SDH
solar district heating

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Ecodistrict Villeneuve : How to develop solar energy with an existing high temperature district heating and a new low consumption housing area ?



DE LA RECHERCHE À L'INDUSTRIE
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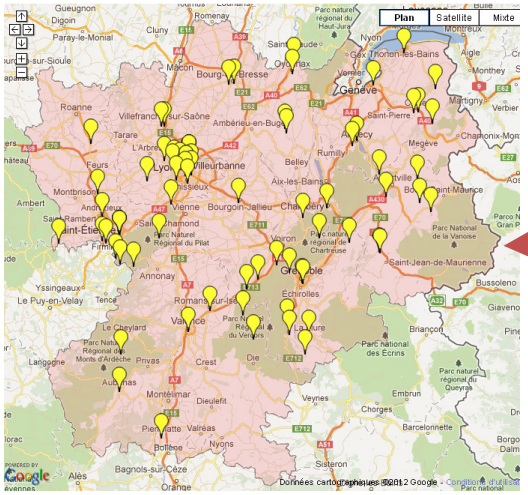
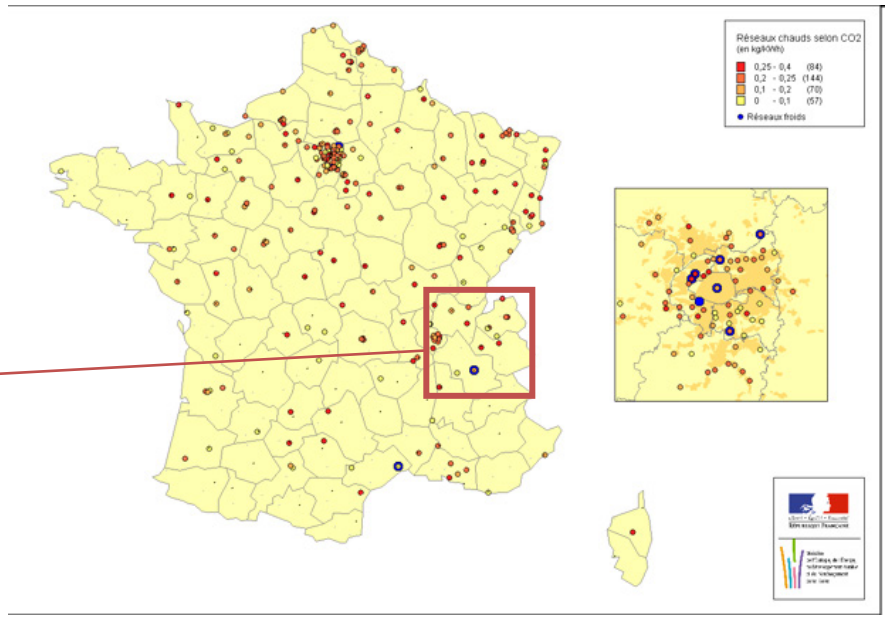
District Heating in France and Chambery city

District heating in France

- Inventory of district heating network :
  - 830 heating networks (>1MW)
  - 16 cooling networks (> 3MW)
  - Many smaller networks …

