Innovative and Energy Efficient

Concept for Solar Cooling (DHW / Cooling Hybrid Strategy):

Practical First Results

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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 ressource use as much as possible
  $\Rightarrow$ 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 !

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Targeted building description

Montpellier Heating and System net utilities
=> System owner

TECSOL : engineering company

AXIMA : Company in charge of the works

Building A view

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

Buildings situation

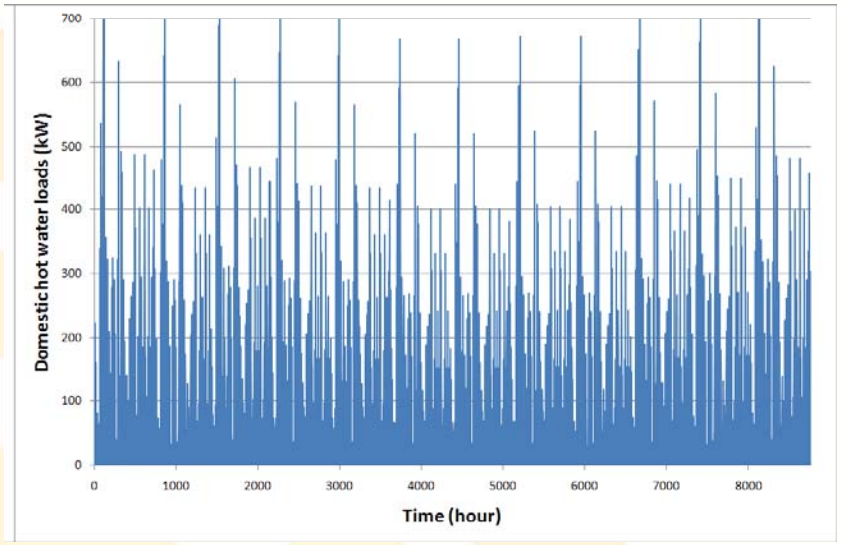
Load

Load : real monitored data from 2010 to 2011

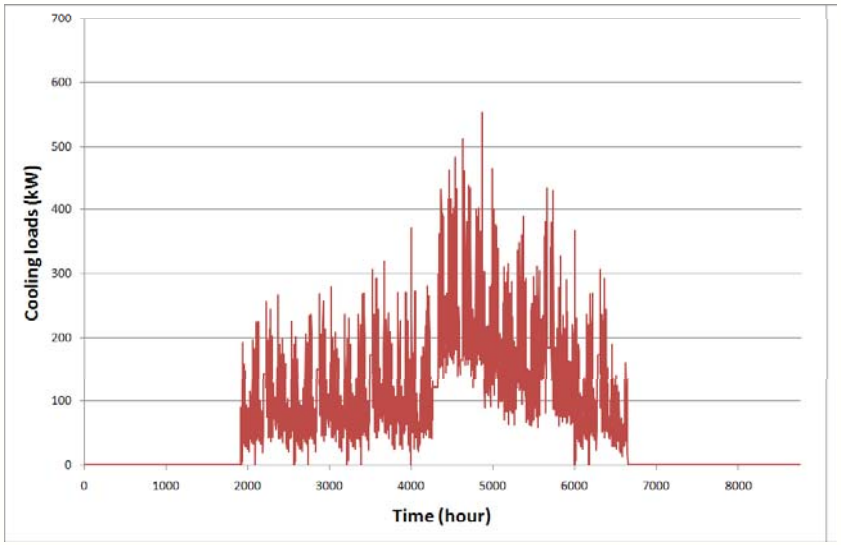
DHW + cooling = 46 kWh/m².y => 1 GWh/y

Heating + cooling equipements : compression chillers + gas burners

(900 kW) (700 kW)



