Some building models for (solar) heating and cooling systems

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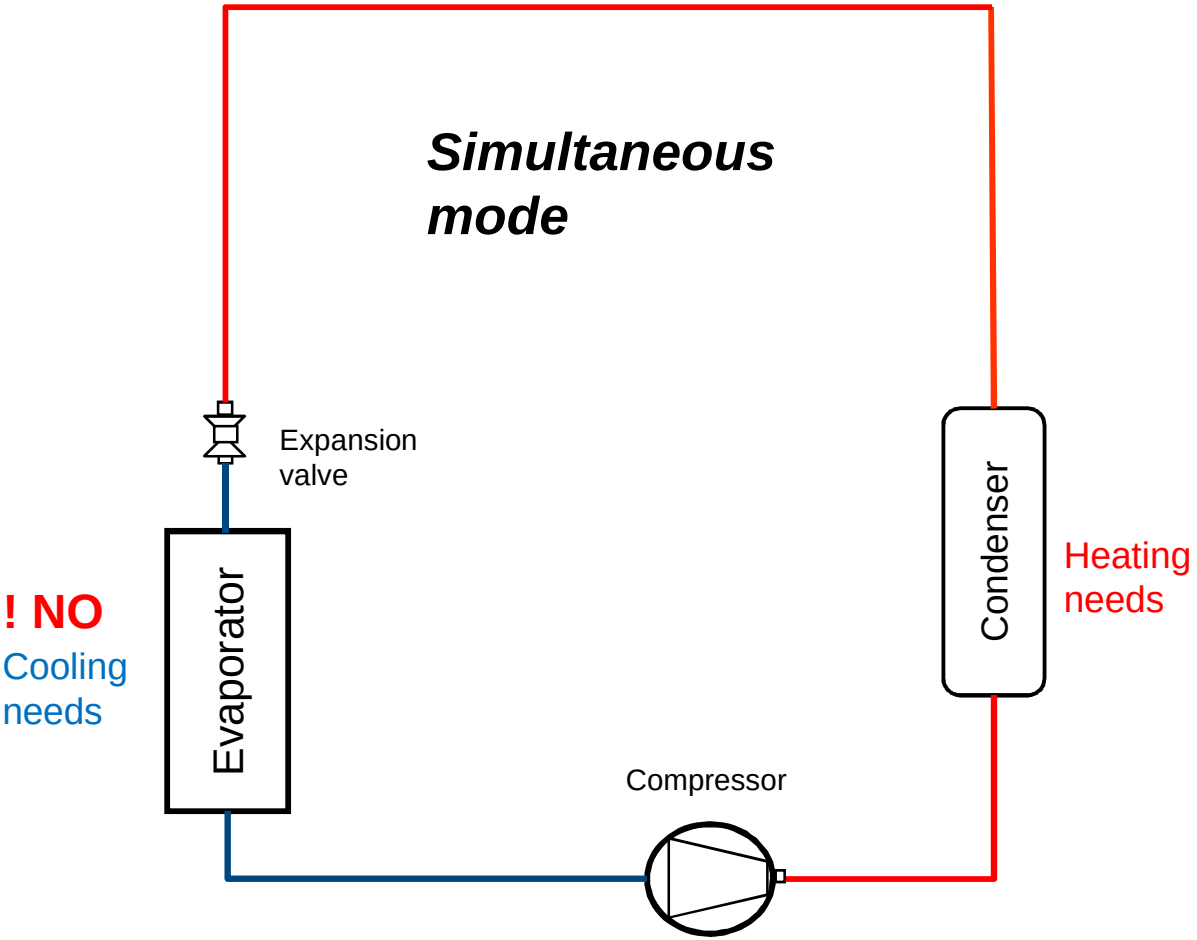
Introduction

- **Results of 2 PhD theses**
- **Trnsys for buildings**
- **EES for heat pumps for simultaneous heating and cooling**

TRNSYS 17

Engineering Equation Solver

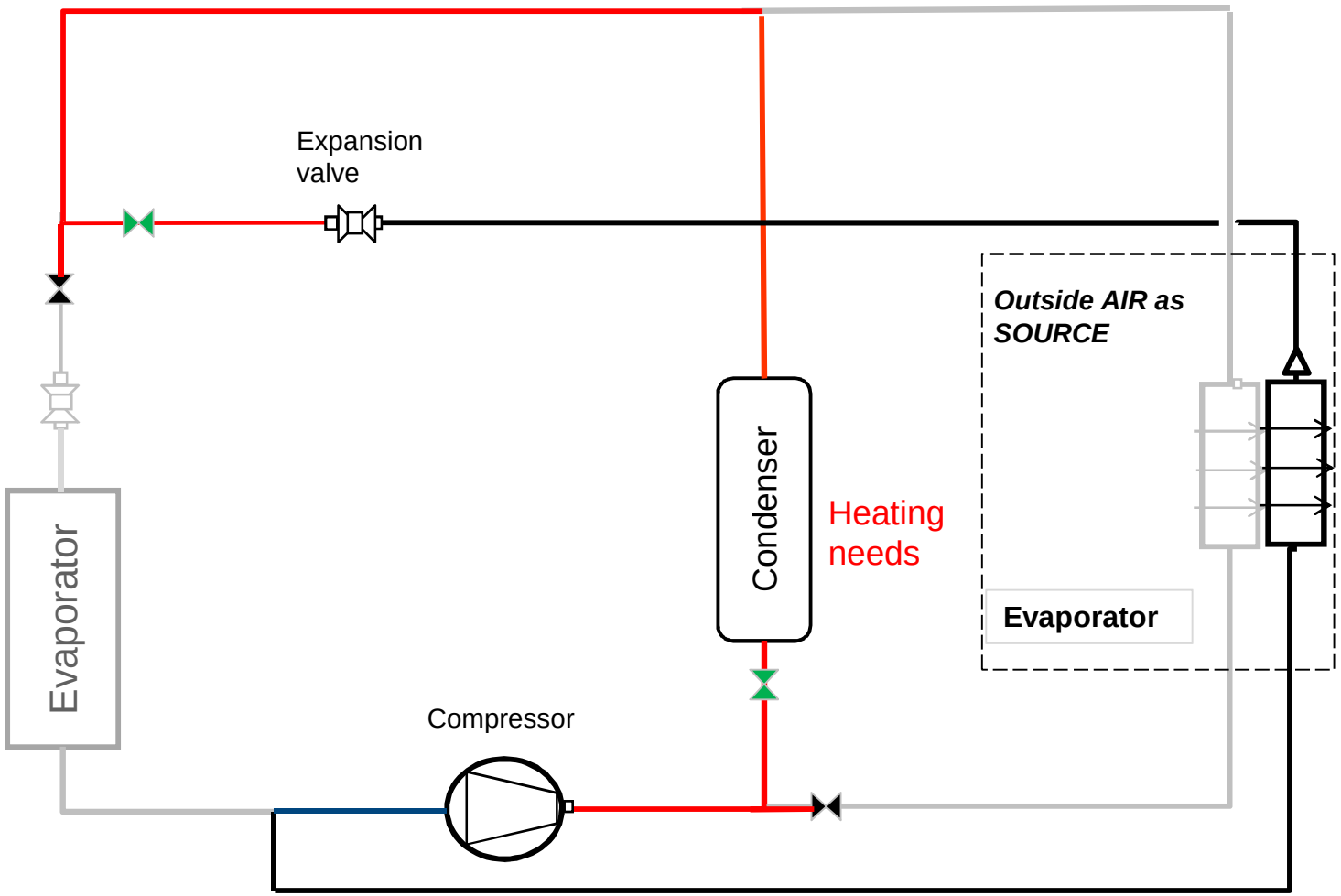
Heat pump for simultaneous heating and cooling



