Modelling an existing combined cooling, heat and power plant in EINSTEIN – tips and tricks

Alex Bertrand,

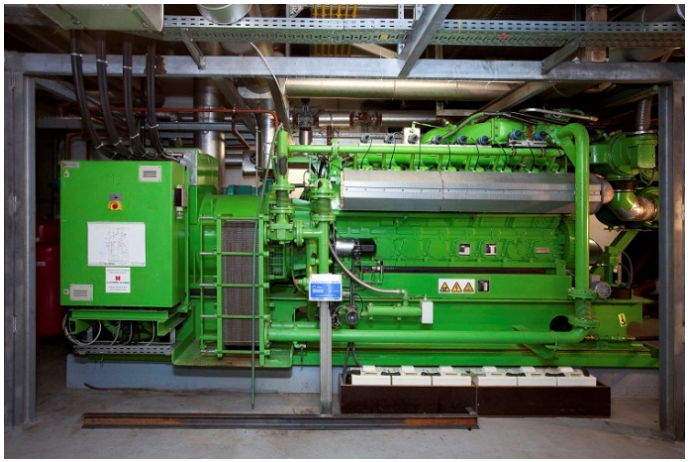
Public Research Centre Henri Tudor, Luxembourg

30th of May, 2012

EINSTEIN II User and Developer day

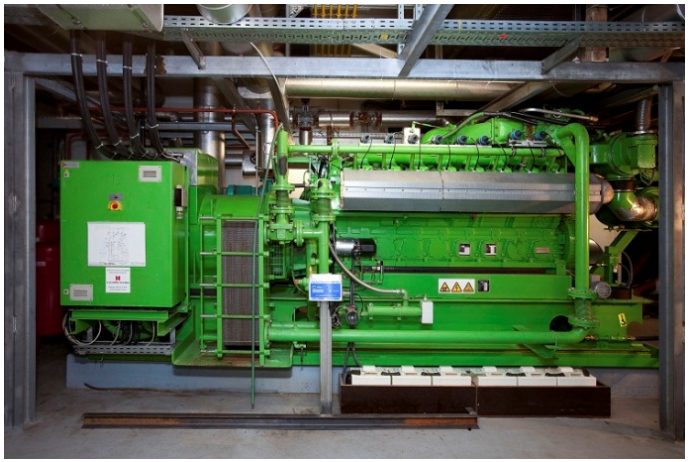
Presentation structure

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



Presentation structure

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



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

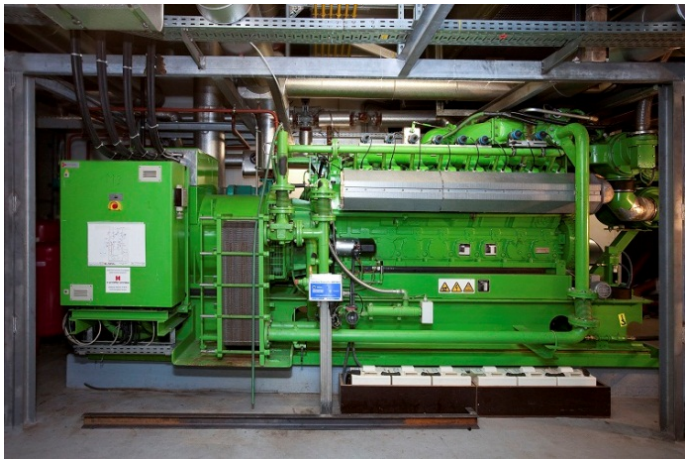
- Foster eco-innovation and support the implementation of ecotechnologies by adopting an integrated and pro-active approach