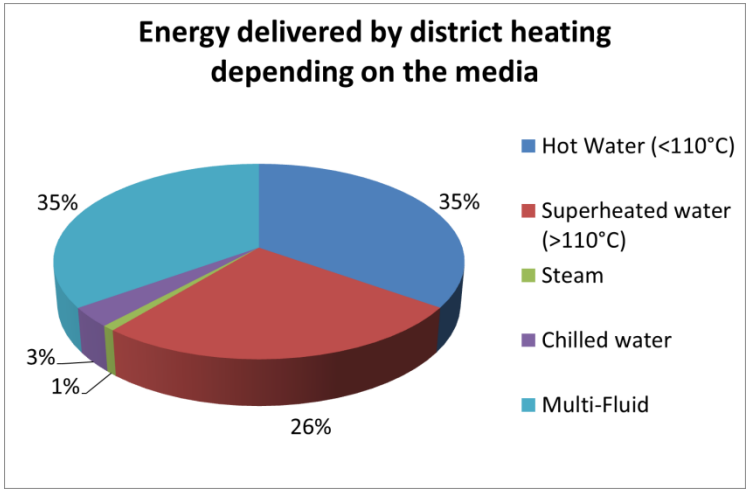


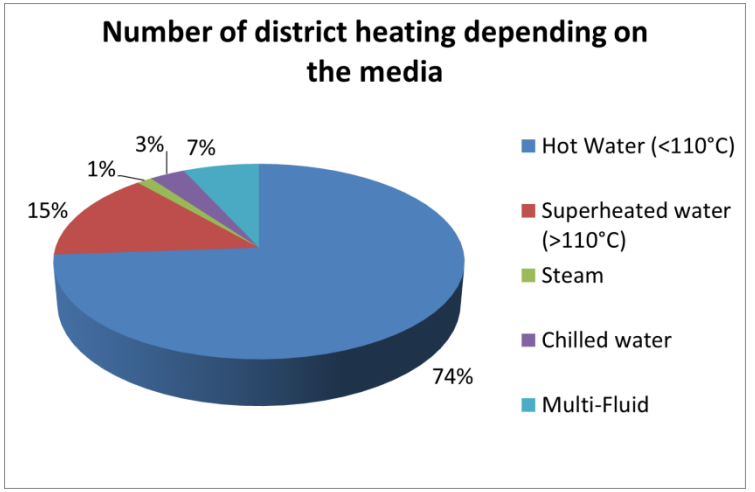


- They are mainly high temperature district network : >85° C
- But new low-temperature district heating are being build for Ecodistrict

High temperature district heating

- Temperature of DH :
  - Only 35% (9 500 GWh) of the heat is delivered by DH with temperature lower than 110° C
  - But it is more than 70% of the DH
- Opportunities :
  - Extension of DH network
  - Buildings retrofitting and reduction of DH temperature
  - Small district heating (P<1MW) unrecorded in this survey that are mainly with a temperature lower than 110° C and supplied from biomass boiler





Source : SNCU Survey 2010

Existing district heating in Chambery

- Chambéry :
  - a city of 60,000 inhabitants (210,000 with agglomeration)
  - very active in the promotion of renewable energy

- Existing district heating :
  - Created in 1949
  - High pressure network : superheated water (160/110° C)
  - Energy mix: Biomass (12%), Waste heat recovery (28%), CHP (23%), gas (37%)
  - Some figures :
    - *3 heat production plant*
    - *1 combined and power plant (CHP)*
    - *55 km of buried pipes (5th French DH)*
    - *550 delivery points*
    - *More than 25 000 equivalent housing*
    - *Energy production : 300 GWh/year (15th French DH)*
  - Type of contract : Public service delegation
  - Utility company : SCDC (subsidiary of COFELY)

Production plant of Croix Rouge

Existing district heating in Chambery

- An overheated district heating (160/110° C) in Chambéry city :

The new Ecodistrict Villeneuve

- This new ecodistrict will be realised in several phases :
  - **Zone 1 : 500 housing + school facilities**
  - **Zone 2 : 390 housing**
  - **Zone 3 : 340 housing**
- The project focuses on Zone 1

The new Solar District Heating of Ecodistrict Villeneuve

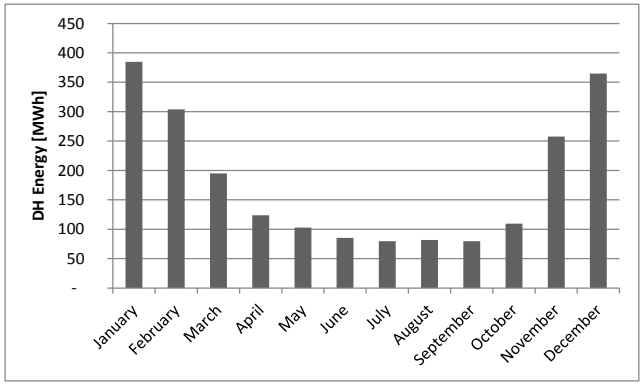
Ecodistrict Villeneuve

- **Characteristics of the housing area :**
  - **480 apartments**
  - **12 buildings**
  - **Annual consumption :**
    - *Space heating : 25 kWh/m²*
    - *Domestic hot water : 20 kWh/m²*

