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Presentation of an innovative thermal loop combining:

Phase change Material heat Storage

Solar energy

Demand side management

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4DH
4th Generation District Heating
Technologies and Systems

Grenoble DH network and ZAC Flaubert

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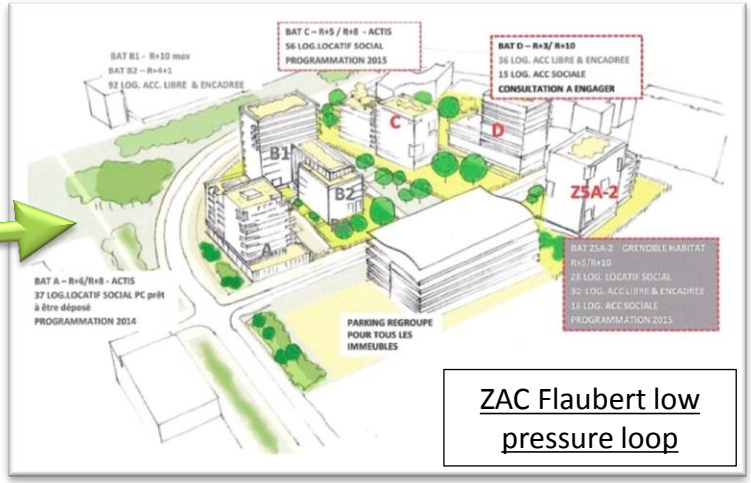
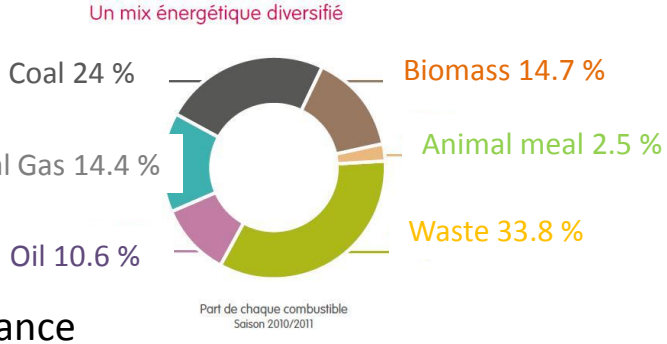
Grenoble DH high pressure network