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

Presentation structure

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



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

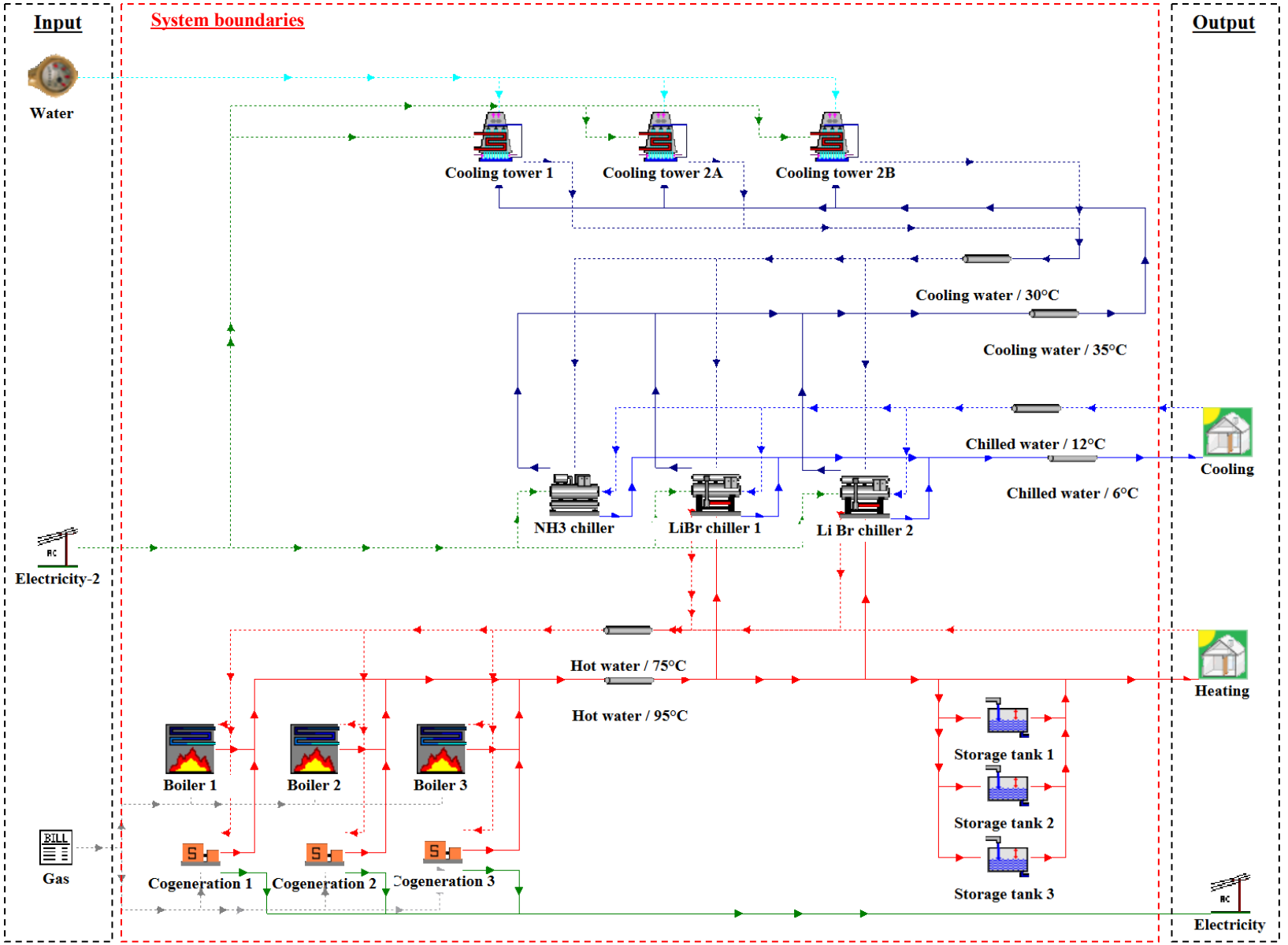
-Assessment of heat recovery on boilers and NH_3 chiller