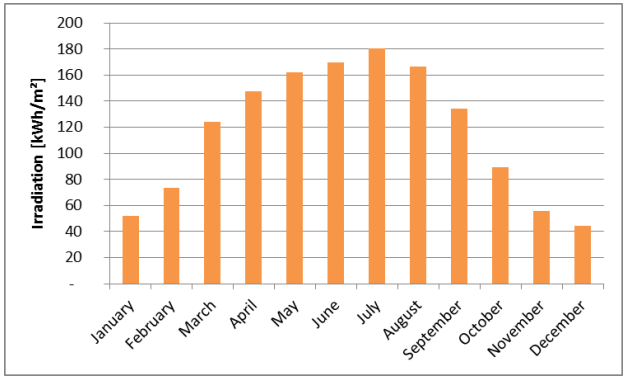
- **DH heating load profile :**
  - **a load curve of the network was defined from the needs of all buildings and losses of network:**
    - *Space heating : building modeling and dynamic simulation with TRNSYS*
    - *Domestic hot water : draw-off profile (IEATask 26 and DHW system modeling including DHW loop)*
    - *Hydraulic of the network : modeling all the pipes of the network*
  - **The total needs of the district heating are 2168 MWh/year**

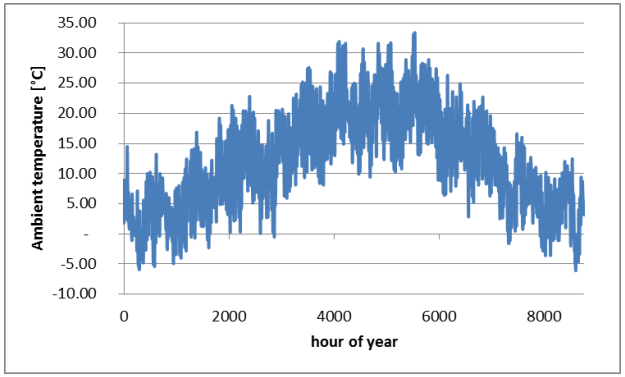
Ecodistrict Villeneuve : hypothesis

- DH load curve :
  - **Total needs : 2168 MWh**



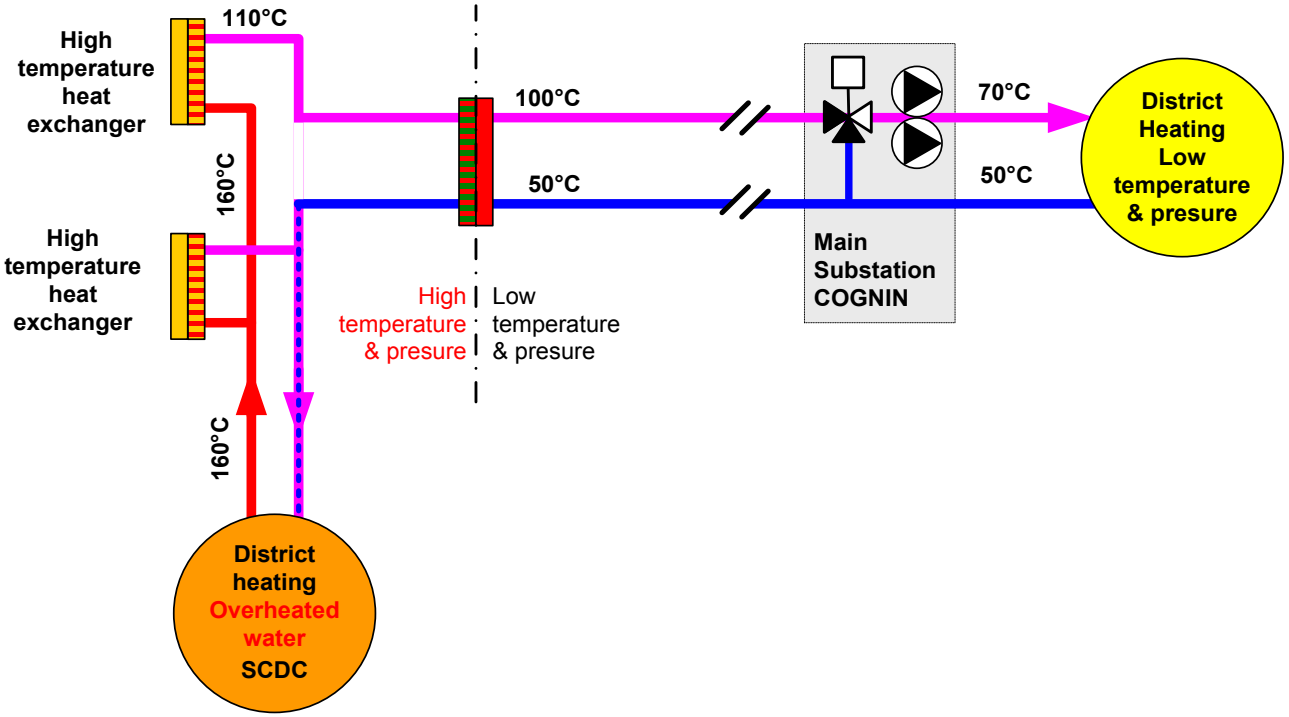
- Climatic data :
  - **Annual irradiation (30°) : 1400 kWh/m²**
  - **Average ambient temperature : 11.8° C**
  - **Heating degree days : HDD_{18}=2500**