ZAC Flaubert low pressure loop

Grenoble DH - Key figures

900 GWh/y heat
90 GWh/y electricity
110 °C < T_{supply} < 180 °C
250 km in length
2nd largest DH system in France

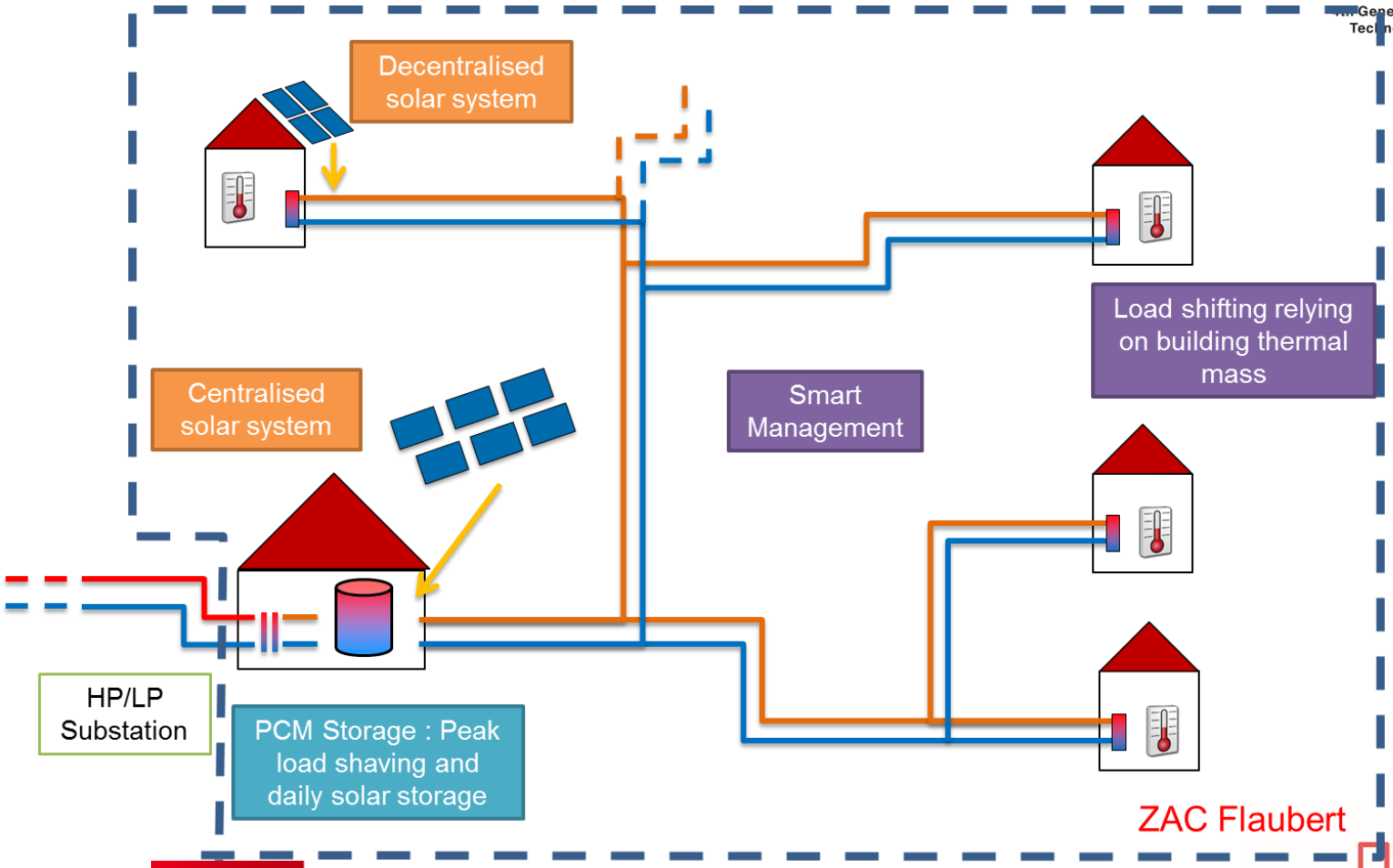


ZAC Flaubert loop - Key figures:

380 dwellings + 11.10^3 m^2 tertiary
40 °C … 70 °C for T_{return} / T_{supply}
2 100 kW

ZAC Flaubert low pressure loop

Flaubert : an innovative Low Pressure DH loop with 3 demonstration themes



The EU FP7 City-Zen project

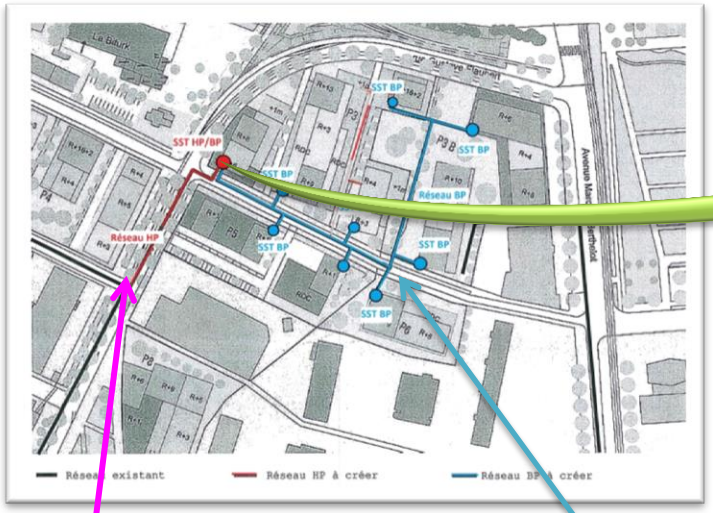
- **City-Zen project deals with the development of the city of the future.**
  - **One main objective of the project is to showcase to society ambitious pilot projects. Demonstrators in Amsterdam and Grenoble will include:**
    - **90 000 m² housing retrofitting**
    - **Fully functional smart-grid development (10 000 dwellings in Amsterdam)**
    - **Demonstration of innovative solutions for district heating and cooling**

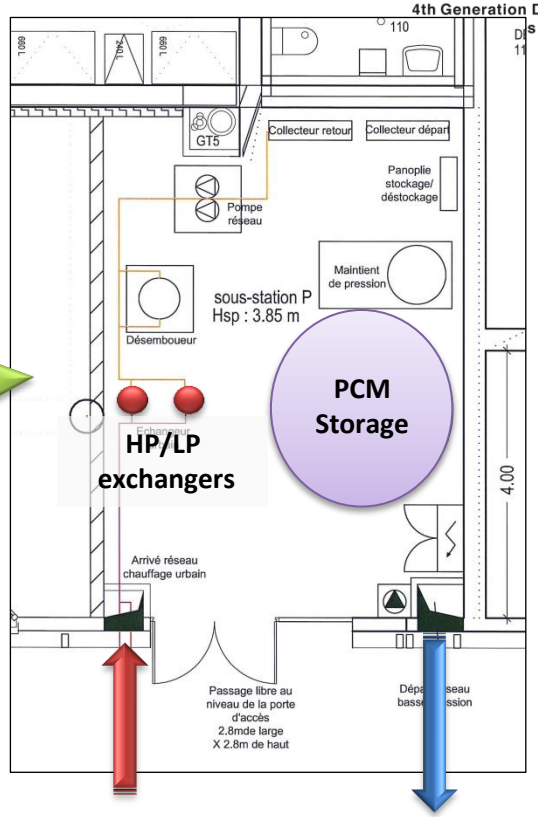
- **Timeline**

PCM storage (1/2)

