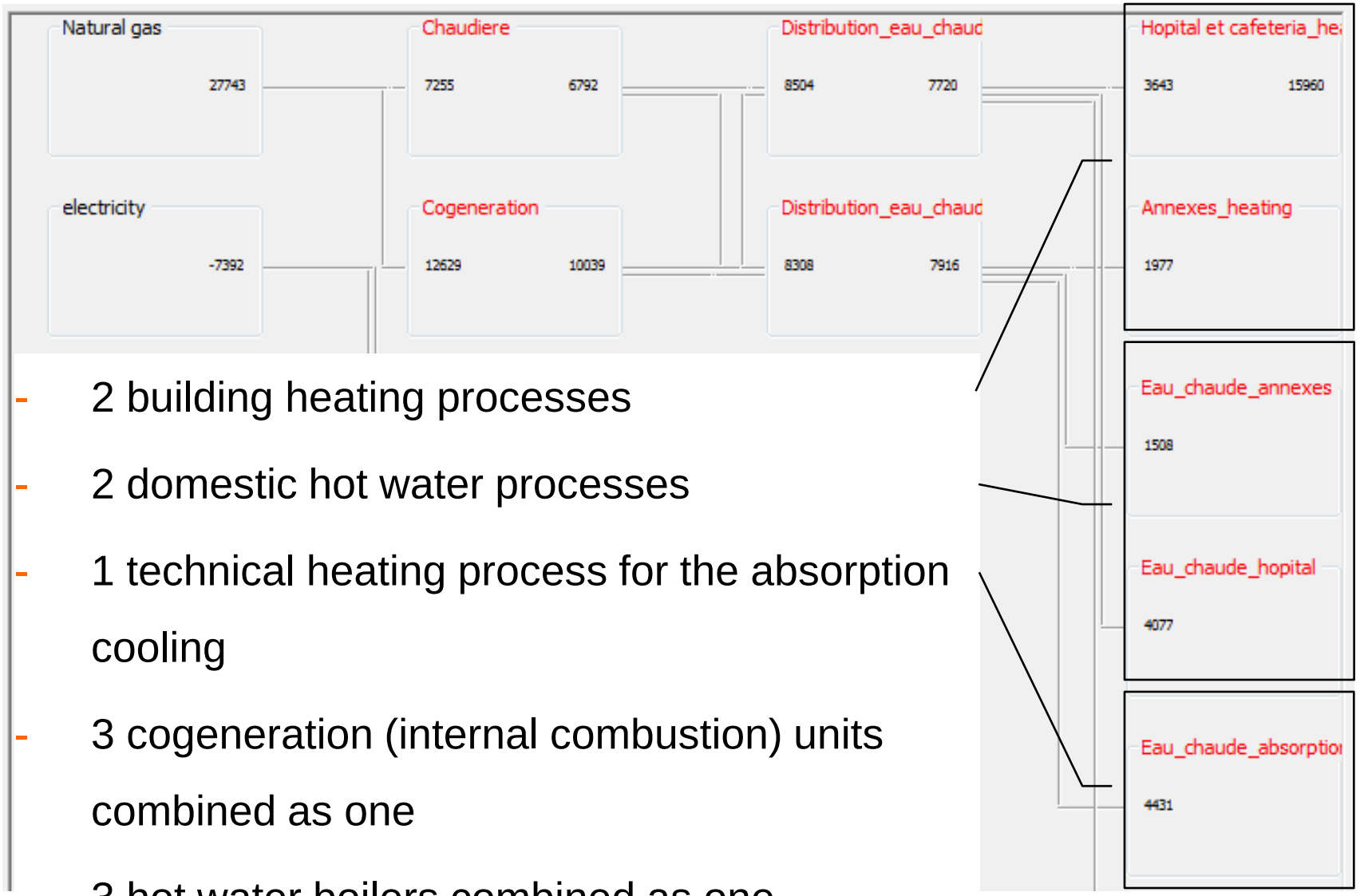


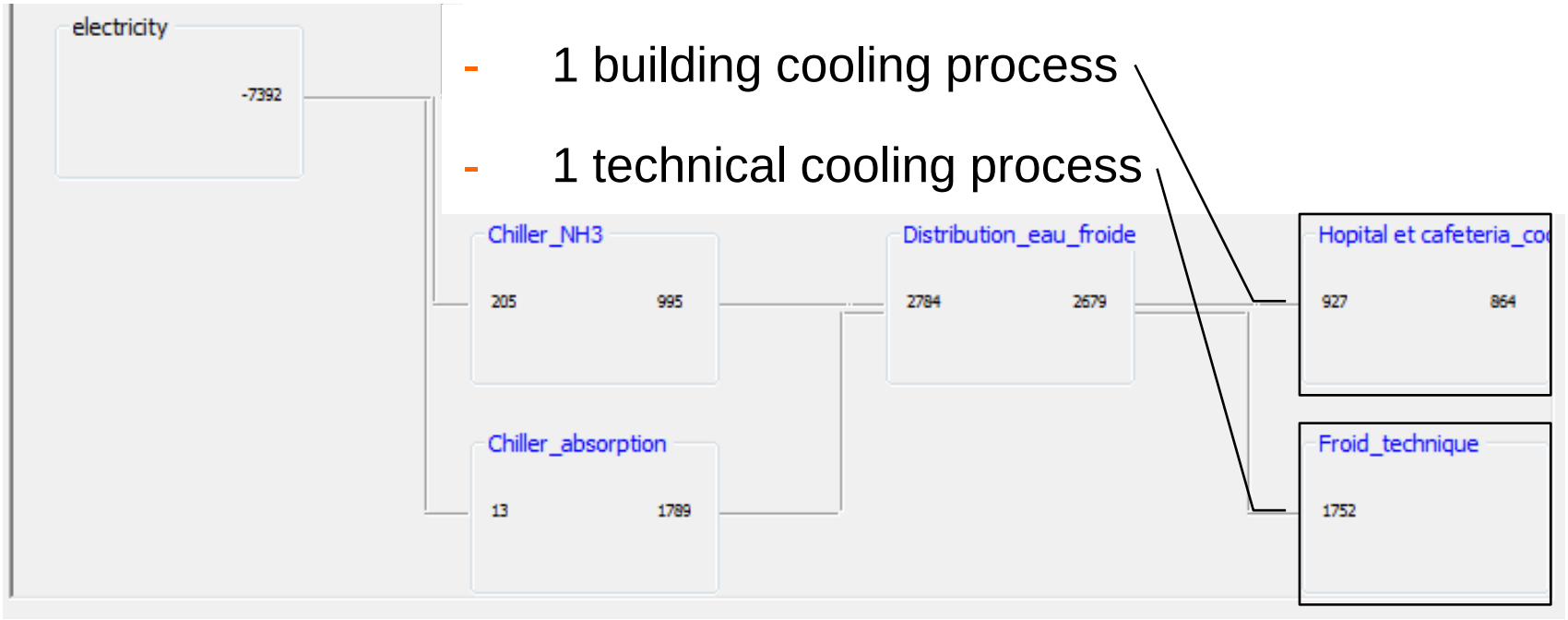
Modelling – Heating (theo.)



- 2 building heating processes
- 2 domestic hot water processes
- 1 technical heating process for the absorption cooling
- 3 cogeneration (internal combustion) units combined as one
- 3 hot water boilers combined as one

Modelling – Cooling (theo.)

- 2 LiBr absorption cooling units combined as one
- 1 NH3 chiller
- 1 building cooling process
- 1 technical cooling process



