Combination of experimental and simulated small scale solar air-conditioning system

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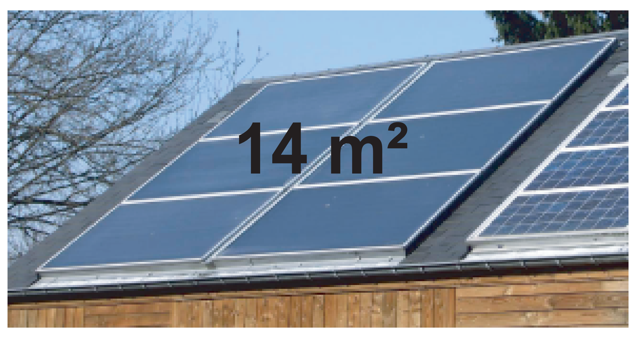
Objective : Evaluate the solar fraction reached by a solar A-C system in real conditions in Belgium

Methodology

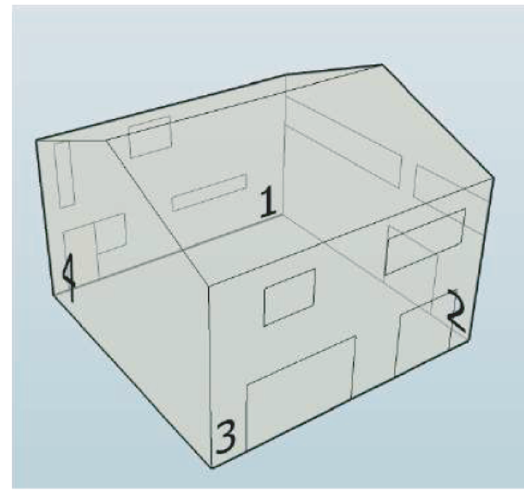
It is proposed in this work to assess the potential of solar energy when operating an air-conditioning system to cool a house. The air-conditioning system considered here is a **thermally driven adsorption chiller** (ADS).

A combination of the experimental and simulated scheme is proposed because of available equipment in the laboratory located in Arlon (South of Belgium). Solar loop and storage tank are effectively installed. On the other hand, the adsorption chiller and the cooling load (< 4 kW) are simulated. Tests were run during summers 2009 and 2010.



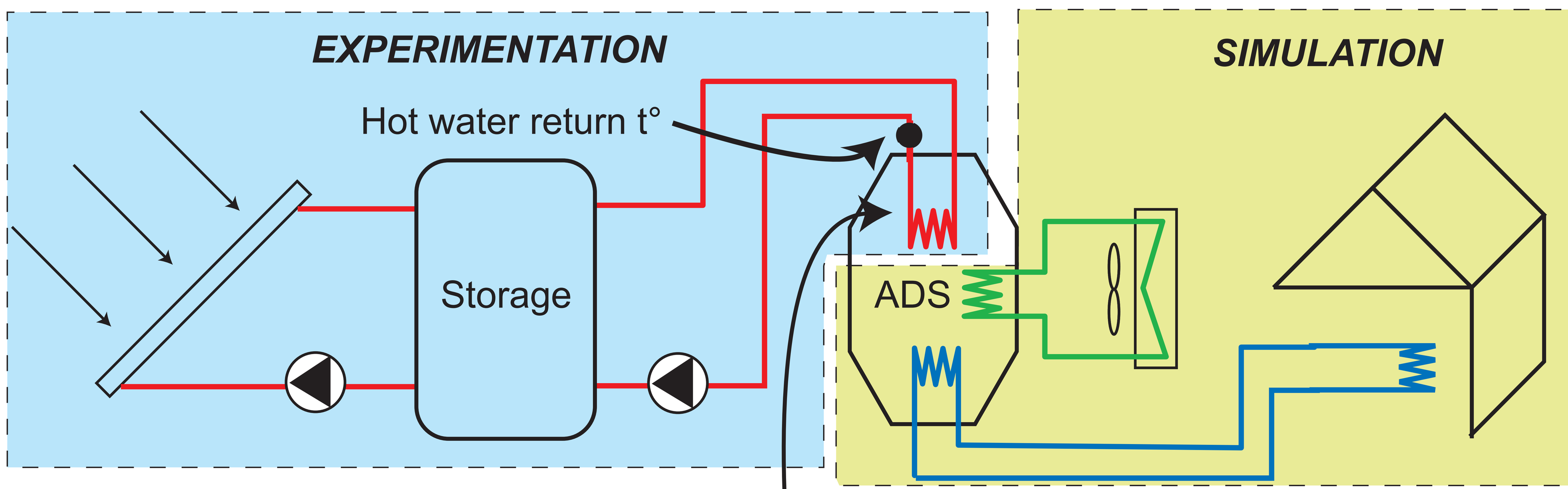
Simulation

The **cooling load** of an average house in our region in real conditions is evaluated.
TRNSYS simulations reveal linear correlation between external temp. and cooling load on an hourly basis.