DHW load on a yearly basis



Cooling load on a yearly basis

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Load & system strategy

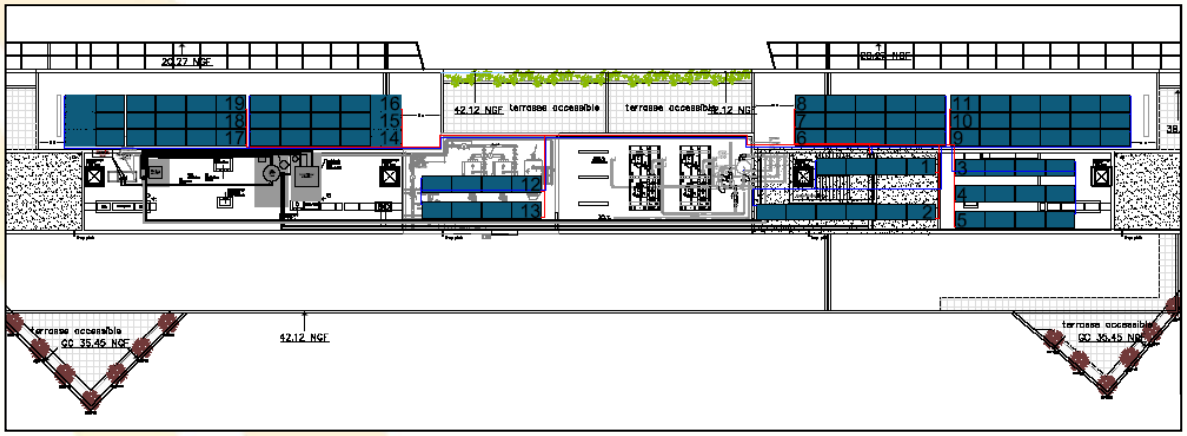
Picture of the collector field

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



Solar collector position on the roof

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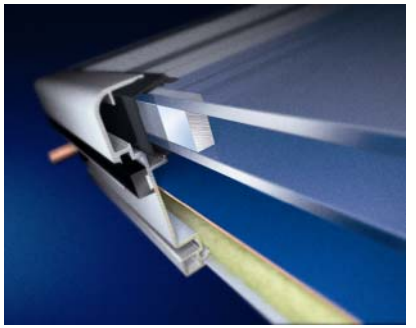
System description

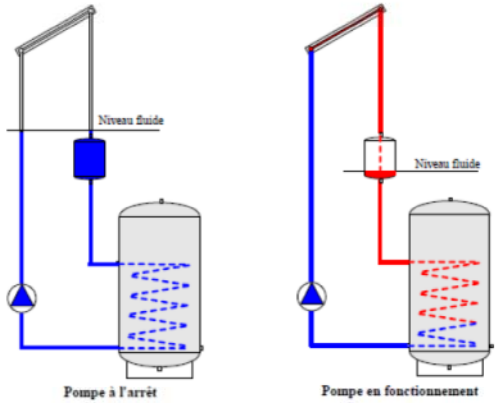
- **240 m² double glazed flat plate collectors**
- **one 35 kW absorption chiller**



Double glazed solar collector

- solar circuit in drainback mode (with water glycol + HX)

Solar collector fields in drainback mode



Drainback principle

- one **1500 liter hot buffer storage tank**
- DHW preheating

(+ 10 m3 DHW additional storage capacity in Building B for dwellings)