Ecodistrict Villeneuve : the concept

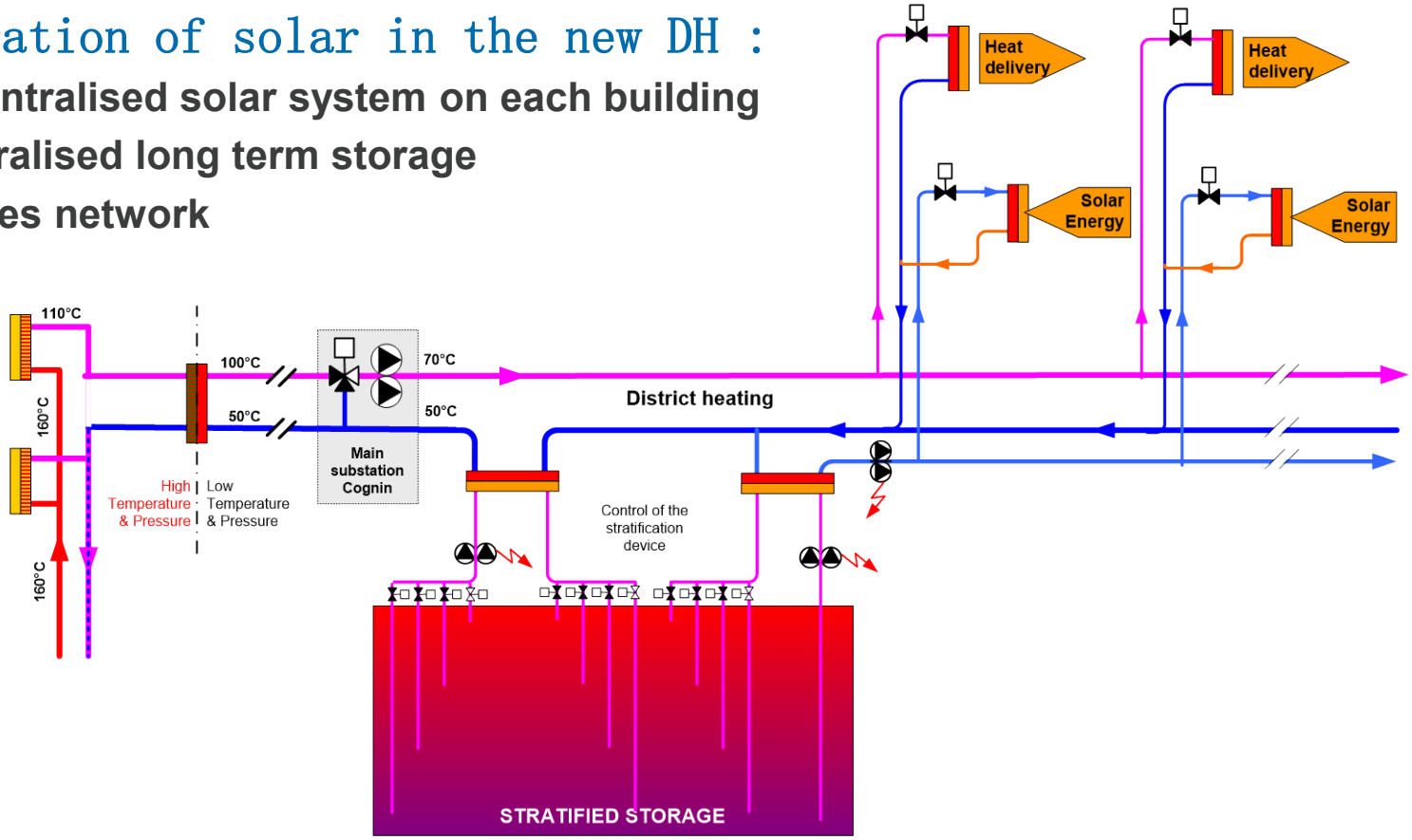
- Extension of the existing DH :
  - New network will be build for the Ecodistrict
  - Low temperature district heating (70/50° C)
  - Auxiliary energy : from the existing high temperature district heating