tudor
Centre de Ressources des Technologies pour l'Environnement

INTELLIGENT ENERGY EUROPE

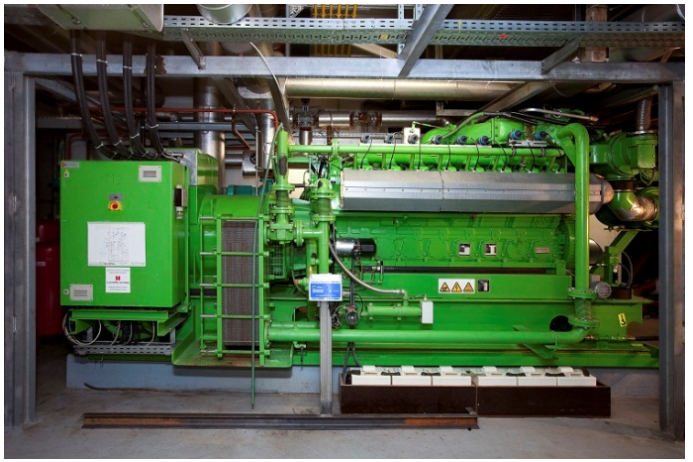
CCHP plant

EINSTEIN thermal energy industry audit

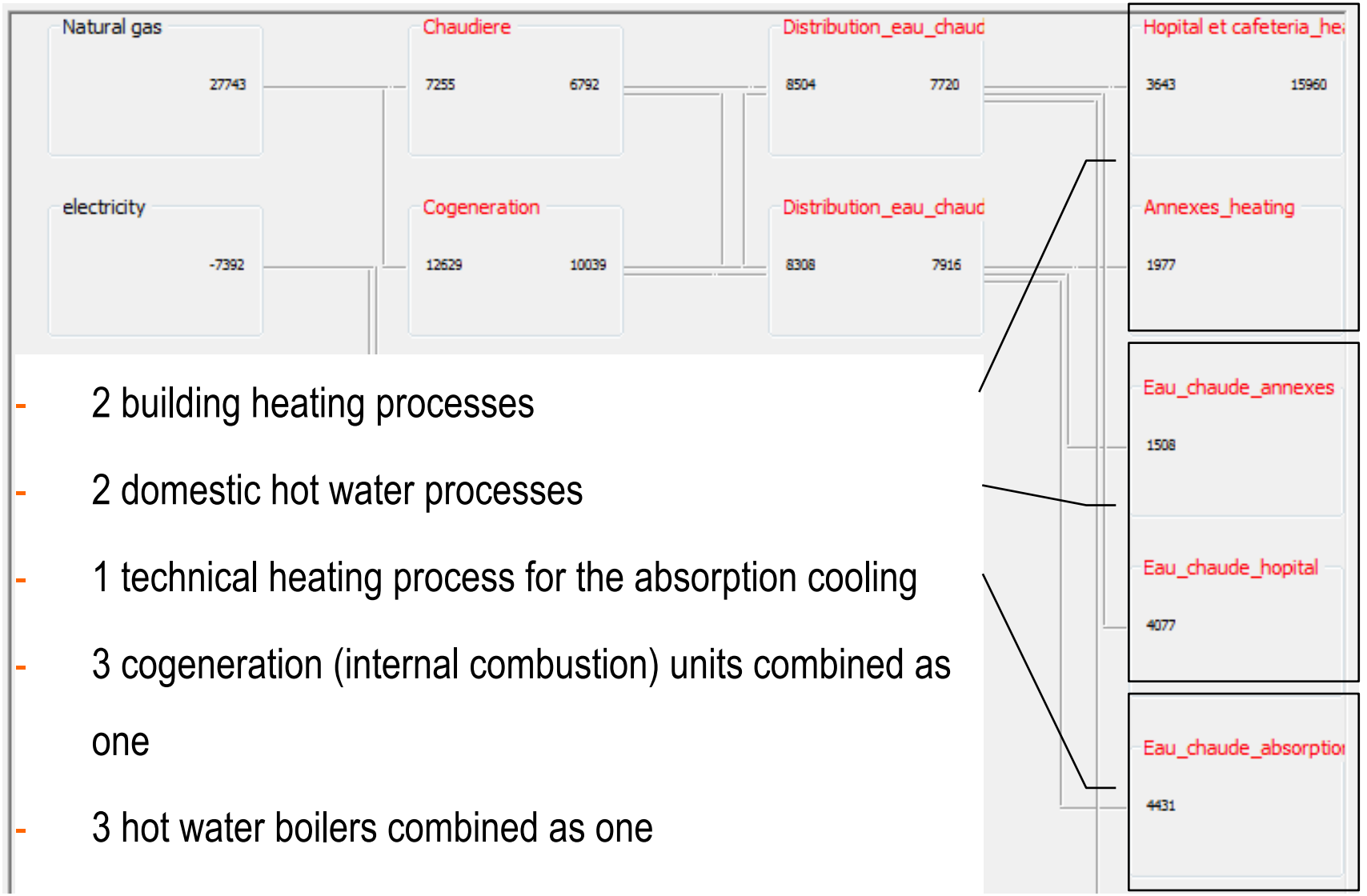


Presentation structure