Adsorption chiller hot water consumption is computed based on cooling load, rejection temperature and thermal COP at current conditions. Hot water return temperature can then be computed. **Heat sink** is controlled to reach this temperature.

Experimentation



Previously computed for each hour of the day

$Q_{cooling\_load}$ [kW] = Text [°C] M + B

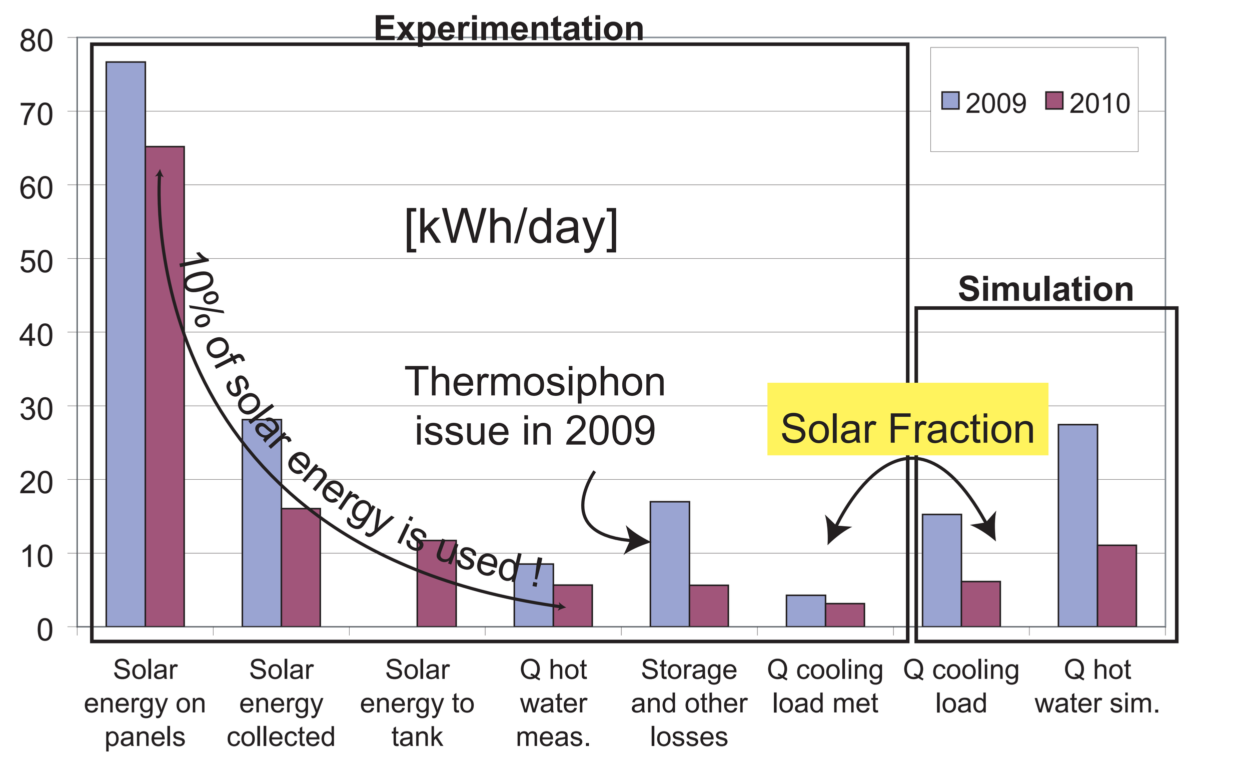
Q_{hot_water} [kW] = $\frac{Q_{cooling\_load}}{COP_{th}}$

