# Experimentation and Simulation of a Small-Scale Adsorption Cooling System in Temperate Climate.


Sébastien Thomas[1]*; Samuel Hennaut[1] ; Stefan Maas[2] ; Philippe André[1]

[1]University of Liège, Belgium (BEMS Building Energy Monitoring and Simulation)

[2]University of Luxembourg. Faculté des Sciences, de la Technologie et de la Communication

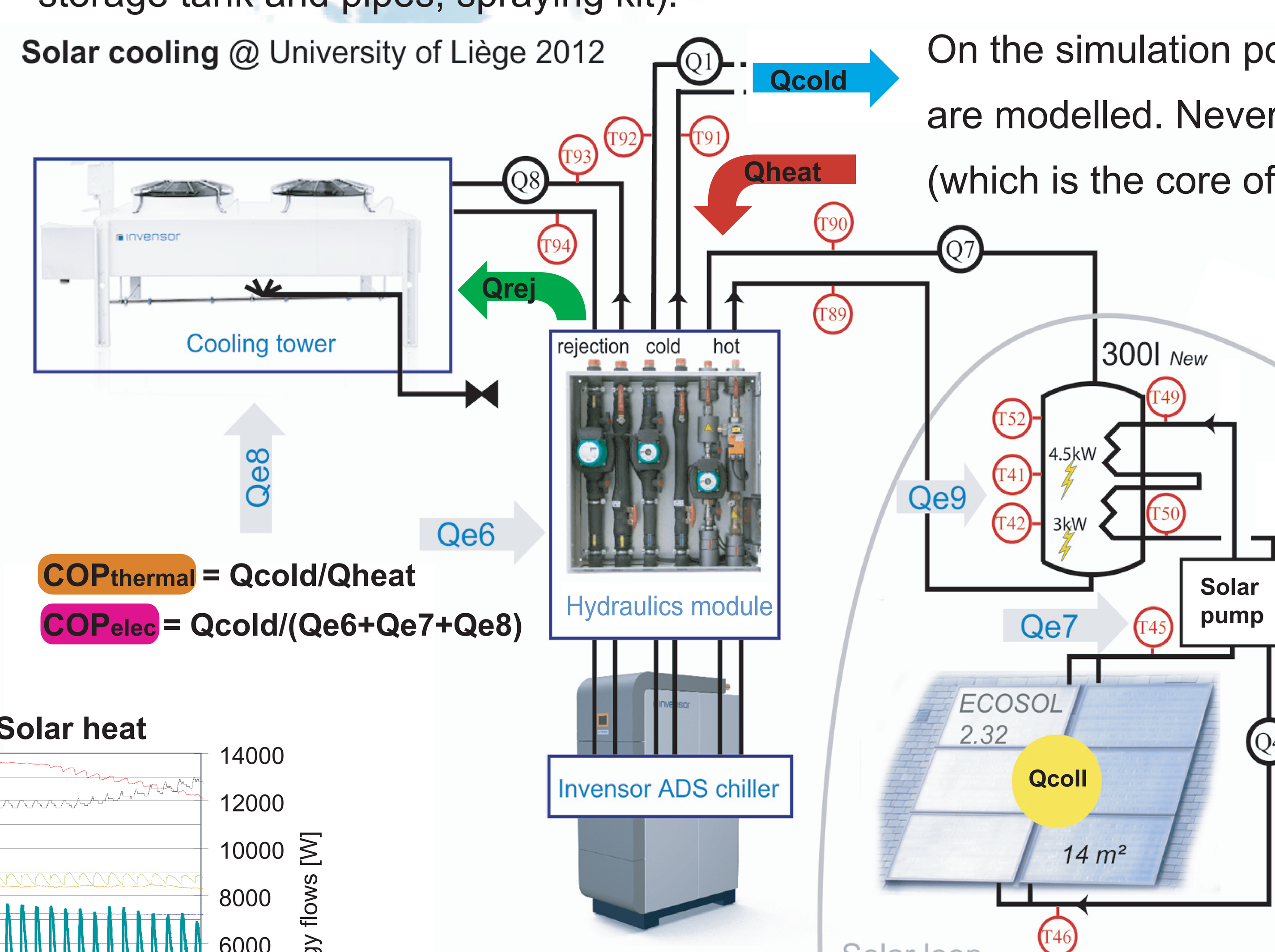
*Corresponding author : sebastien.thomas@ulg.ac.be