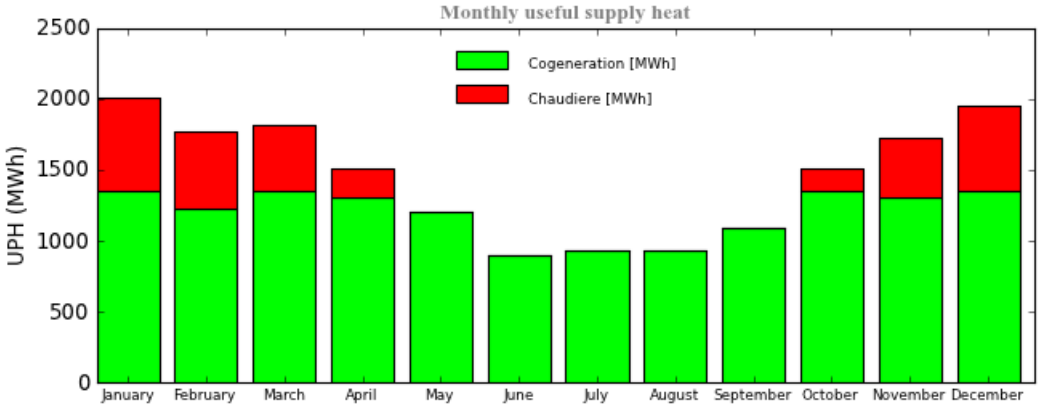
Modelling – Alternative 1

- Objective: assessment of the CCHP plant under ideal working conditions

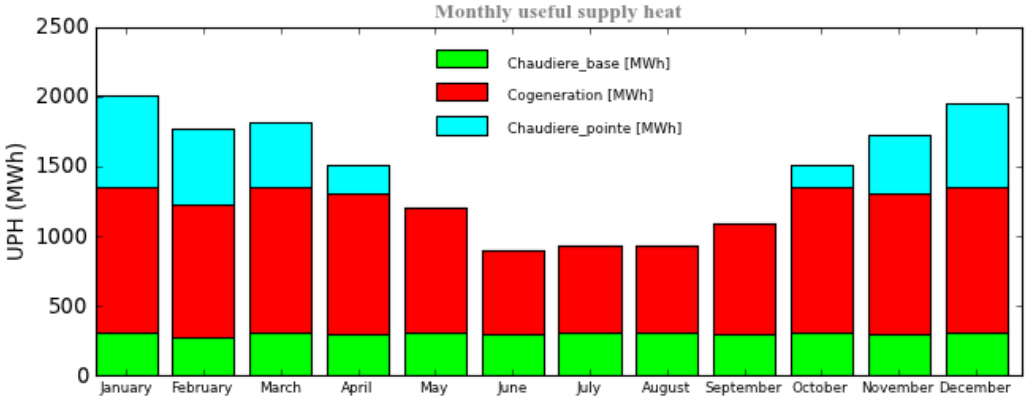
➔ Alternative showing the impact of system interruptions (e.g. for maintenance) and management (CHPs only allowed to work between 6h00 and 22h00 due to noise constrains)

Modelling – Alternative 1

- Alternative 1:



- Real situation (alternative «0»):

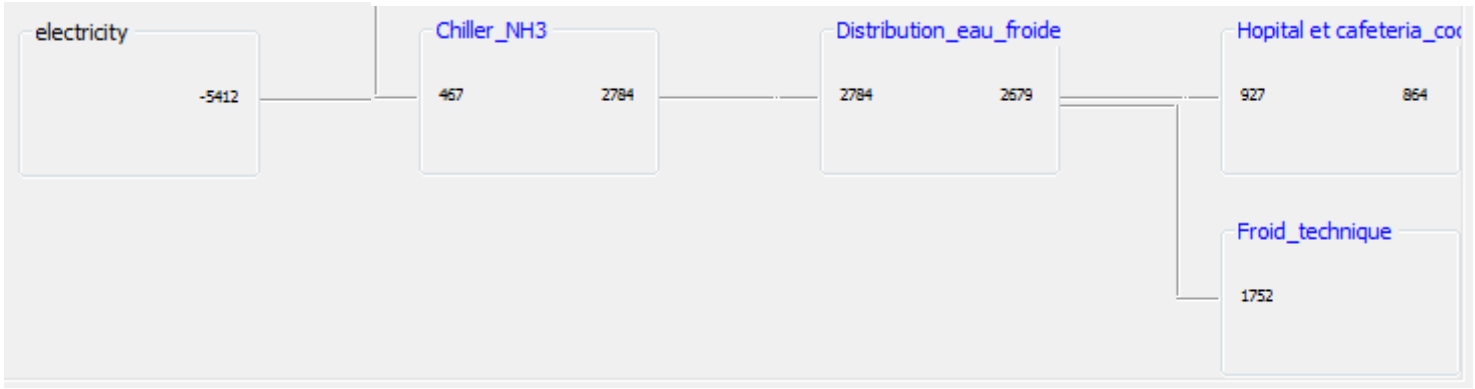


Modelling – Alternative 2

- Objective: assessment of the replacement of the absorption chillers with mechanical chillers

➔ Alternative requested by the hospital, as CHPs limited in their working anyway.