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



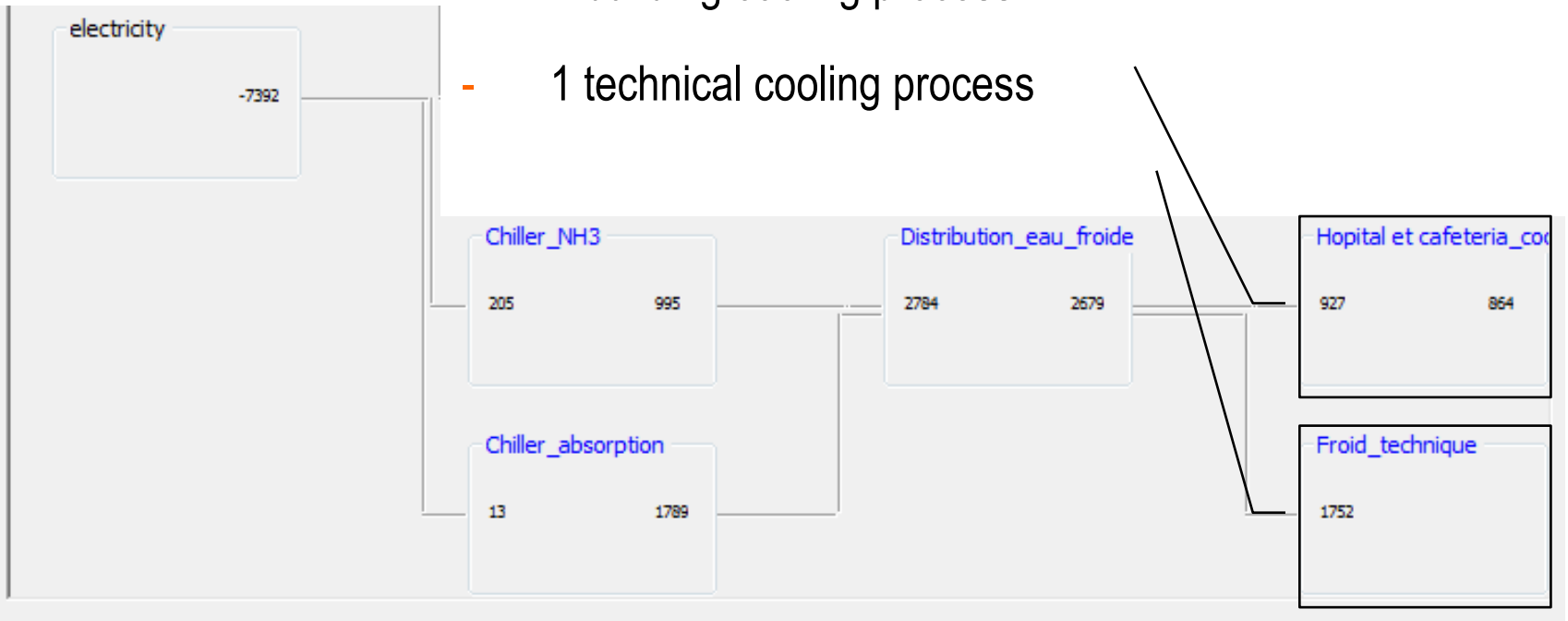
Modelling – Heating (theo.)



- 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

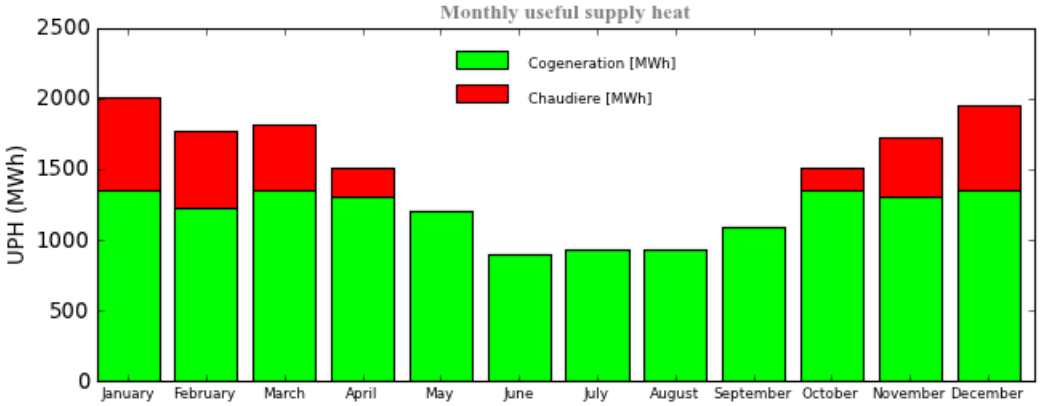
Modelling – Cooling (theo.)