*Objective :* To measure the thermal and electrical energy performance of a small scale air-conditioning system

## Solar air-conditioning system components

A small-scale adsorption chiller was installed in April 2011 in a laboratory building in Belgium. This building is equipped with a fully monitored heat and cold production and distribution system. A solar collector field (14m²) used for building heating and domestic hot water production exists. The heart of the system contains an adsorption chiller INVENSOR LTC09 (9 $kW_{cold}$ ), a dry cooling tower and a hydraulic module including pumps. After one season measurement, some system improvements have been achieved (new storage tank and pipes, spraying kit).

**Solar cooling** @ University of Liège 2012




## Control strategy

The main assumption deals with the cooling load. The building is cooled whatever the climatic conditions. In this way all the cold water produced is used to cool the building.

Due to the small solar collector area, the heat released to the chiller was not sufficient most of the time. Some tests were run with electrical heater additionally to the collector power (see typical days results)

## Simulation

On the simulation point of view, various parts of the system are modelled. Nevertheless, the adsorption chiller model (which is the core of the system) has not yet reached good agreement with measured data.

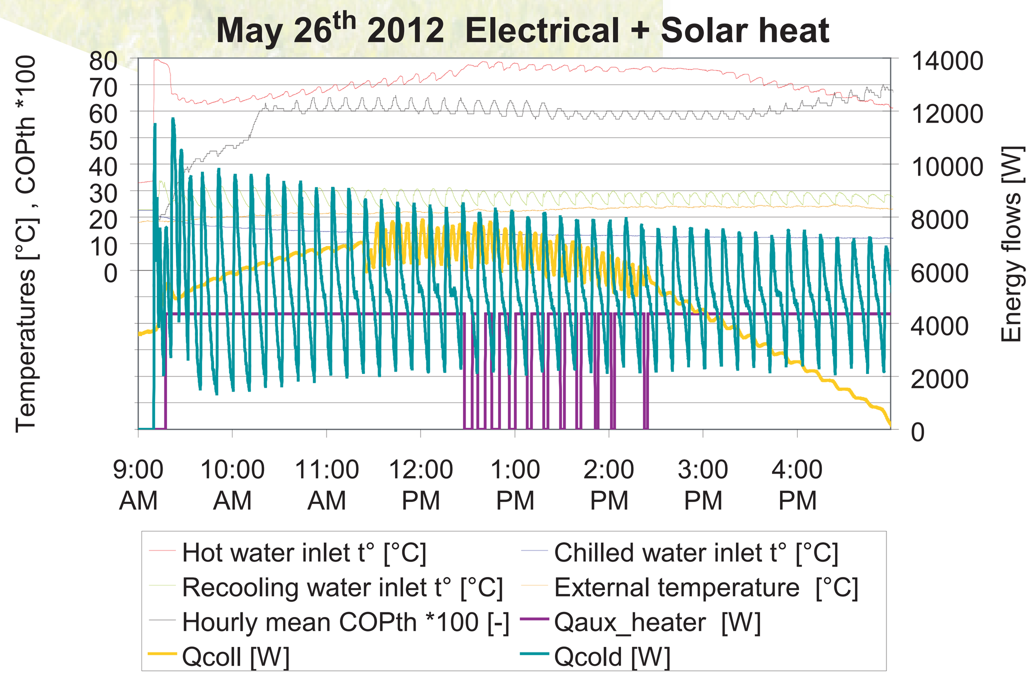
## Electricity sharing

The electricity consumption is measured for each solar air-conditioning component (Qe6 involves hydraulics module and the chiller).