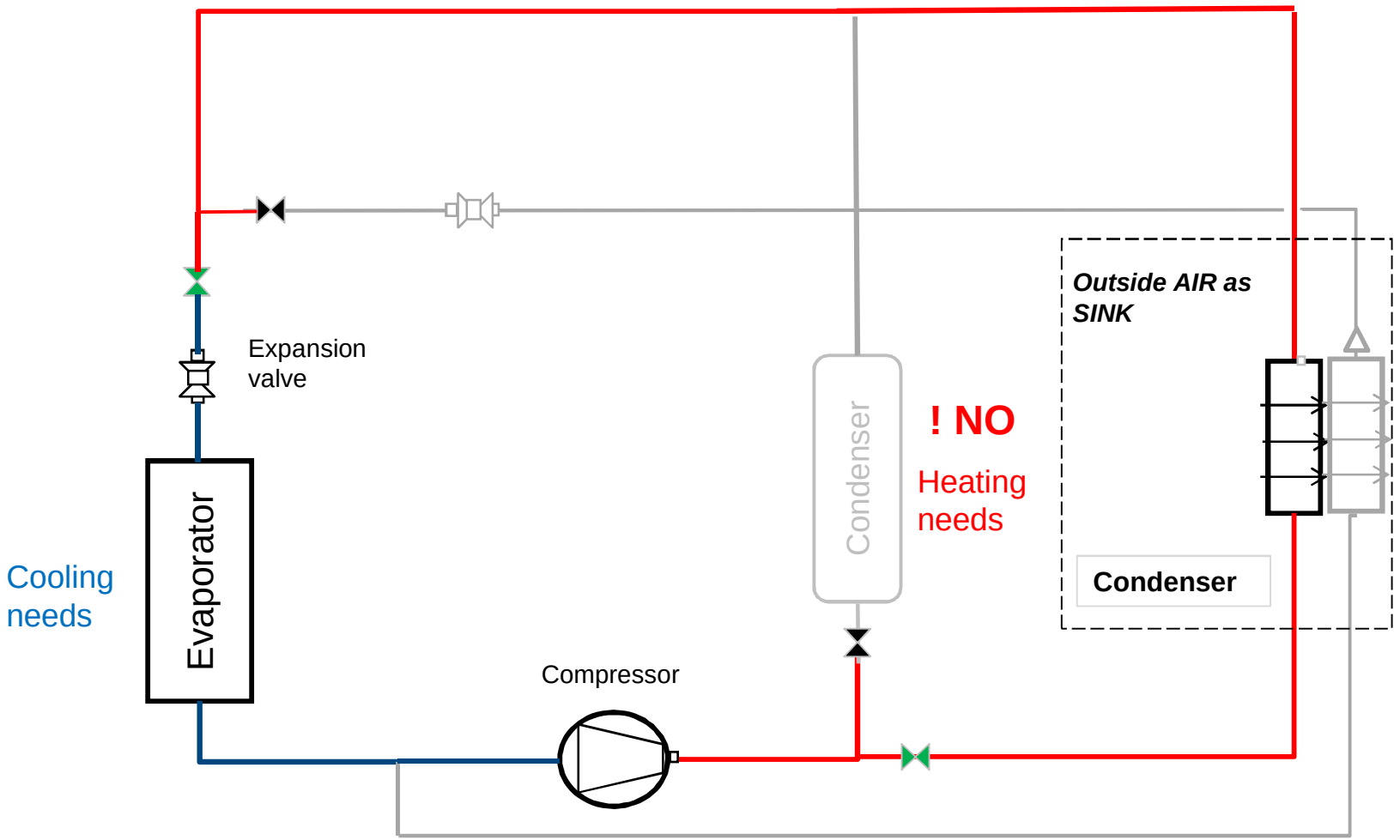
Heating mode

! NO

Cooling needs



Cooling mode



Modelled buildings

1. Hotel

2. Low-energy residential collective building

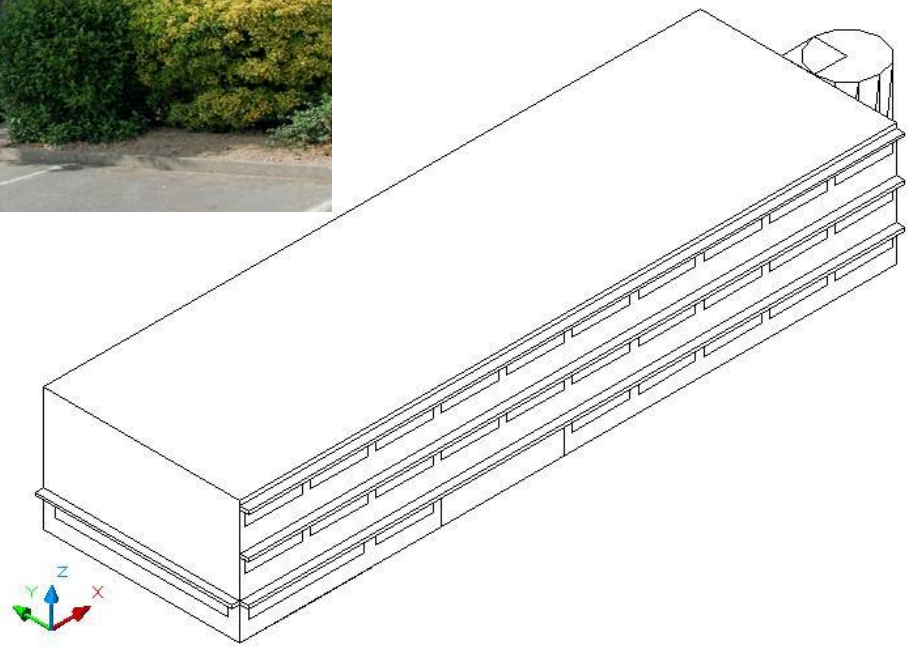
3. Office building

4. Retail store

1. Hotel description

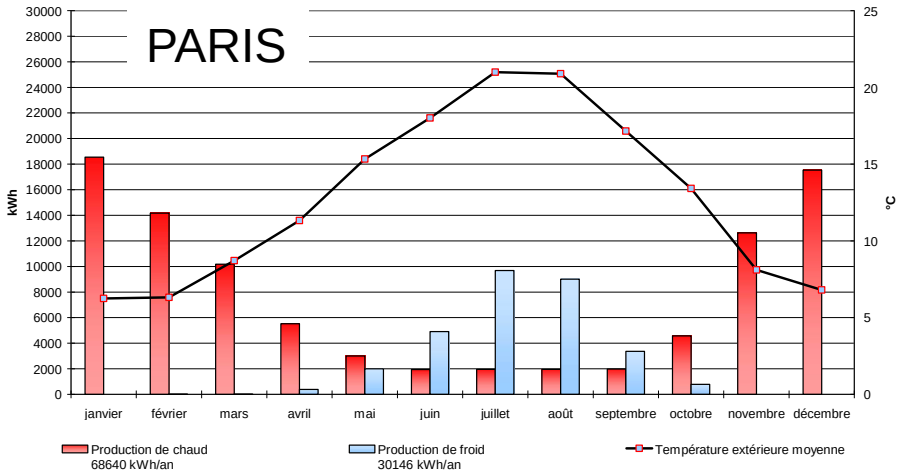
- **Campanile Hotel nearby University**

- **45 bedrooms**
- **Hotel.doc**

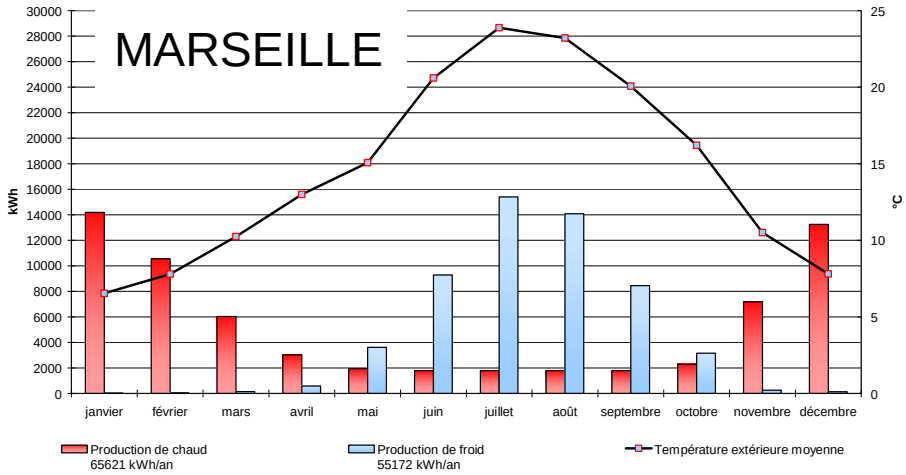


Hourly and annual evolutions

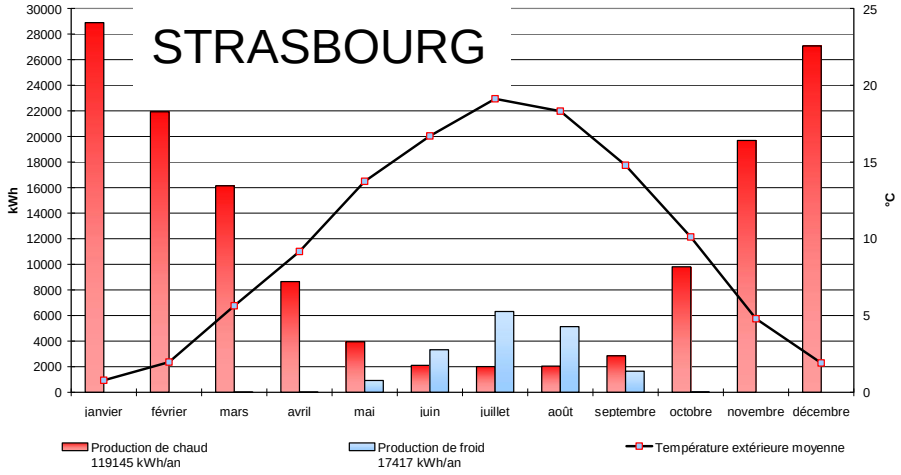