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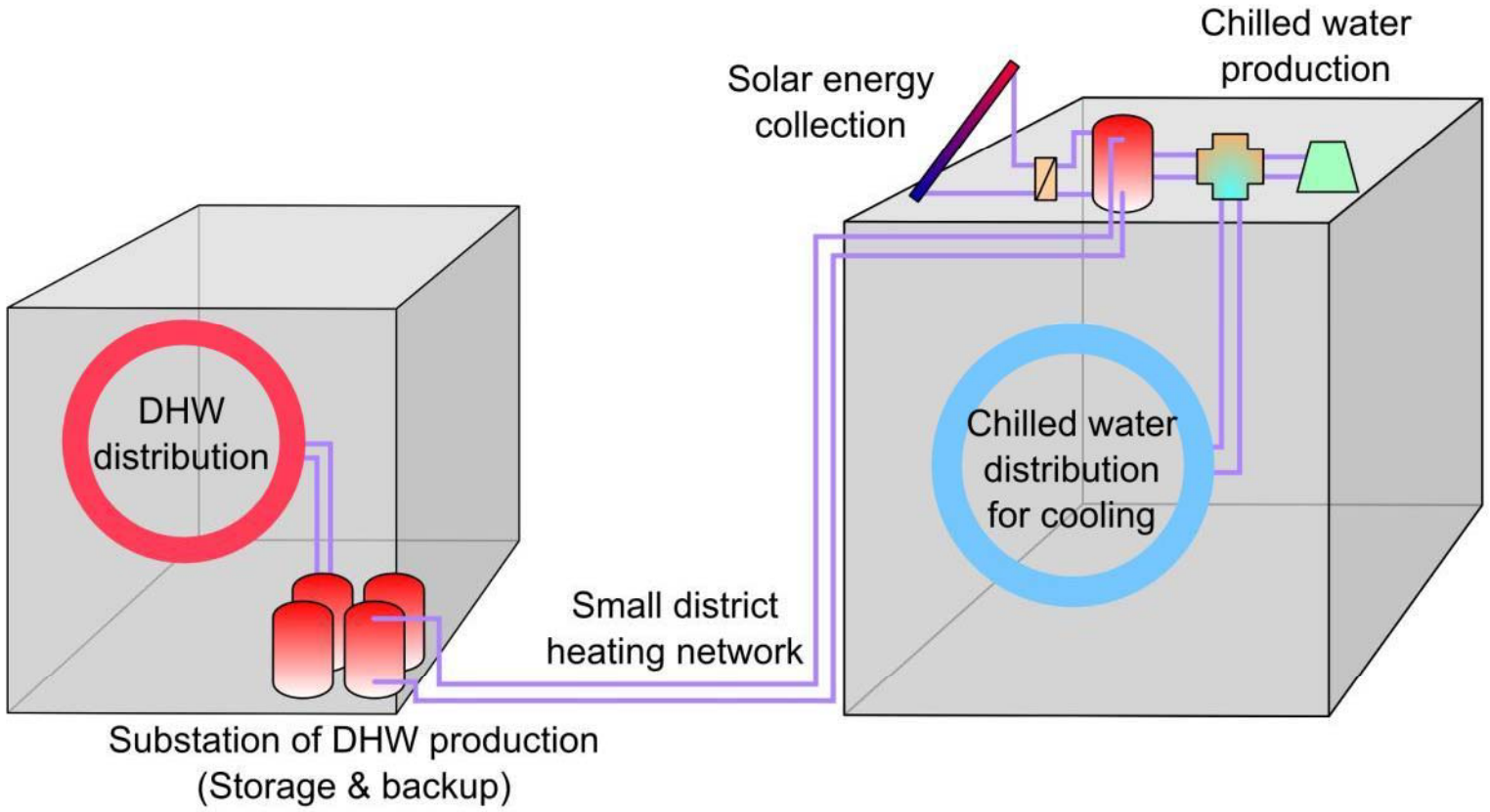
Hydraulic principle



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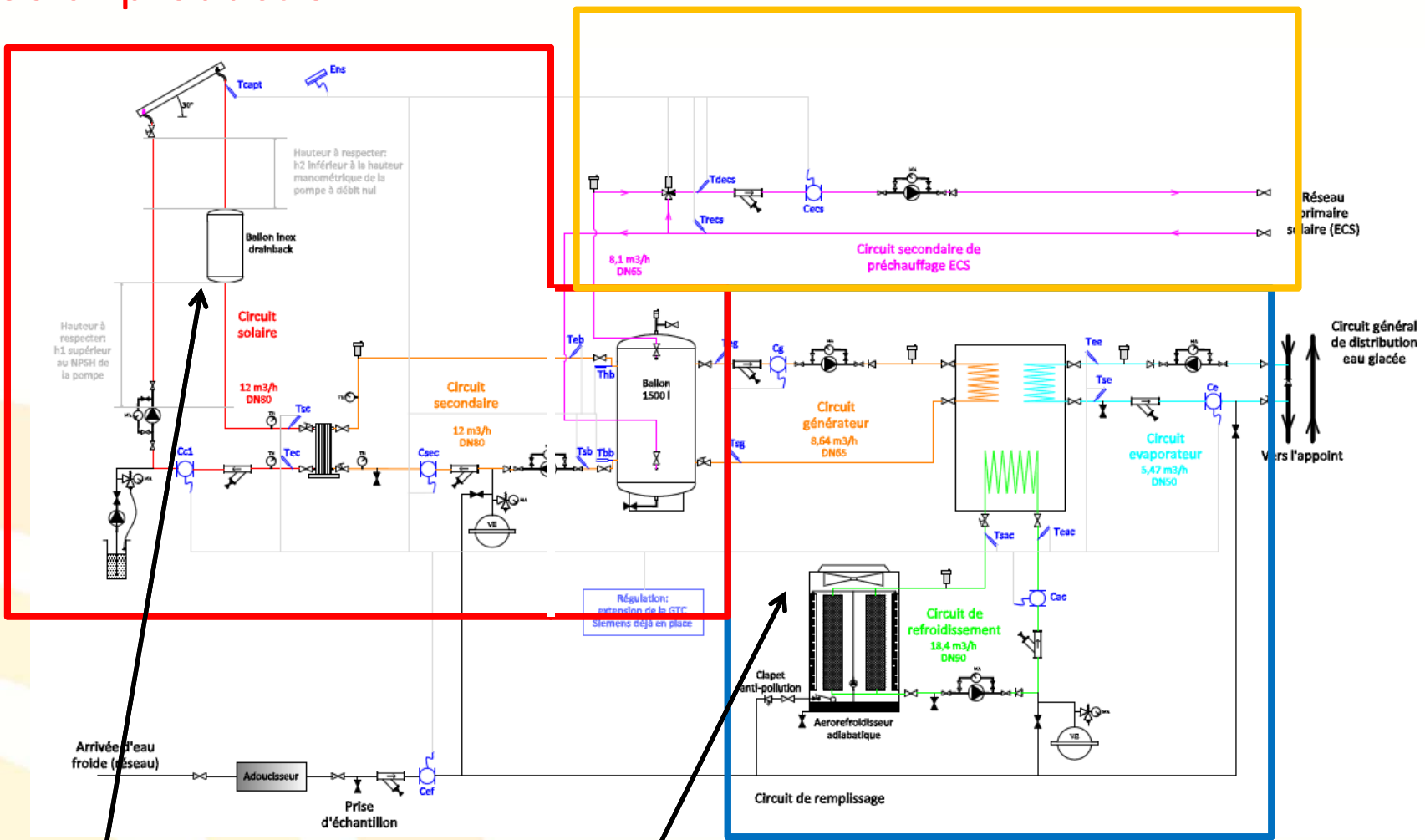
Hydraulic scheme