Ecodistrict Villeneuve : SDH

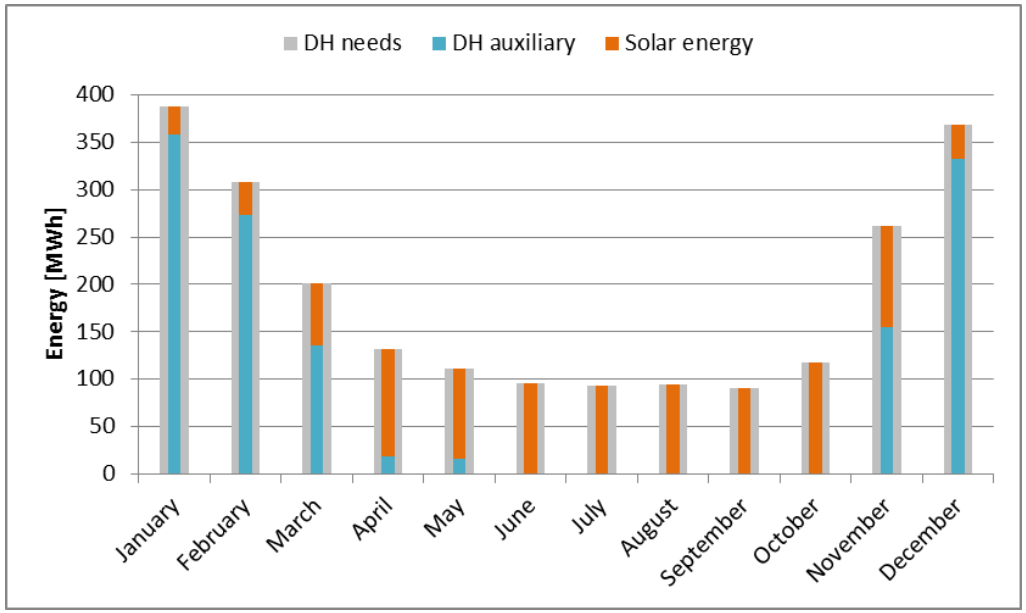
- Objectives :
  - High solar fraction : 40%

- Integration of solar in the new DH :
  - Decentralised solar system on each building
  - Centralised long term storage
  - 3 pipes network