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

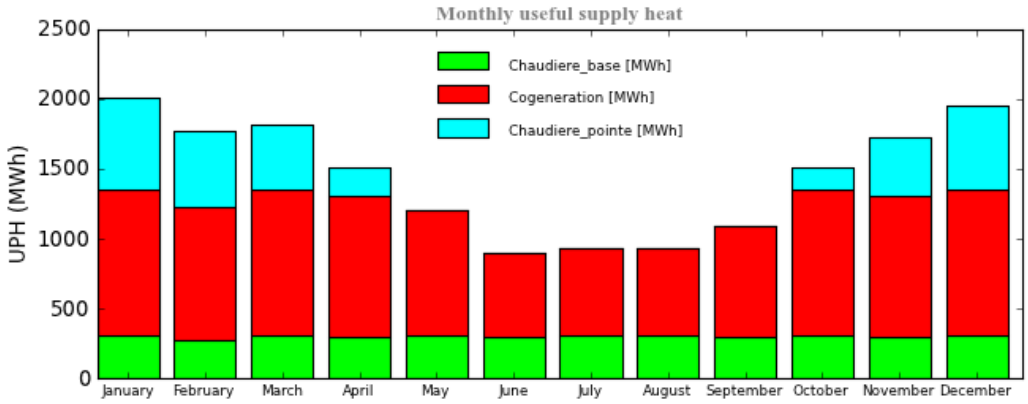


Modelling – Difficulties

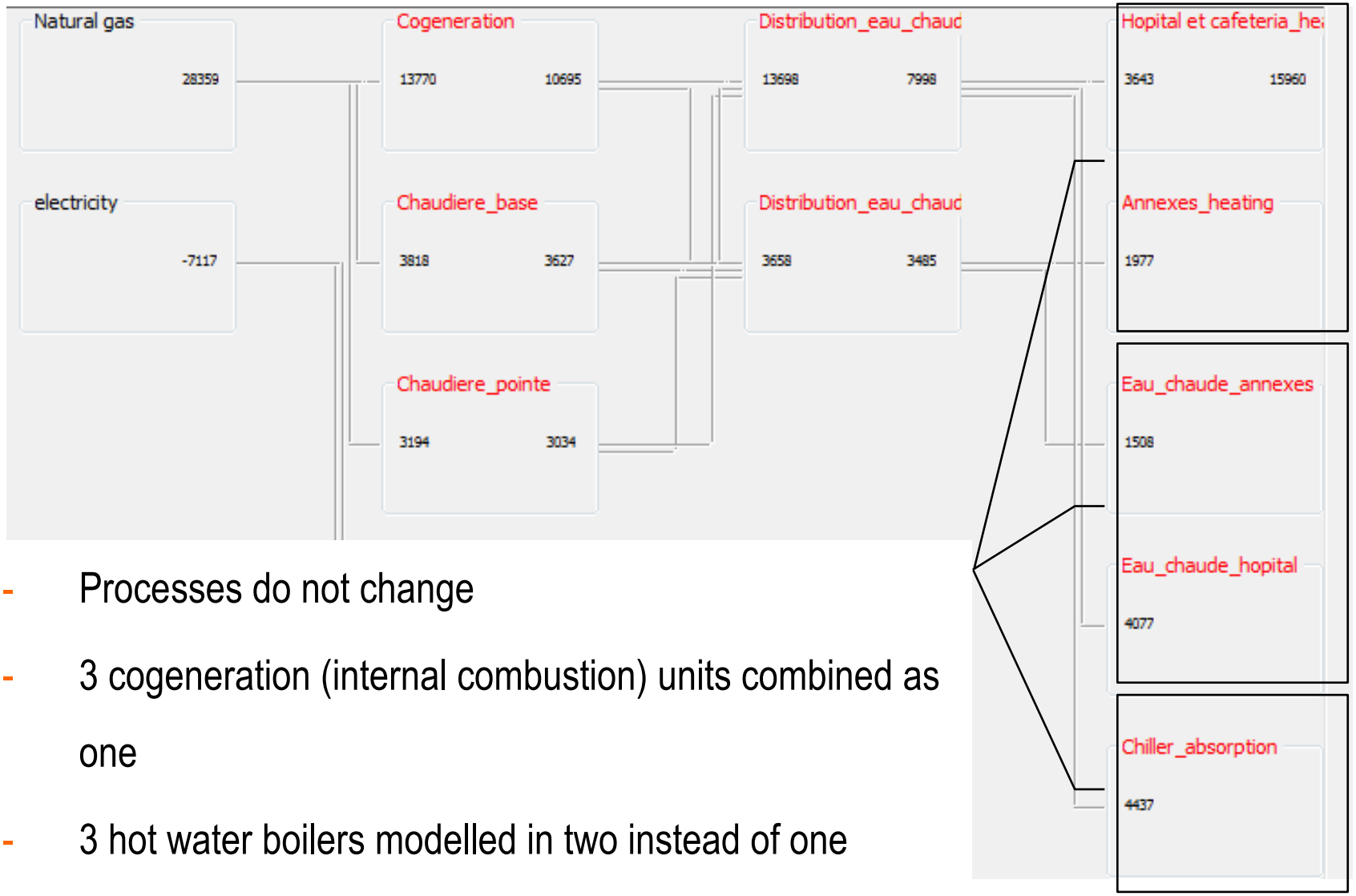
- Ideal, basic «EINSTEIN», situation:



- Real situation:



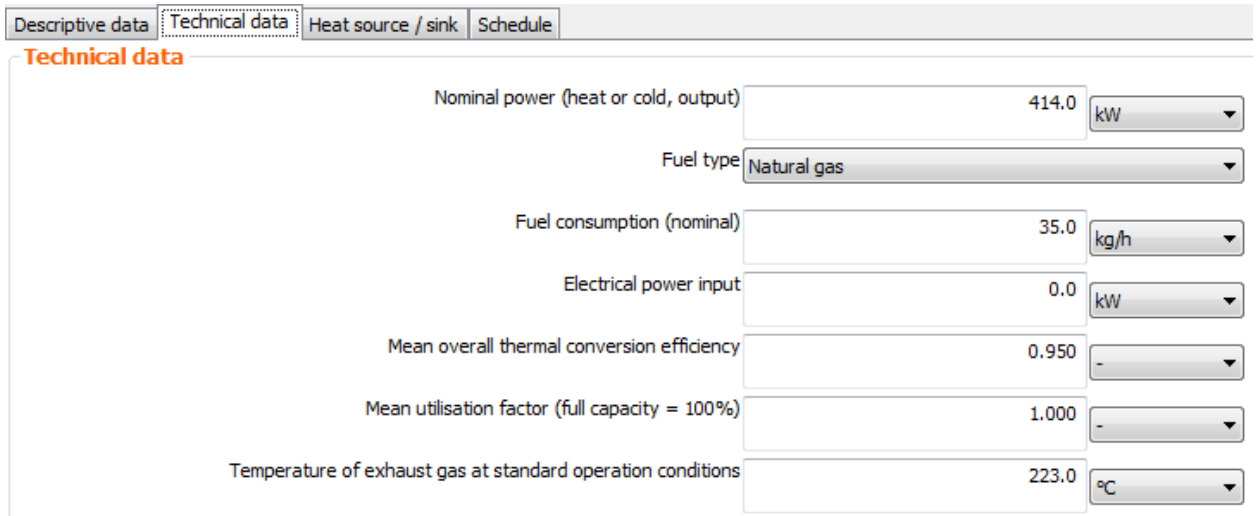
Modelling – Heating (real)



- Processes do not change
- 3 cogeneration (internal combustion) units combined as one
- 3 hot water boilers modelled in two instead of one (iterative approach for calibration)

Modelling – Iter. process

1. Position the equipment in the heat cascade
2. Define base-load boiler with a mean utilisation factor of «1»
3. Distribute heating power and fuel consumption between the 2 boilers to obtain the correct USH between the equipment