Besoins de chaud (chauffage + production d'ECS) et de froid (rafraîchissement) d'un hôtel de 45 chambres assez fortement vitré à Paris



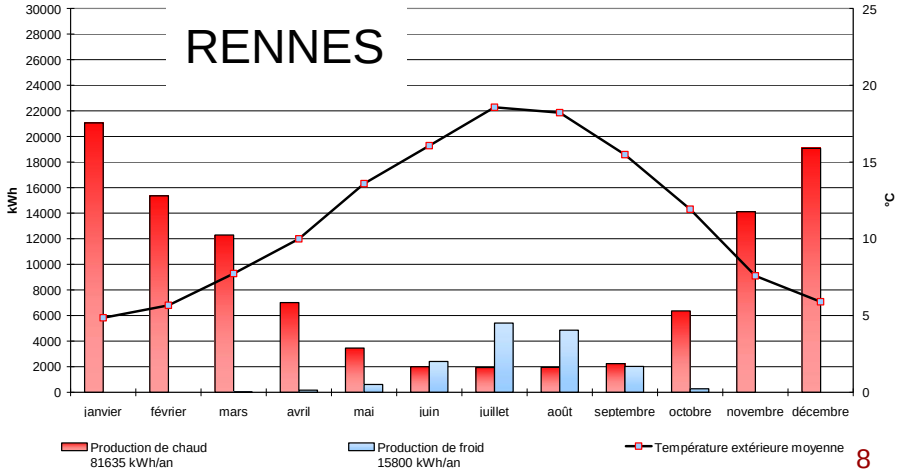
Besoins de chaud (chauffage + production d'ECS) et de froid (rafraîchissement) d'un hôtel de 45 chambres assez fortement vitré à Marseille



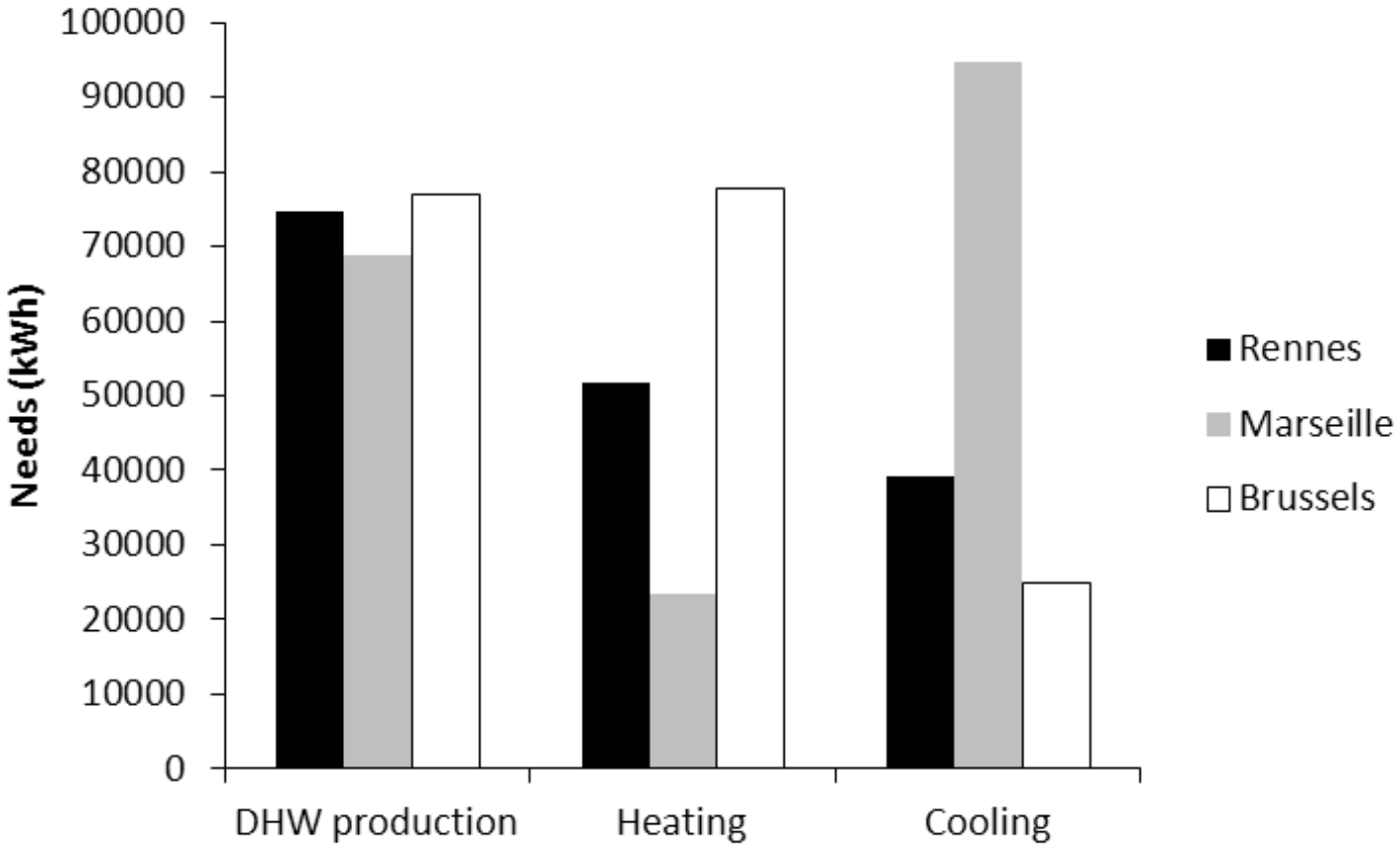
Besoins de chaud (chauffage + production d'ECS) et de froid (rafraîchissement) d'un hôtel de 45 chambres assez fortement vitré à Strasbourg