Ecodistrict Villeneuve : SDH performance

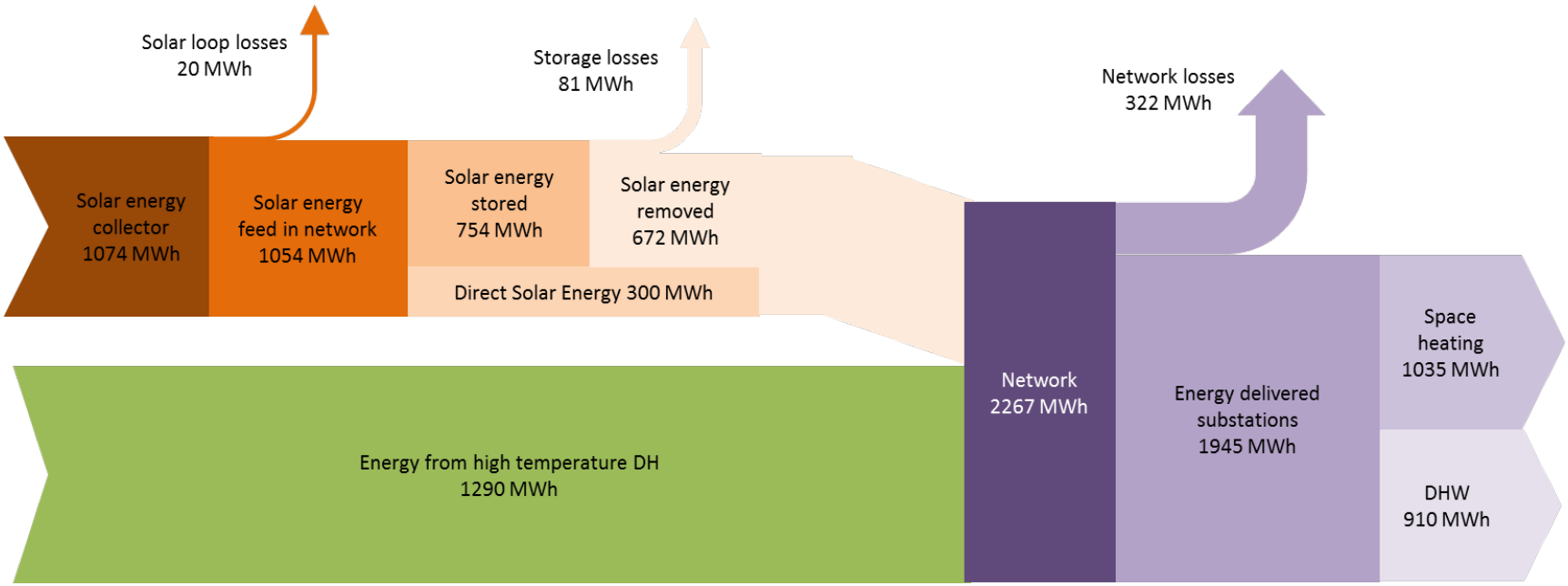
- Performance of the solar district heating :
  - **Solar collector : 2160 m² (high temperature flat plate)**
  - **Storage tank : 3000m3**



  - **Complete autonomy of the sub network from June to October**

Ecodistrict Villeneuve : SDH performance

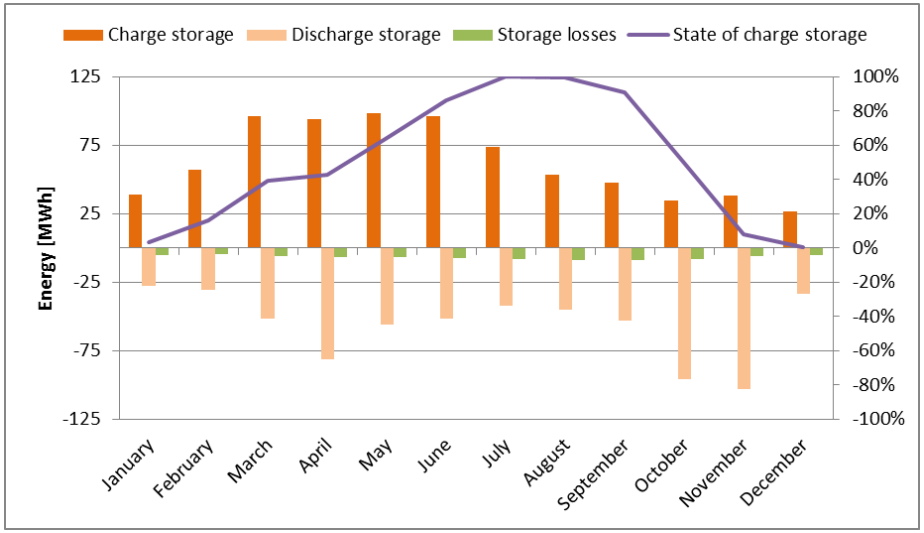
- Performance of the solar district heating :