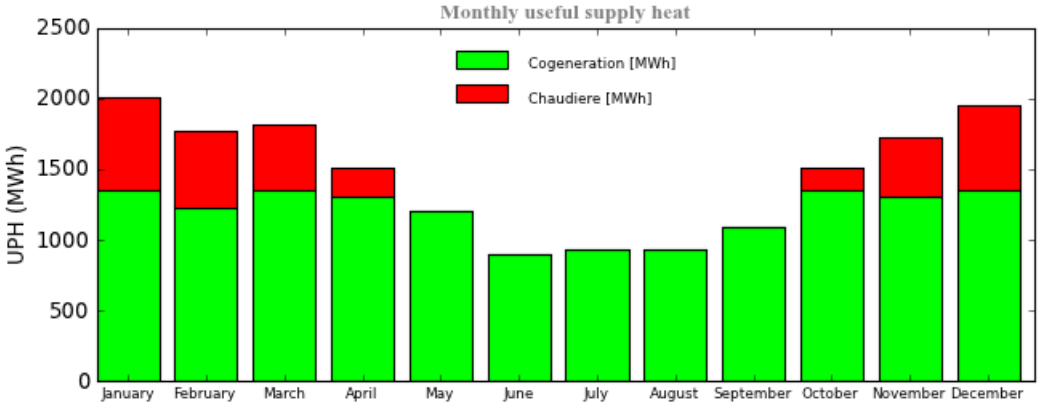
Modelling – Alternative 1

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

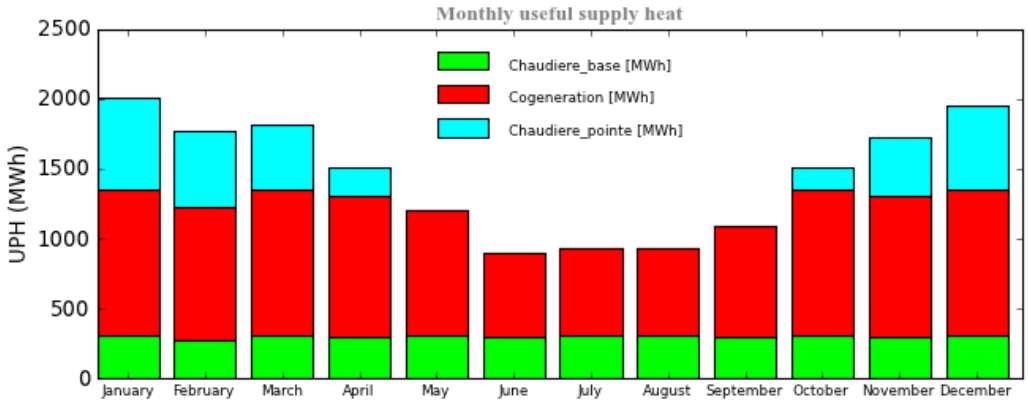
 Alternative showing the impact of system interruptions (e.g. for maintenance) and management (CHPs only allowed to work between 6h00 and 22h00 due to noise constrains)

Modelling – Alternative 1

- Alternative 1:



- Real situation (alternative «0»):

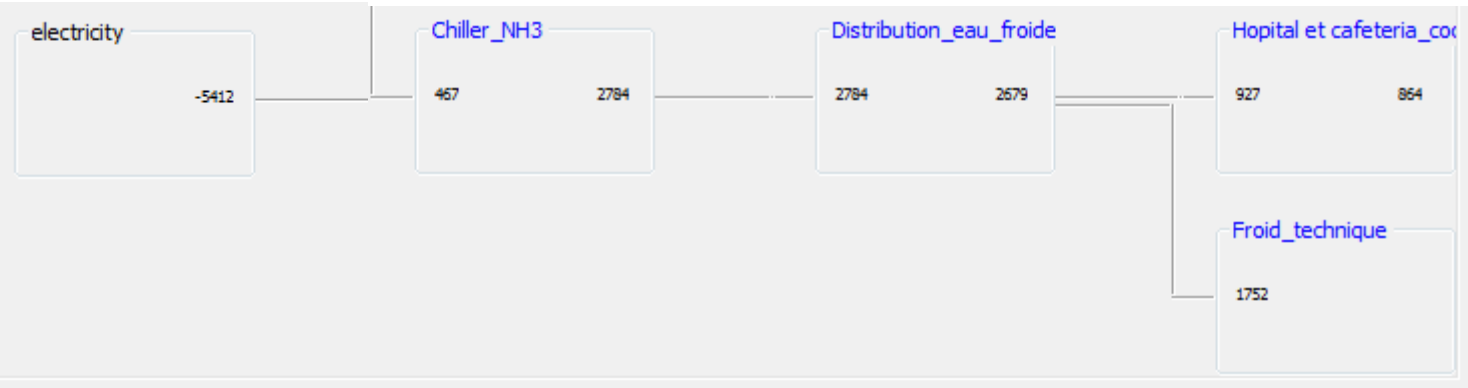


Modelling – Alternative 2

- 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

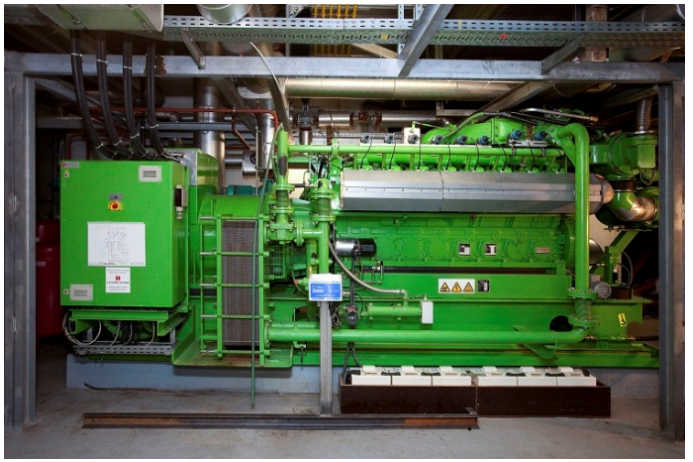
- Objective: assessment of heat recovery potential on boilers exhaust gas and NH_3 chiller