Solar production

DHW distribution



Drainback system

Cold production

Anti legionnella adiabatique cooling tower

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Expected results

	DHW production (kWh)	Cooling production (kWh)	Electric consumption (kWh)	Solar productivity* (kWh/m²)	Electrical COP (-)	Solar fraction (%)
January	2 476	0	256	10,3	9,7	7,7 %
February	4 694	0	371	19,6	12,7	19,1 %
March	11 073	0	566	46,1	19,6	22,2 %
April	16 252	228	723	68,7	22,8	17,3 %
May	18 556	1 843	892	85,0	22,9	18,7 %
June	14 002	3 033	938	71,0	18,2	16,8 %
July	12 083	7 348	1329	81,0	14,6	9,8 %
August	11 583	6 281	1207	74,4	14,8	11,6 %
September	7 939	1 340	661	38,7	14,0	9,2 %
October	8 896	0	547	37,1	16,3	25,6 %
November	3 450	0	293	14,4	11,8	12,7 %
December	2 077	0	234	8,7	8,9	6,6 %
TOTAL	**113 080**	**20 073**	**8 017**	**554,8**	**16,6**	**13,9 %**

** Solar productivity: Calculated in winter as the distributed hot energy divided by the collector surface, and in summer the distributed cold energy is divided by the collector surface but also by the thermal COP of the chiller.*

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**

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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

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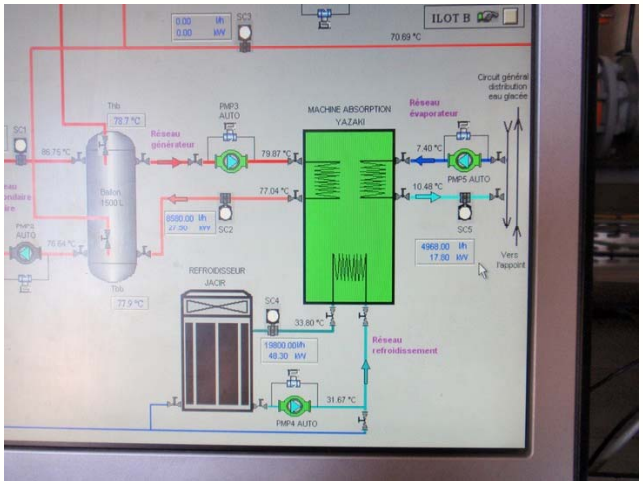
First results

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

* **Ongoing work preparation** to modify the solar chilled water introduction into the Net



Screen snapshot showing working system

* **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

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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 coast 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**

1 car making 2 500 km/y produces **350 kg** CO2

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 ressource & simplicity ot 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**

Thanks for your attention !

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