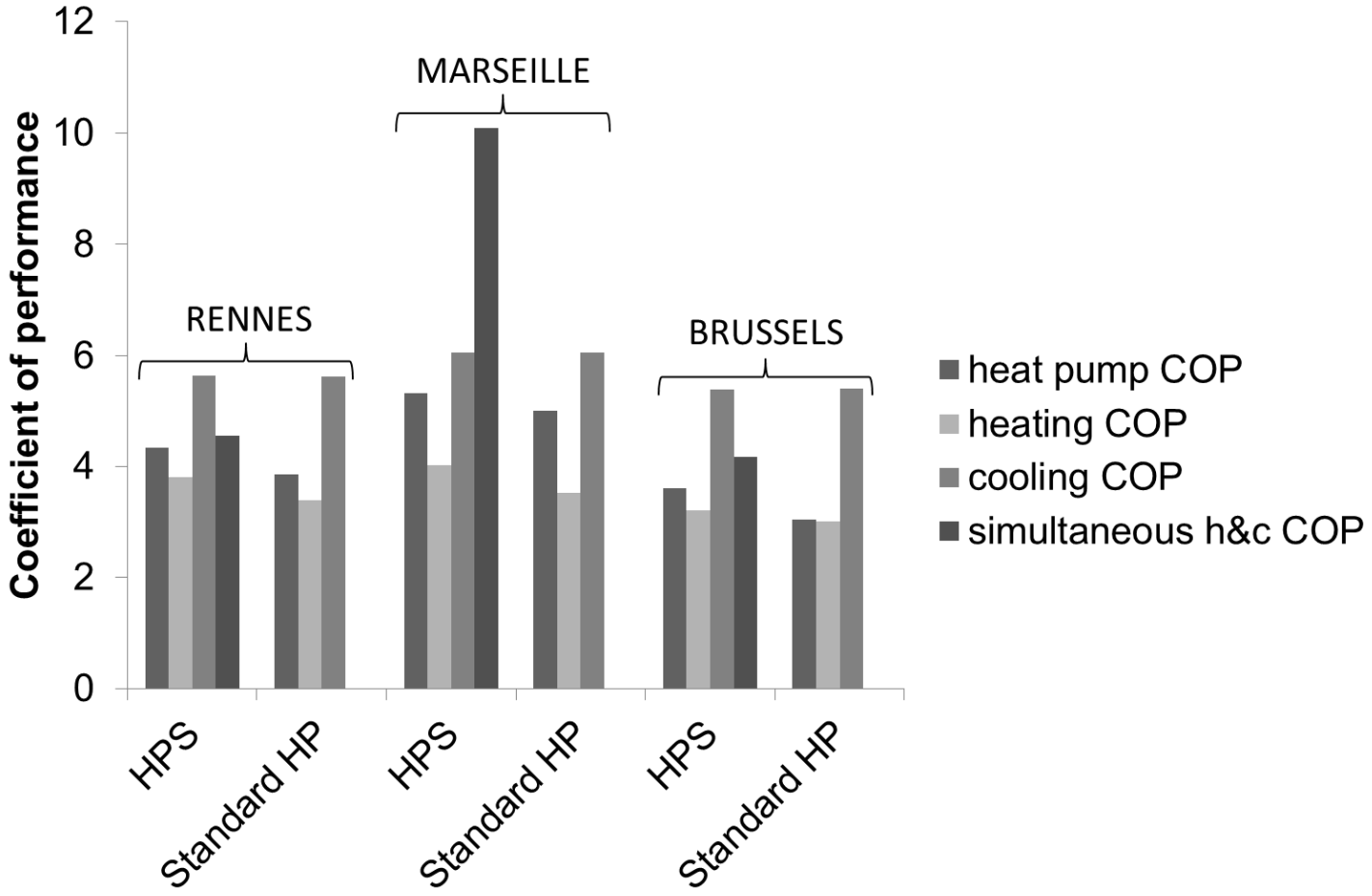
Besoins de chaud (chauffage + production d'ECS) et de froid (rafraîchissement) d'un hôtel de 45 chambres assez fortement vitré à Rennes