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

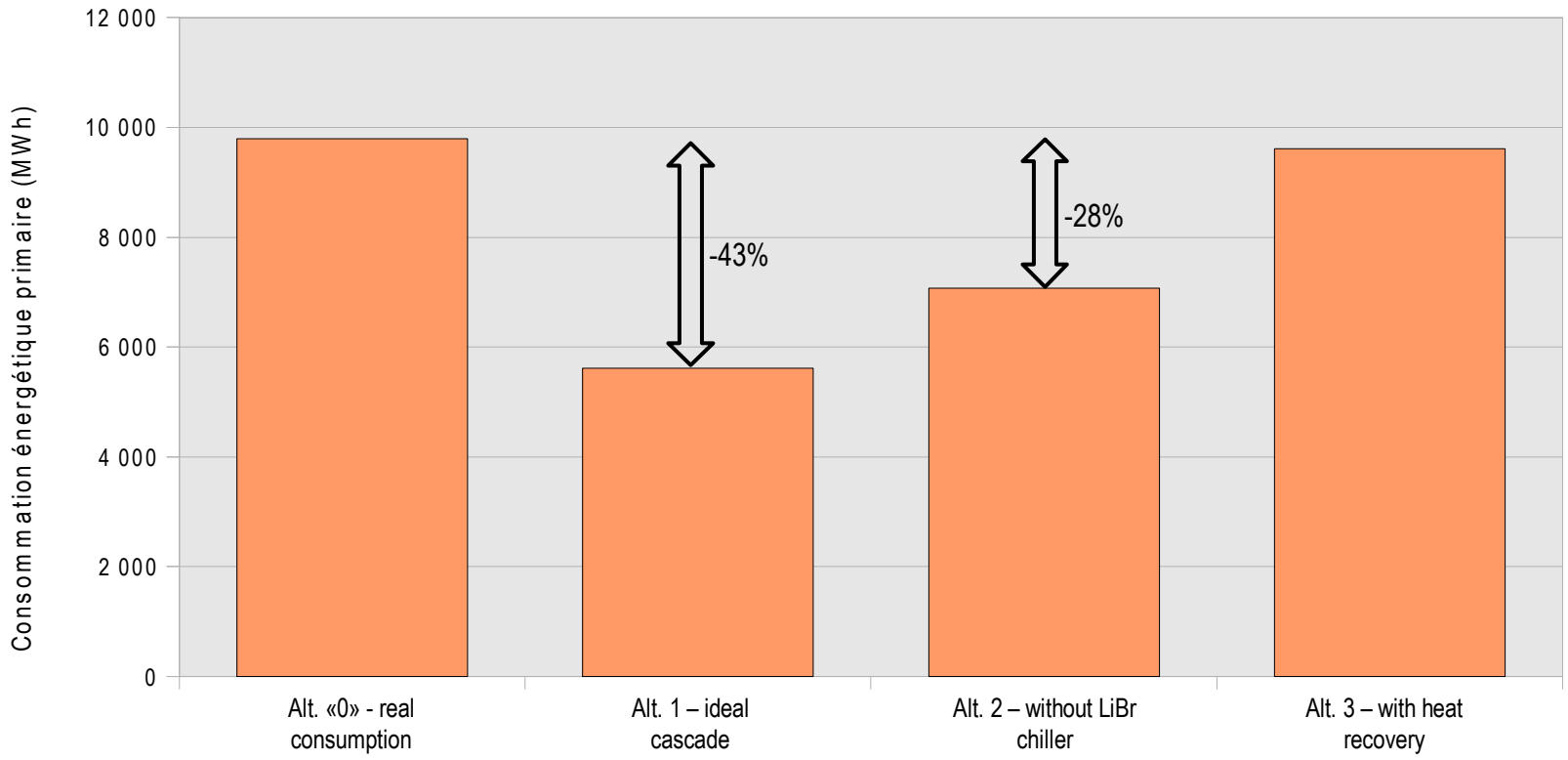
 Heat sources are the hot water demand of the 2 buildings and the heating of the main building

Presentation structure

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



Outcomes – Primary energy



Primary energy factor of Luxemburgish electricity mix: 3,0

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

tudor
Centre de Ressources des Technologies pour l'Environnement

INTELLIGENT ENERGY EUROPE

EINSTEIN thermal energy industry audit

Thank you for your attention

Any questions?

alexandre.bertrand@tudor.lu

www.crte.lu