➔ Model:



Modelling – Alternative 3

- Objective: assessment of heat recovery potential on boilers exhaust gas and NH_3 chiller

➔ Exhaust gas exit at 223°C, therefore yielding a certain potential for recovery

➔ Heat sources are the hot water demand of the 2 buildings and the heating of the main building

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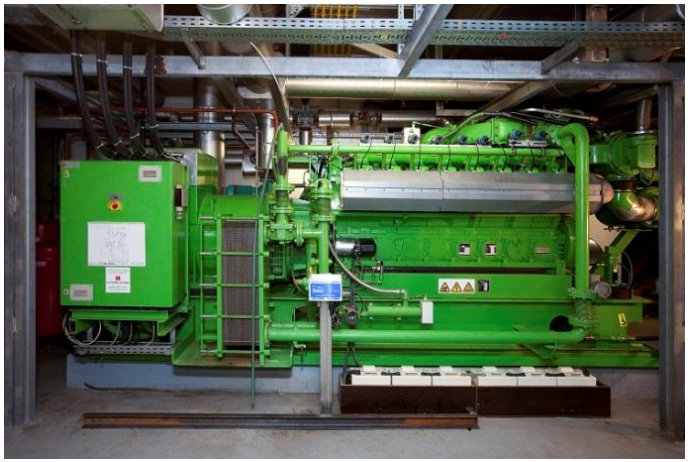
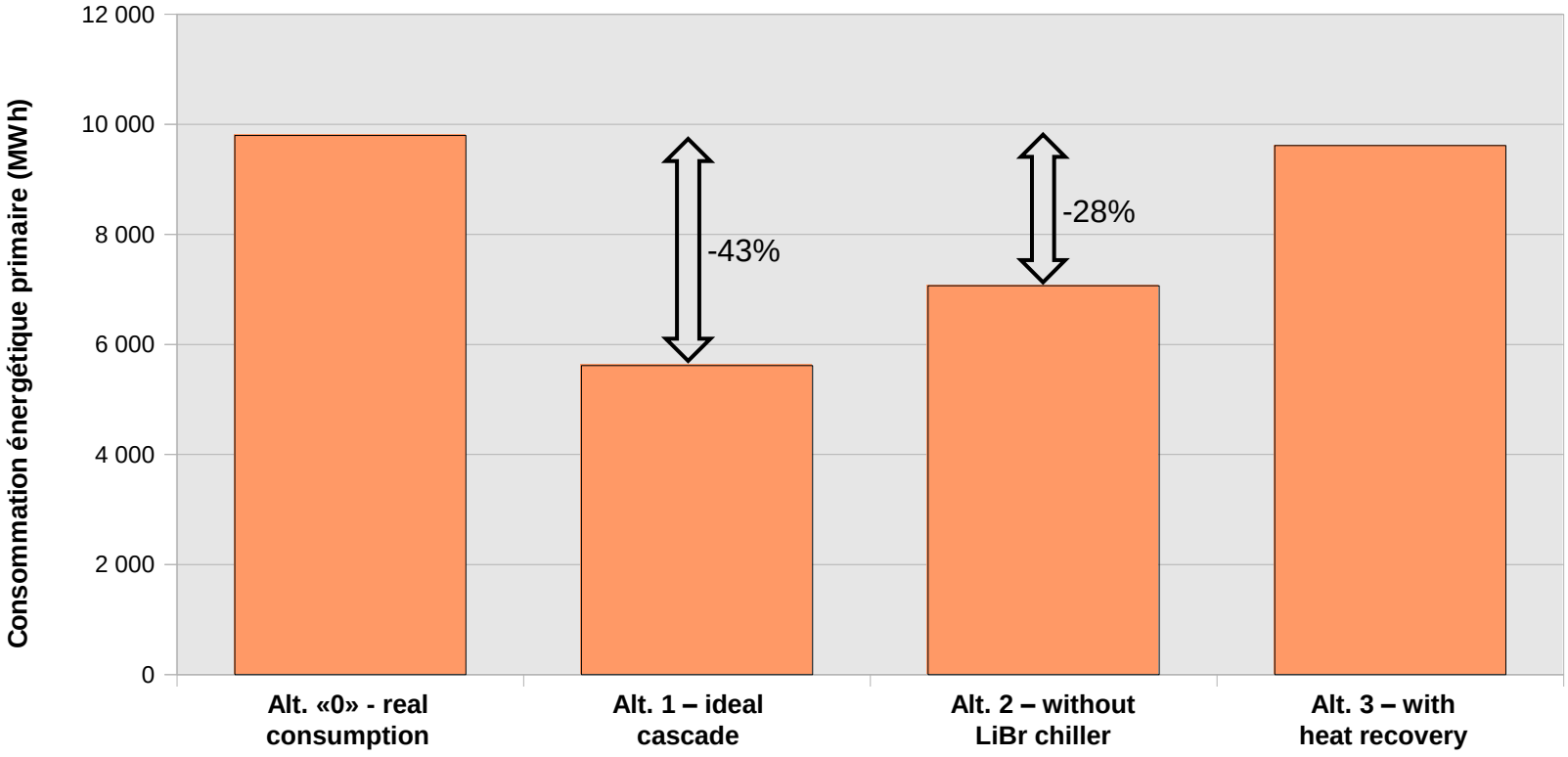
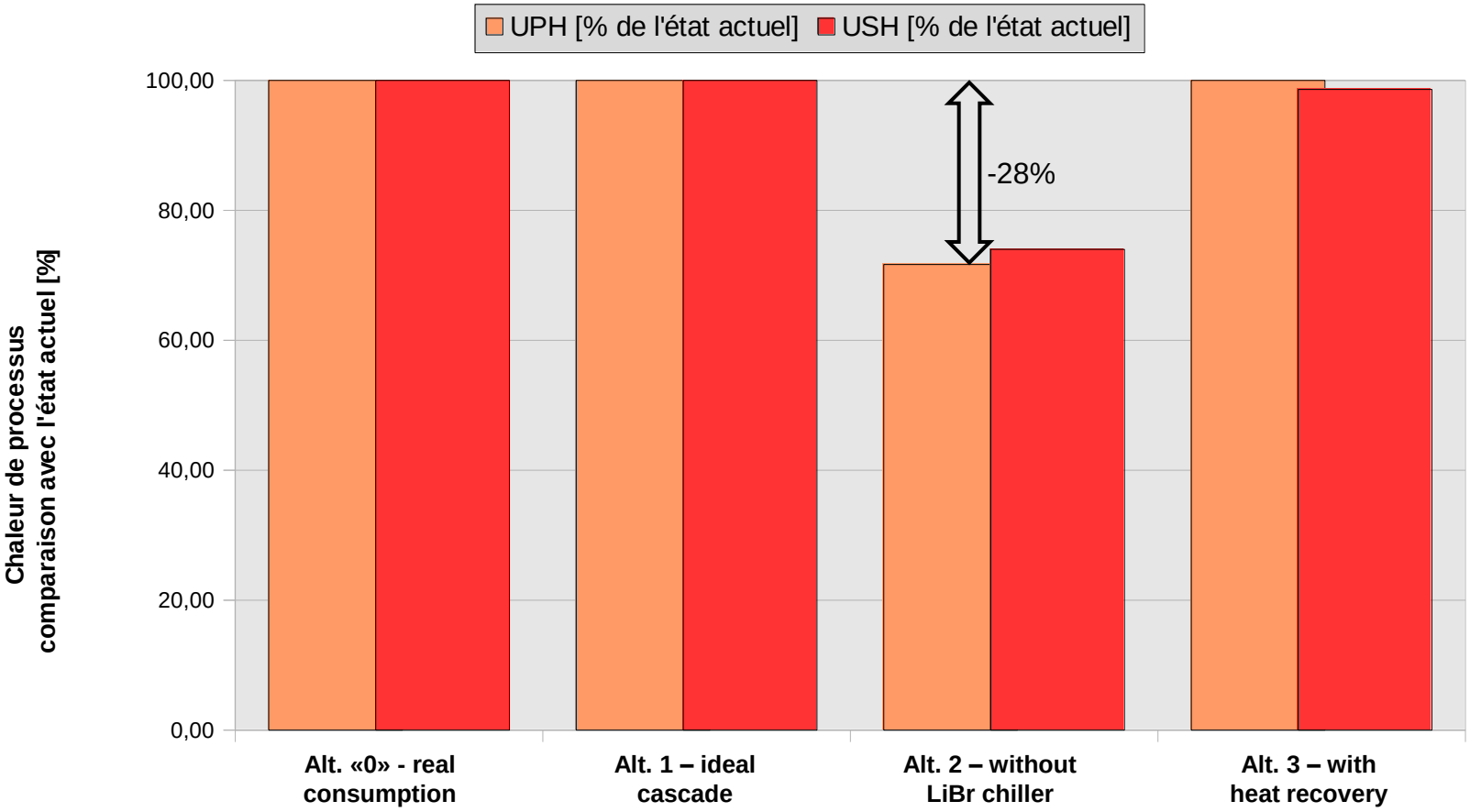