Demonstration theme n°1 :

- ✓ Implementation of PCM storage inside a normal technical room beside the HP/LP heat exchangers





GRENOBLE

High Pressure network

ZAC FLAUBERT

Low Pressure network

HP network

LP network

PCM storage (2/2)

Background at CEA :

Prototypes of PCM storage built by CEA for Concentrated Solar Plant application :

Tube and shell technology

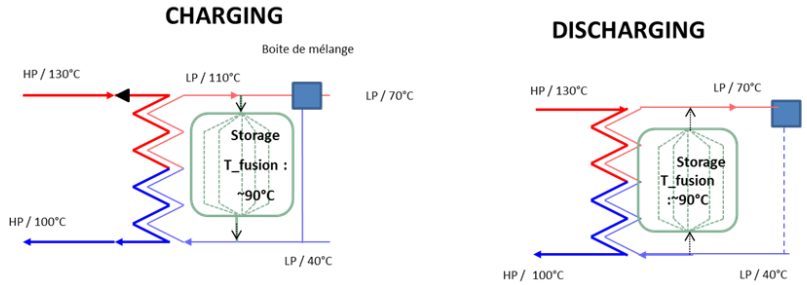
POC : MASTIN facility
19 tubes – 200kg of PCM
Parrafin wax

Prototype at CEA:
3m^3 – 6 tons of PCM
300 kW.h – 100kW.h/m^3
$NaNO_3$

Current work:

Adaptation of the CSP baseline technology to the Flaubert application:

- Definition of an implementation scheme:



- Selection of a PCM adapted to the melting temperature required for a urban heating network: objective of a PCM at 100kW.h/m^3

- Thermal-hydraulic calculations to adapt the internal heat exchanger of the storage to the fluid and the power of a district heating application.

Thermal solar

Demonstration theme n°2 :

✓ Integration of Solar Thermal Generation in Low Pressure District Heating

- Solar thermal plant with high performance solar collectors
  - → Directly connected to the Low Pressure District Heating
  - → Collector area ~ 200 m²
  - → Solar thermal energy : ~ 100 MWh
  - → Annual Solar fraction : ~ 5%

- Coupling solar energy and PCM storage solutions
  - → PCM storage used for DH peak shaving in winter
  - → PCM storage used for solar energy storage in summer

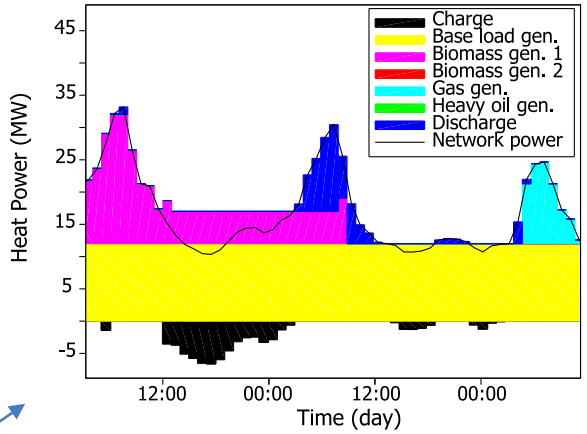
Example of integration of solar thermal collectors on building roofs in Crailsheim (Germany)

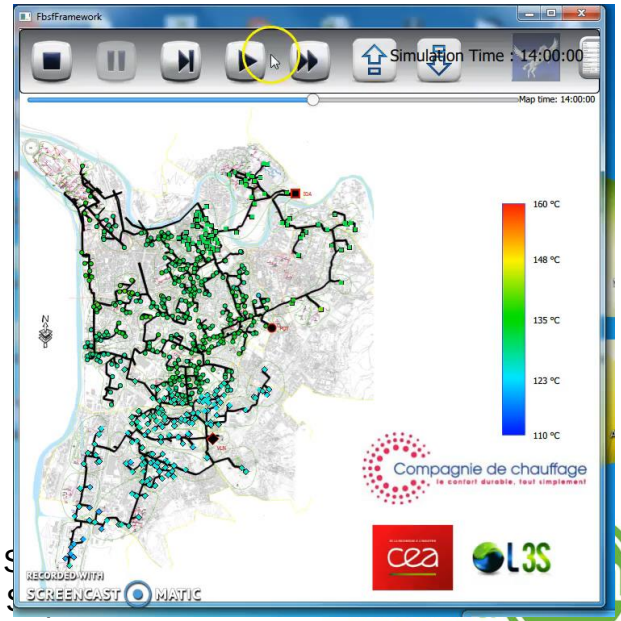
Smart DH control (1/2)