Real time measured
Real time computed

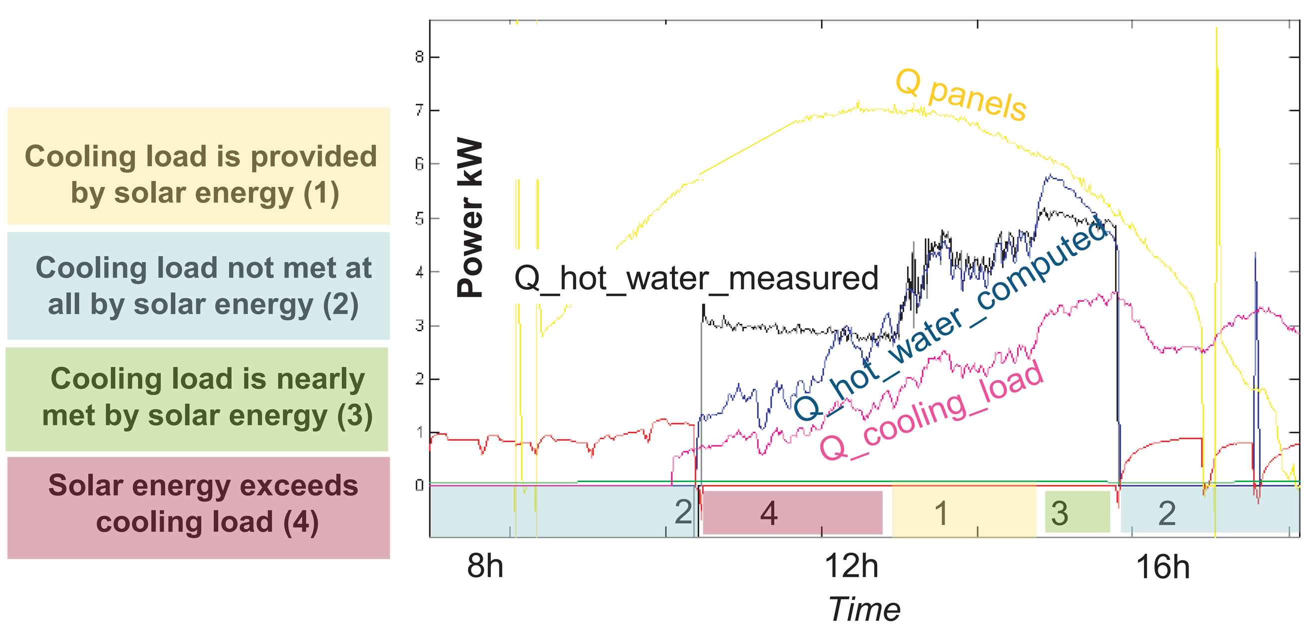
Solar collector field feeds a hot water storage. If it reaches 65°C (minimal temperature for the chiller operation), a certain amount of heat is dissipated into a heat sink : Q_{hot_water}

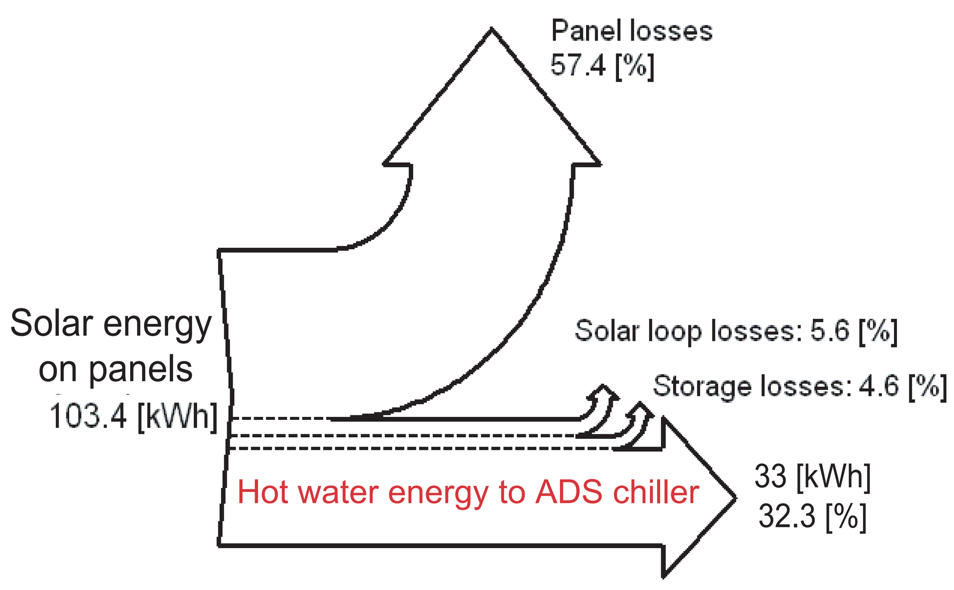
Results

Energy flows for the whole test periods :
2009 : 31 days - quite hot summer
2010 : 36 days - cloudy and wet summer !



Energy flows for typical hot days





Results summary

	2009	2010
Experimentation duration [day]	31	36
Solar fraction [-]	0.31	0.51
Solar energy on panels [kWh/day]	76.7	65.2
Hot water energy to ADS chiller [kWh/day]	8.5	5.7
Cooling load met by ADS chiller [kWh/day]	4.3	3.1
Building cooling load [kWh/day]	15.2	6.1
Hot days		
Days with cooling load > 20 kWh	10	3
Typical hot day	16th August	21st August
Solar fraction [-]	0.21	0.6
Solar energy on panels [kWh]	78.1	103.4
Hot_water energy to ADS chiller [kWh]	15.8	37.1
Cooling load met by ADS chiller [kWh]	8.2	20.6
Building cooling load [kWh]	39.1	34.4

Conclusion

The real time coupling between installed solar loop and simulated adsorption chiller works; the heat sink is able to dissipate a controlled energy quantity.
Evaluation of the solar fraction is then possible.

Summer 2009 was hot but measurement issues lead to low solar fraction (31%). Problems were solved in 2010 : a quite-hot testing period reaches 51%.