Annual thermal demands

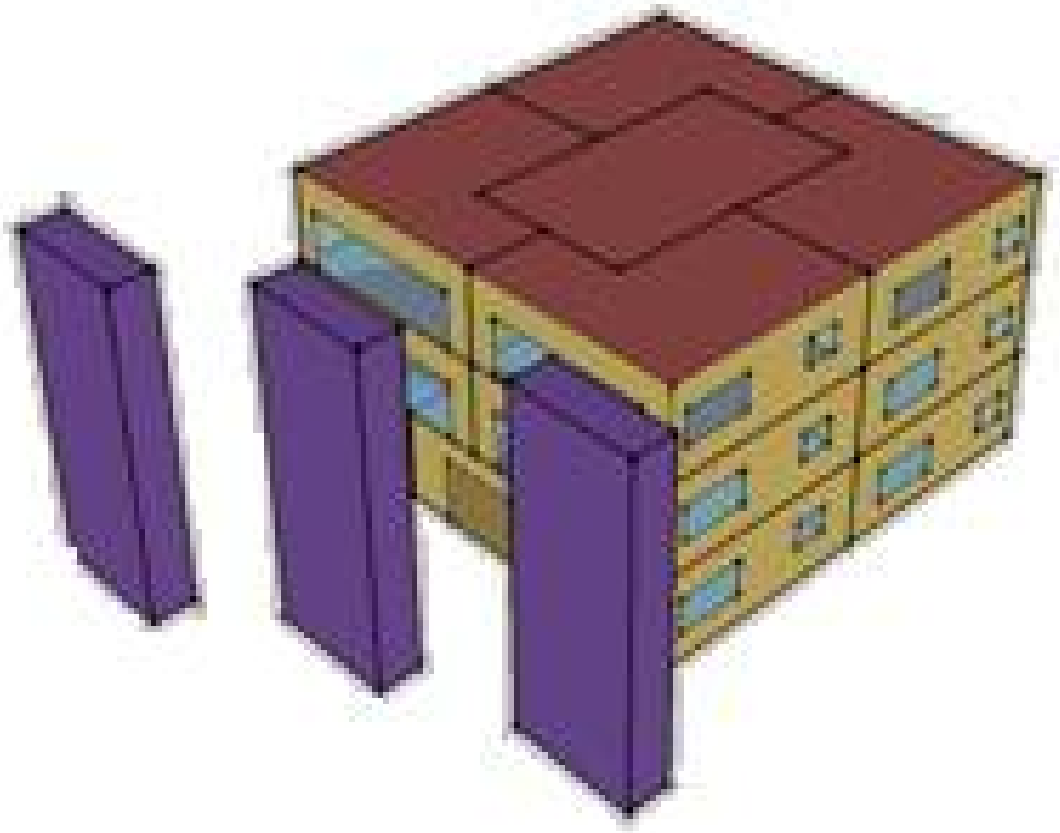


Seasonal heating and/or cooling COPs



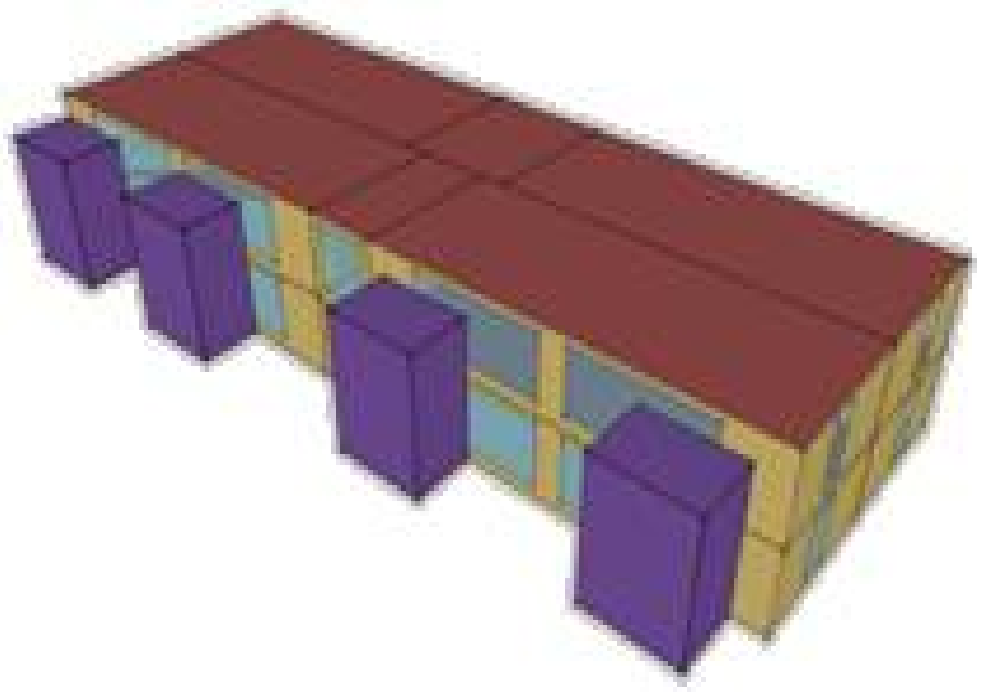
2. Low-energy residential

- **15 appartments**



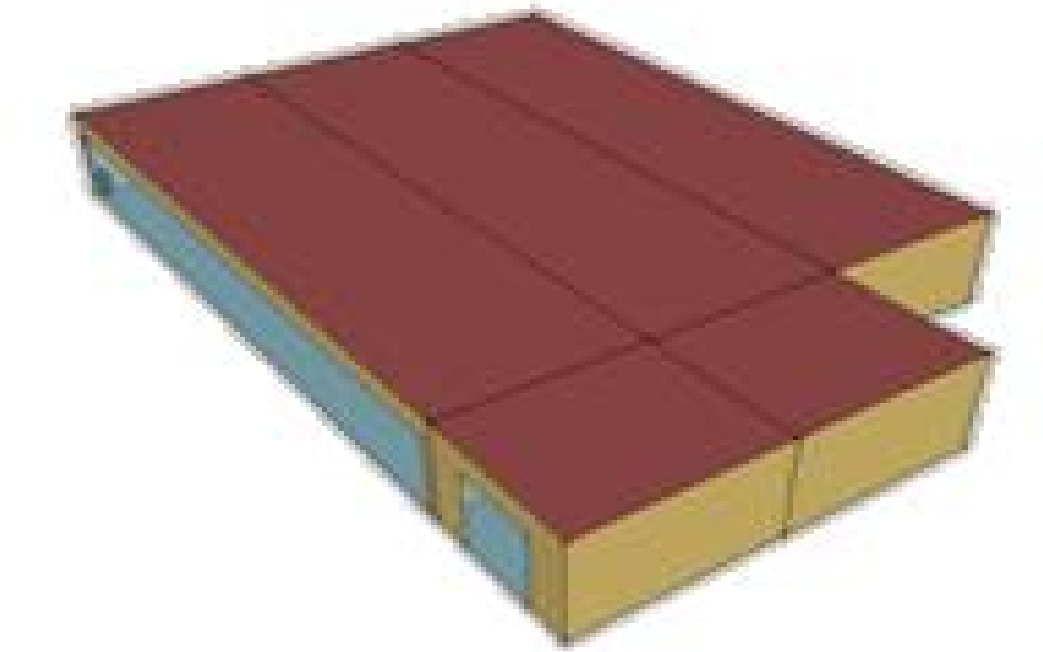
3. Office building

- **12 thermal zones**
- **With server room**



4. Retail store

- **5 thermal zones**
- **Without cooling → with cooling**



Characteristics and boundary conditions

Building type	Floor area (m^2)	Number of thermal zones	Number of people	Occupation Scenario		Lighting (W/m^2)	Number of pieces of equipment of 230 W
				Week days	Weekend		
Low-Energy Building	675	15	24	6h-9h 18h-24h	6h-24h	5	64
Office building	792	12	123	8h-20h	No occupation	10	141
Retail store	1467	5	134	8h-21h	Saturday 8h-21h	10	9