Outcomes – Primary energy

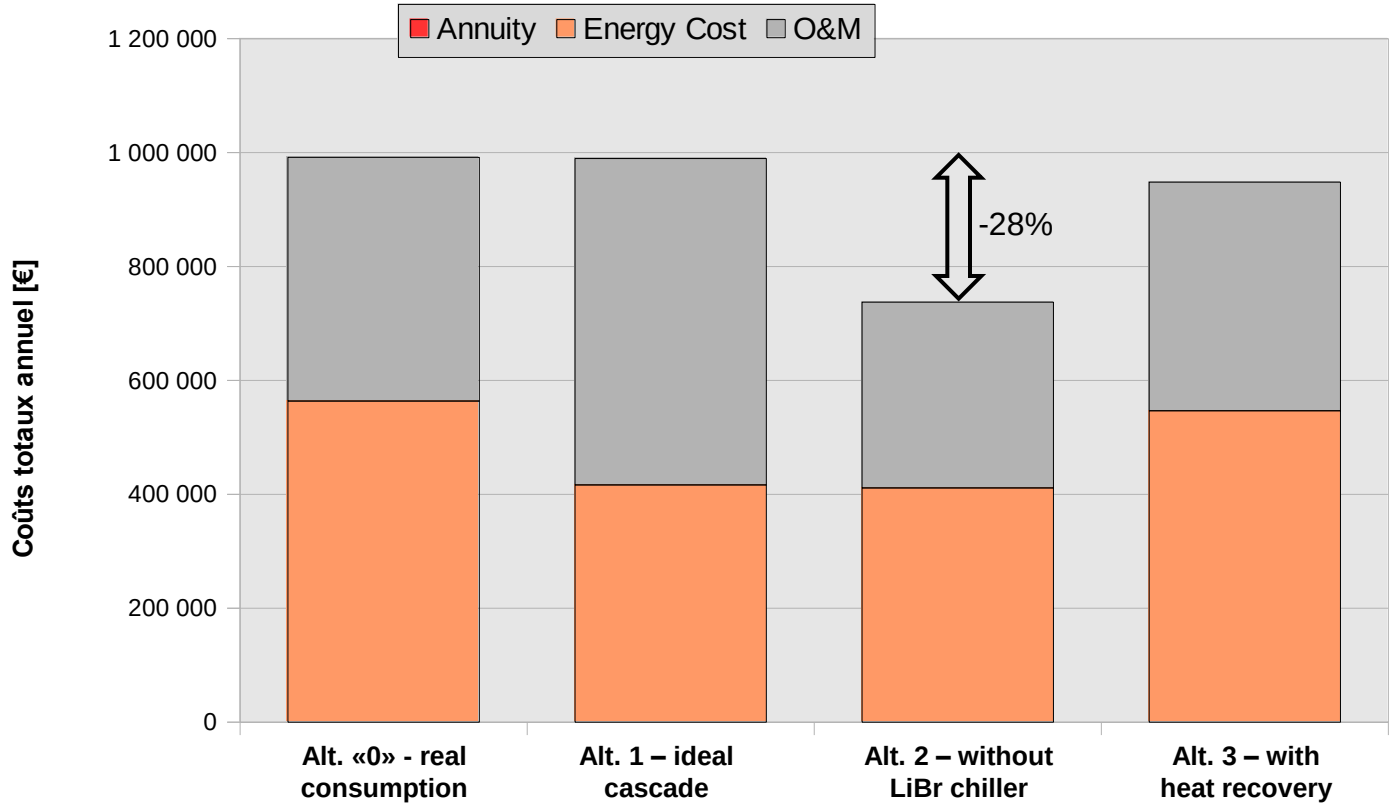


Primary energy factor of Luxemburgish electricity mix: 3,0

Outcomes – UPH / USH



Outcomes – Annual costs



Conclusions

1. Modelling of a real CCHP plant requires a different approach to reflect real equipment behaviour
2. EINSTEIN can be used to calculate the ideal behaviour of a system
3. Avoiding the LiBr chiller would reduce certain environmental impacts (radioactive waste, water consumption) and costs

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Centre de Ressources des Technologies pour l'Environnement

INTELLIGENT ENERGY EUROPE

EINSTEIN thermal energy industry audit

Thank you for your attention

Any questions?

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www.crte.lu