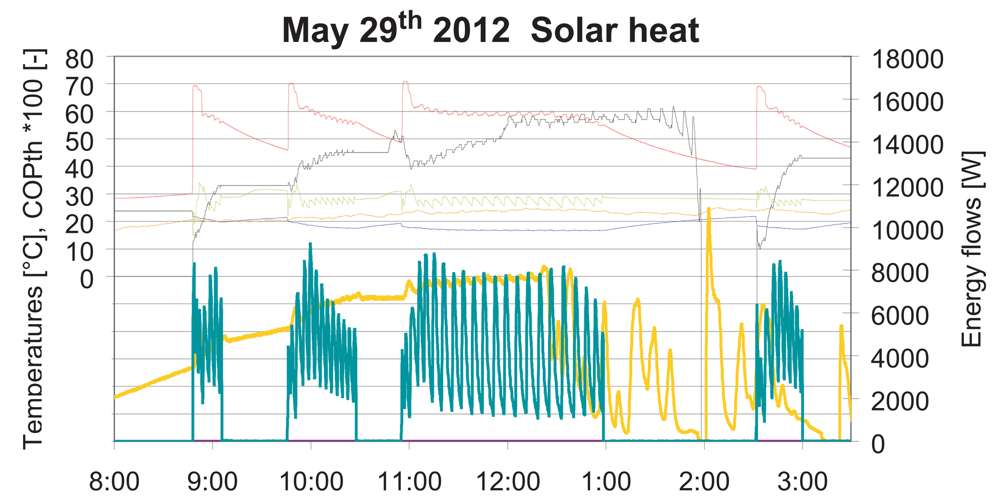
| Electricity sharing for typical days [%] | Chiller + pumps Qe6 | Fans Qe8 | Solar loop pump Qe7 | Standby consumption % of total cons. |
|---|---|---|---|---|
| **June 27th 2011** hottest day solar heat | 33 | 56 | 11 | 10 |
| **July 4th 2011** sunny day solar heat | 62 | 15 | 23 | 12 |
| **May 26th 2012** Elec + Solar heat | 68 | 20 | 12 | 7 |
| **May 29th 2012** Solar only | 59 | 18 | 23 | 20 |

## Typical days results

**May 26th 2012 Electrical + Solar heat**




**May 29th 2012 Solar heat**




## Global results

Three chiller operation periods were recorded (92 days) during two summers (2011 and 2012).

The daily performance reaches good results for sunny days. Half of the days encountered less than 5 kWh/m² incident global radiation. Those days did generally not meet large cold energy production. It implies a negative fraction of energy ($f_{save}$) savings (compared to a reference system) for long periods results.

An electrical heater is implemented into the hot water storage tank to overcome the lack of sun energy. This testing period showed higher electrical and thermal COPs. Avoiding start-stop chiller operation increases significantly the solar air-conditioning performance.

## Daily results summary

| | Qcoll | Qcold | $COP_{thermal}$ | $COP_{elec}$ | $f_{save}$ | External temp. |
|---|---|---|---|---|---|---|
| **Units & comments** | [kWh] | [kWh] | [-] | [-] | [%] | mean / max [°C] |
| **June 27th 2011** hottest day - solar heat | 45.8 | 21.3 | 0.54 | 3.21 | 13 | 24/32 |
| **July 4th 2011** sunny day - solar heat | 44.6 | 17.9 | 0.44 | 5.14 | 45 | 18/26 |
| **May 26th 2012** Elec + Solar heat | 44.3 | 47 | 0.6 | 7.85 | - | 21/29 |
| **May 29th 2012** Solar only | 34.3 | 15.2 | 0.47 | 5.02 | 44 | 19/25 |

## Conclusion

**Measurements of the solar cooling system provide a number of performance indicators. High energy savings can be reached for typical sunny days (up to 45%). Cloudy days involve a signifcant drop in both thermal and electrical performances. Long period analysis revealed no energy savings.**

**Electricity savings fields are pointed out : standby and fan (for very hot days) consumptions could easily be decreased to improve the system electrical performance.**