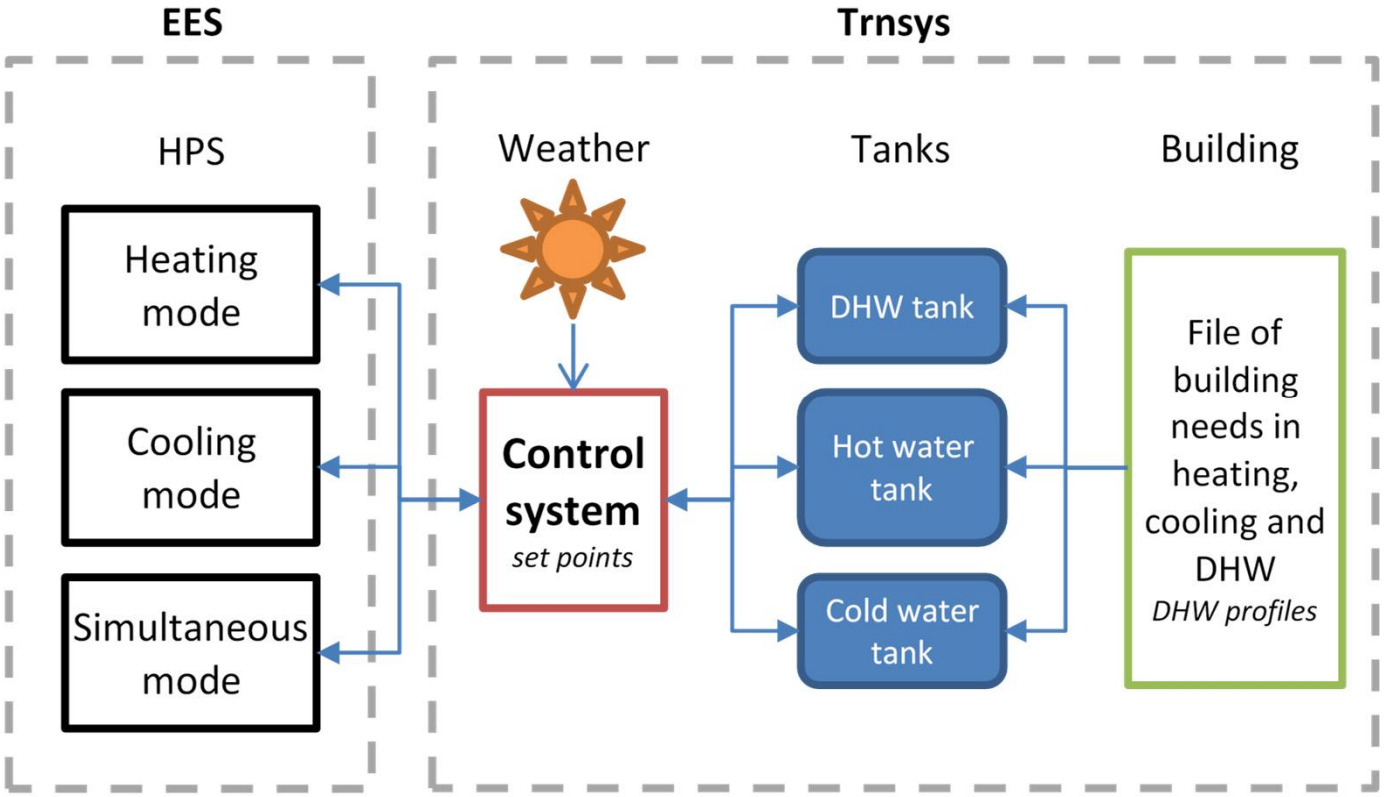
- **DHW demand**

$$q_{DHW} = 1.163 \cdot V_{DHW} \cdot (T_{DHW} - T_{cw})$$

- **Retail store: 10 litres per day and per person at 45 ° C**
- **Office building: 5 litres per day and per employee at 60 ° C**
- **Low-energy residential building: 40 litres per day and per resident at 60 ° C**

