Introduction

* Long history in France for solar cooling (1980-2011)

**However,** special national conditions for solar cooling:
- **Mild** climate (cooling season especially in South of France)
- **Low energy price** (one of the lowest in the World for electricity)
- **Not very good feedback** till now on performance levels (technical dysfunctionning, low economical interest, lack of providers)

⇒ Important need to structure the sector & get Full Best practice

**Big challenge:** which system/project to follow up the story in 2012?
Introduction

Solution:
- Emergence Program (high incentive against guarantee of results)
- Extend the solar resource use as much as possible
  ⇒ Idea to go to a mix DHW (instead of heating) + cooling system
- Find a site where the system integration is possible including a simple scheme and simple working conditions
- Find a customer motivated for such an application

« Amiral block » Solar DHW/Cooling project in Montpellier!

Targeted building description

Montpellier Heating and System net utilities
=> System owner
TECSOL: engineering company
AXIMA: Company in charge of the works

Existing Building block in ZAC Jacques Coeur in Port Marianne area (Montpellier, France, built in 2010)
2 parts: building A & B (mini district)
Building A: 11,000 m² for offices and shops
Building B: 10,600 m² with 167 dwellings
Load

Load: real monitored data from 2010 to 2011
DHW + cooling = 46 kWh/m².y => 1 GWh/y

Heating + cooling equipments: compression chillers + gas burners
(900 kW)  (700 kW)

Load & system strategy

Sizing strategy:
- available place on the roof
- simplicity & maximum yield

⇒ nearly 500 m² available on different locations on the Block A roof => 240 m² solar collector

- DHW only in Winter + cooling (if possible +DHW) in Summer
**System description**

- 240 m² double glazed flat plate collectors
- one 35 kW absorption chiller
- solar circuit in drainback mode (with water glycol + HX)
- one 1500 liter hot buffer storage tank
- DHW preheating
  (+ 10 m³ DHW additional storage capacity in Building B for dwellings)

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**Hydraulic principle**

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Hydraulic scheme

Solar production

DHW distribution

Drainback system

Cold production

Anti legionella adiabatique cooling tower

Expected results

Emergence program: mini annual thermal performance levels to reach
- Solar yield is estimated to 554.8 kWh/m².year >> 350 kWh/m².year
- Electrical COP is estimated to 16.6 >> 5

⇒ Project eligible to the Emergence funds
Lessons learnt from installation & first running

- Architectural issues:
  Existing building with a lot of caution in the architectural integration process

- Installer skills:
  Very few installers skilled for both absorption / solar / control => learning process and high importance of engineering coordination

- Building in use:
  Preventing any disturbance to companies/organizations working in the lower floors of the building

- Evaporator circuit connection to the main chilled water circuit of the building:
  Need to move from the production side (high flow/low temperature difference) to the distribution side (lower flow / important temperature diff.) to optimize solar cooling input

First monitoring results

- Nominal working conditions for domestic hot water production since May 2012

- Latest work:
  Modification of the solar chilled water introduction into the Net

- Excess of available heat in sunny days:
  Perfect safety functionality of the Drainback system against overheating

- Short test sequences:
  - Checked capacity to run properly the chiller
  - Power balance around the chiller:
    - Generator: 28 kW – 80/77°C
    - Evaporator: 18 kW – 7.5/10.5°C
    - Heat rejection: 46 kW – 31.5/34°C
First monitoring results

* Nominal functioning from August (fully sunny day / average sunny day)

- 7 hours operation
- Generator temperature range: 80-88°C
- Recooling stable conditions

Monitoring campaign ongoing (after cooling season, heating season now)
First monitoring results

* DHW monitoring results for a Winter day

<table>
<thead>
<tr>
<th>Date</th>
<th>18 March 2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energies</td>
<td></td>
</tr>
<tr>
<td>Available solar energy</td>
<td>1491.28 kWh</td>
</tr>
<tr>
<td>Collected solar energy (secondary circuit)</td>
<td>563.48 kWh</td>
</tr>
<tr>
<td>Solar DHW distributed (after the buffer tank)</td>
<td>494.17 kWh</td>
</tr>
<tr>
<td>Electrical energy consumed</td>
<td>12.29 kWh</td>
</tr>
<tr>
<td>Ratios et calculations</td>
<td></td>
</tr>
<tr>
<td>Collector &amp; Heat exchanger yield</td>
<td>37.78 %</td>
</tr>
<tr>
<td>Buffer tank yield</td>
<td>87.70 %</td>
</tr>
<tr>
<td>Installation yield (from solar to DHW)</td>
<td>33.14 %</td>
</tr>
<tr>
<td>Electrical COP</td>
<td>40.22 -</td>
</tr>
</tbody>
</table>

Energies and energies ratio for March 18th 2013

The installation performances on a sunny day in March are quite good with an electrical COP reaching 40.
First monitoring results

* DHW monitoring results for a Winter period

Energies and electrical COP for a 9 days period in March 2013

Day 2 – Solar Cooling Conference - 12/04/2013
Venue: CSIRO, North Ryde, Sydney

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Economics

Total cost of the project (cooling + DHW): 330 000 € (w/o eng.)

Public funding available for the project: 50%

Final investment cost for the customer: ≈ 165 000€

Savings:
- For cooling: * electric central heat pumps with average electrical SEER = 2
  * electricity price = 0.04664 €/kWh
- For DHW production: * gas boiler (average η = 80%)
  * gas price = 0.04182 €/kWh

Annual gross saving of ≈ 8 000 €/year
Annual actualized saving during 20 years: 11 100€/year
(average 6% /year increase for energy price)
Economics & Environment

ROI of the project not very performing (≈ 15 years) ... **BUT**

- Guarantee for the customer of performances (Emergence system)
- Considered as a Demo project (experiment + no profitable project (cover total cost on system life)

CO2 savings from this solar cooling/DHW installation.

**Hypothesis**:
- For electricity: 120 g of CO2/kWh
- For gas: 273 g of CO2/kWh

=> 40 tons CO2 / y

Equivalent to **25 cars travelling 11 500 km/y**

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Conclusion

- Project **running since May 2012**
- **Start up / optimisation phase** in early Summer 2012
- Very **learnful first feedbacks**
- **Complete monitoring system** permitting future full feedback on energy performance level
- **Interesting new concept** for DHW/solar cooling:
  - **Maximal usability** of solar resource & simplicity of the system
  - **Economical optimum** (gains for DHW + Cooling production)
  - **No risk of regular oversizing**
  - **Drainback strategy** in case of dysfunctionning
  - **First application** of the French Incentive Emergence Program
  - One case of mini **Solar District Heating/Cooling system**

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Thanks for your attention!

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