Demonstration theme n°3 : development of a smart management module

Model **P**redictive **C**ontrol (MPC) scheme using

- Load prediction
- dynamic simulation
- **M**ixed **I**nteger **L**inear **P**rogramming (MILP)





- ✓ Production optimization
- ✓ Supply temperature optimization
- ✓ Demand side management

Smart DH control (2/2)

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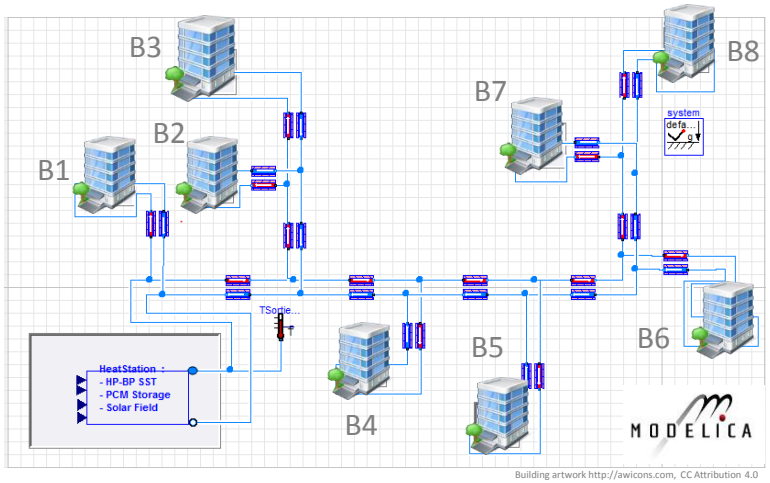
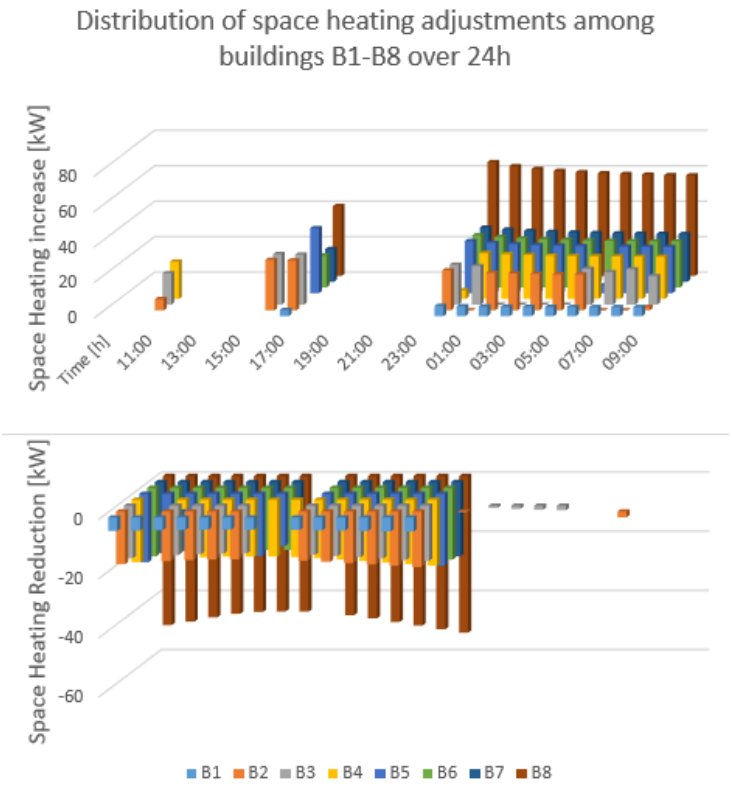
Current development work on demand-side management module:

- → Initial modelling of buildings and their load shifting capabilities
- → Optimal algorithm for defining demand-side management strategies





Synthesis and Perspectives

An innovative thermal loop, combining PCM storage, solar energy and smart management is currently being designed in Grenoble.

Main challenges are:

- Storage module: selection of a PCM
- Installation of Solar Panels: finding available surfaces in a densely populated area
- Demand-side management module: real-time monitoring of end-user's thermal comfort

Implementation and performance assessment are respectively planned in 2017 and 2018.

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Thanks for your attention!

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