Coupling buildings / heat pumps

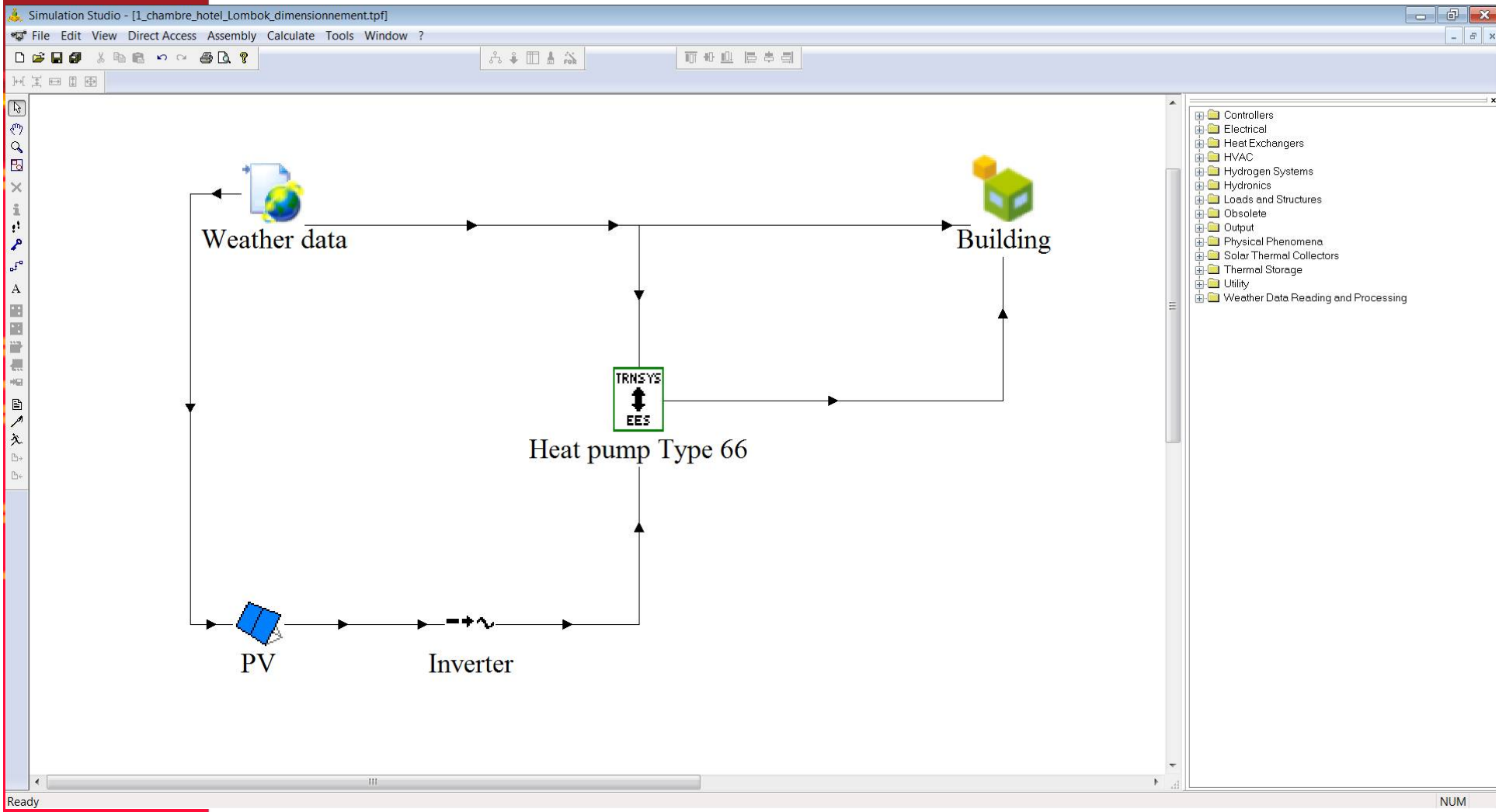
- **Co-solving technique**



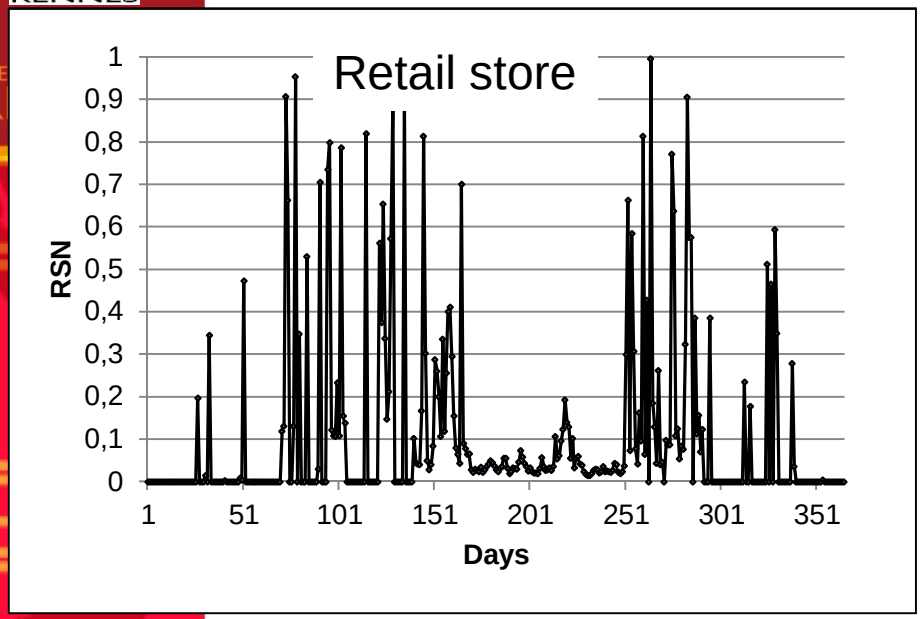
Indicator: Ratio of Simultaneous Needs

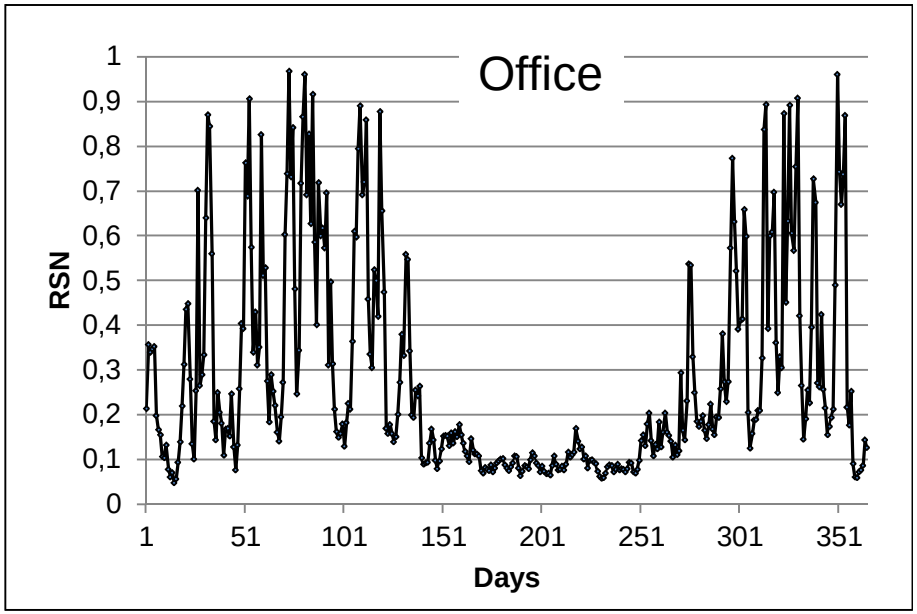
$$RSN = min\left(\frac{\sum_{24\,h} q_c}{\sum_{24\,h} q_h + q_{DHW}} , \frac{\sum_{24\,h} q_h + q_{DHW}}{\sum_{24\,h} q_c} \right)$$

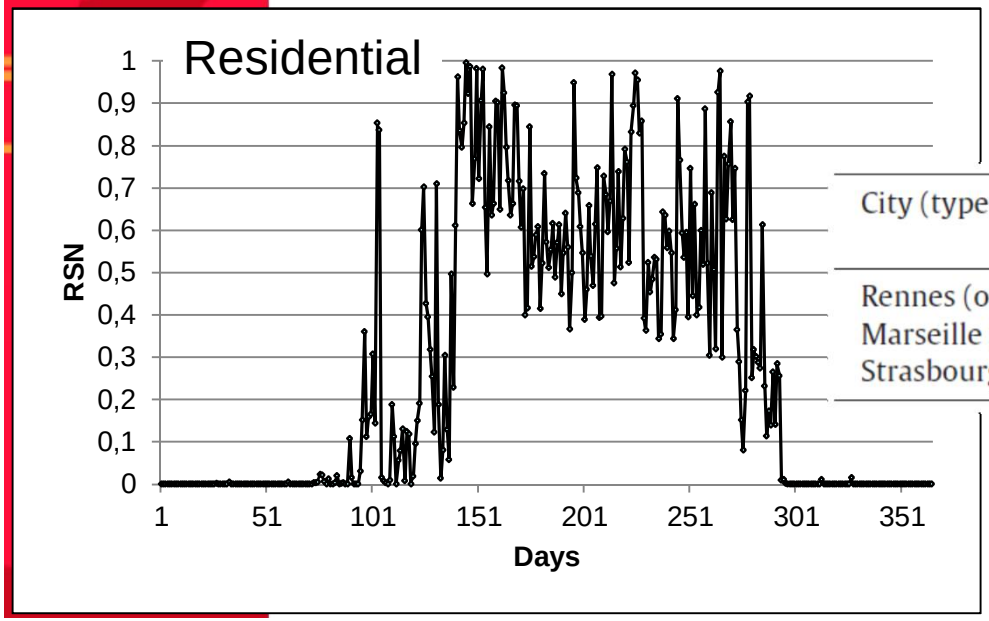
In practice


Simulation Studio - [1_chambre_hotel_Lombok_dimensionnement.tpf]
File Edit View Direct Access Assembly Calculate Tools Window ?
Weather data
Building
TRNSYS
EES
Heat pump Type 66
PV
Inverter
Controllers
Electrical
Heat Exchangers
HVAC
Hydrogen Systems
Hydronics
Loads and Structures
Obsolete
Output
Physical Phenomena
Solar Thermal Collectors
Thermal Storage
Utility
Weather Data Reading and Processing
Ready
NUM

RSN results



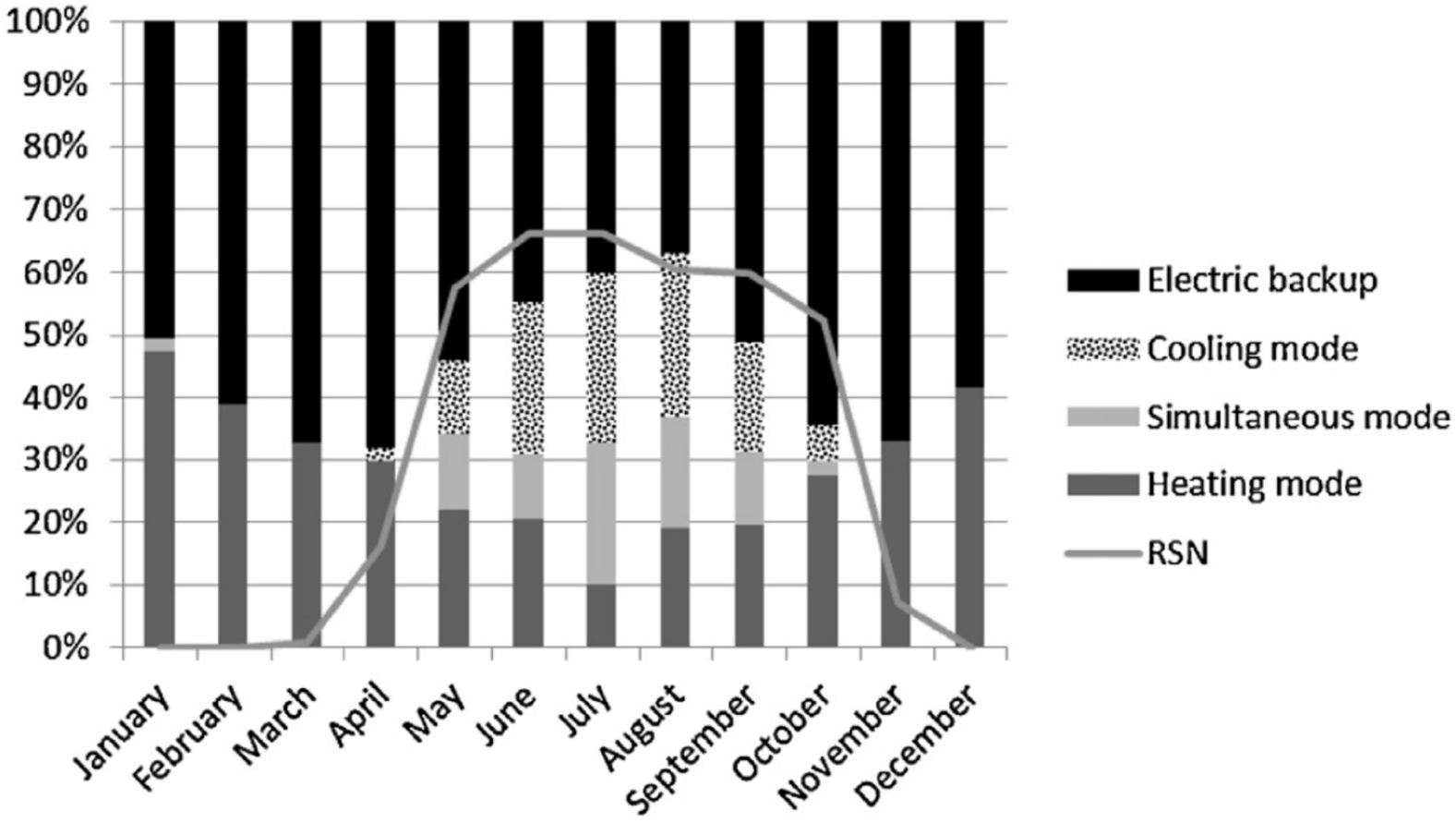




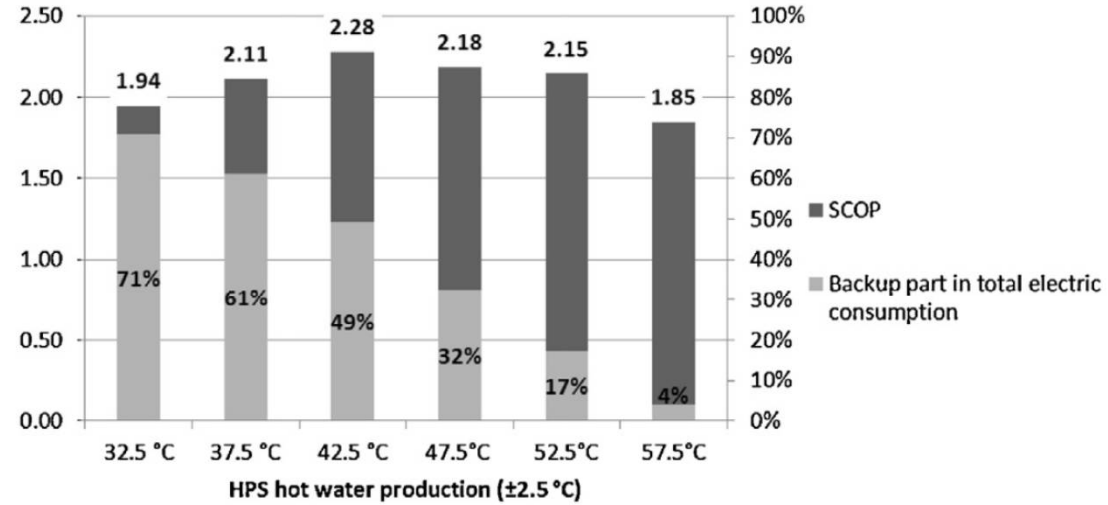
City (type of climate)	Low-energy building (%)	Office building (%)	Retail store (%)
Rennes (oceanic)	28.00	28.17	10.17
Marseille (Mediterranean)	30.52	24.37	10.26
Strasbourg (continental)	22.50	22.57	6.86

Apportionment of electric consumptions

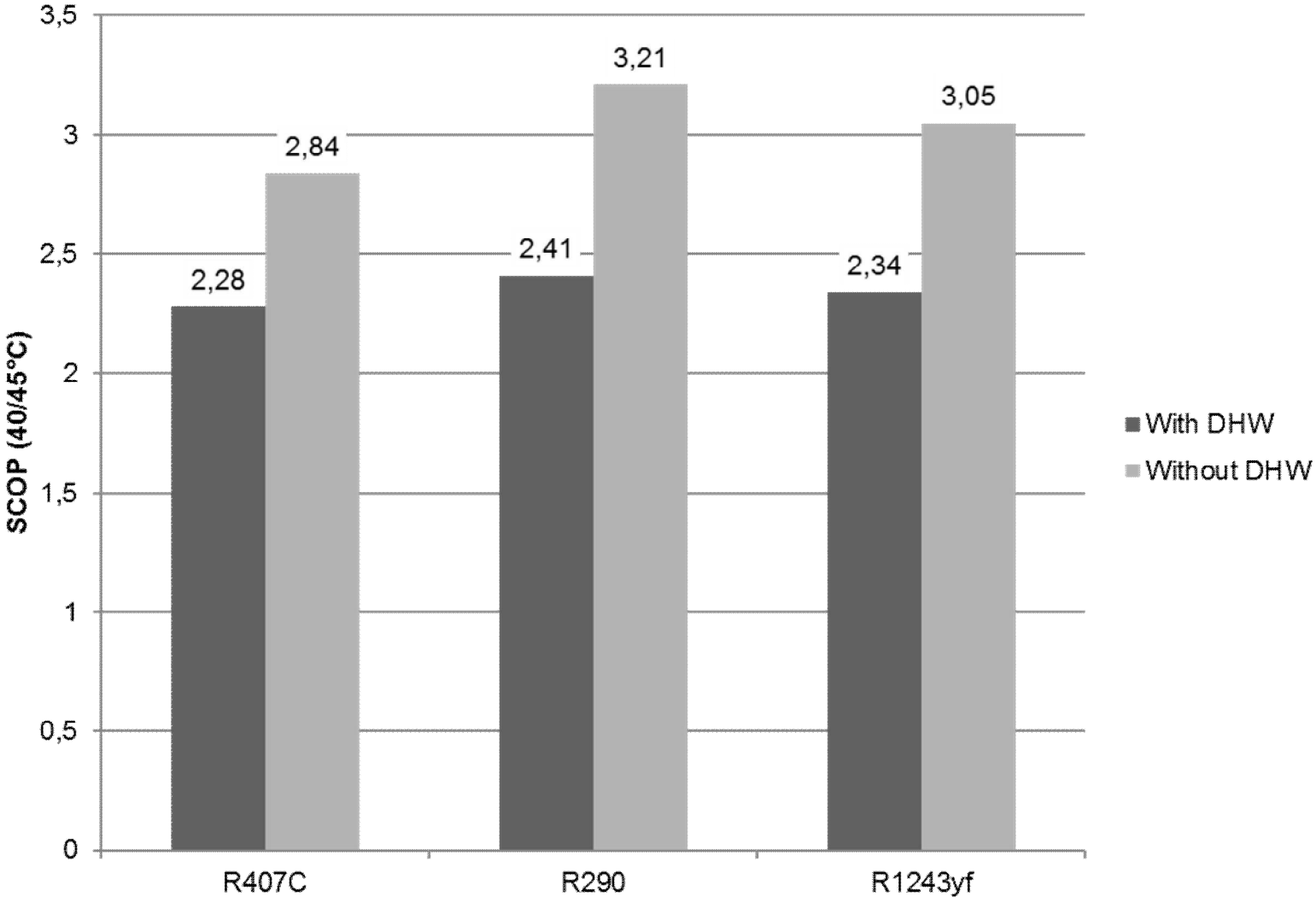
- With a low-energy residential building



Impact of hot water temperature



3 refrigerants



Conclusion

- Models based on realistic assumptions for Rennes
- A series of simulation results available for subtask B
- Need to calibrate our models and results to the standard form of the deliverables

References

- PhD thesis P. Byrne
- PhD thesis R. Ghoubali
- Byrne P., Miriel J., Lénat Y. Modelling and simulation of a heat pump for simultaneous heating and cooling. Building Simulation: An International Journal (IF=1,029) Vol 5, pp. 219–232, septembre 2012.
- Ghoubali R., Byrne P., Miriel J., Bazantay F. Simulation study of heat pumps for simultaneous heating and cooling coupled to buildings. Energy and Buildings (IF=3,666), Vol 72, pp. 141–149, avril 2014.