- **Fractionnal energy savings f_{SAV} : 40.5%**

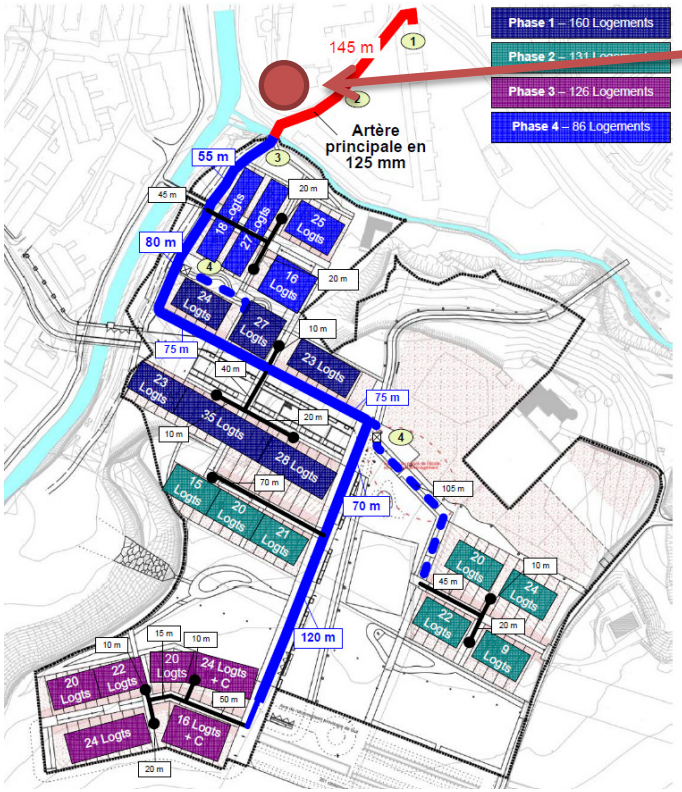
Ecodistrict Villeneuve : SDH Storage tank

- Focus on the storage tank :



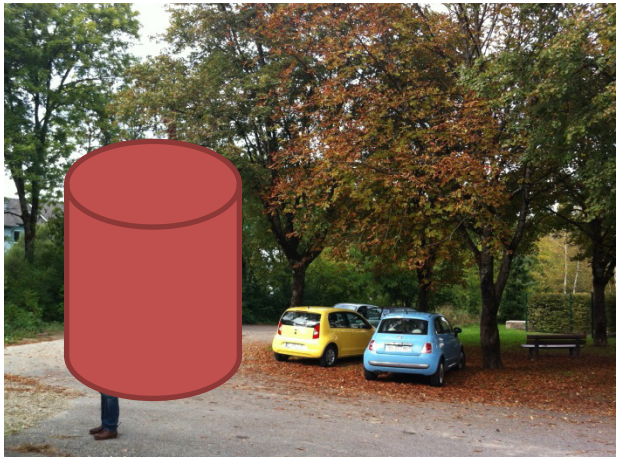
- **Solar fraction from November to March is low**
- **From November the state of charge of the storage is less than 10% and provides no more energy**
- **The storage volume can be valorized:**
  - *by storing carbon-free energy from the high temperature district heating during heat surplus from biomass or incinerators;*
  - *by storing energy to meet the daily consumption peaks and limits the use of peak generators.*

Location and integration of the storage tank



Storage tank

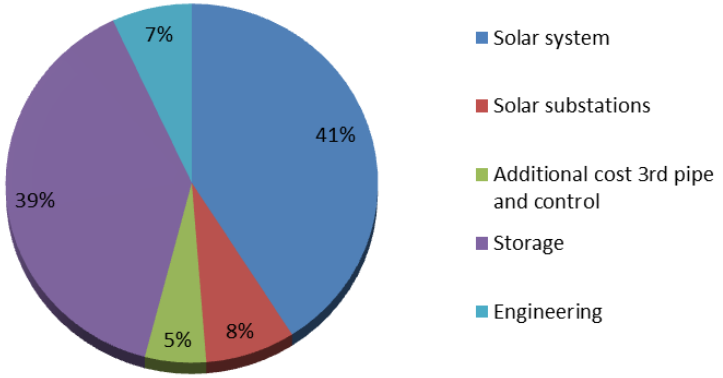
or



Ecodistrict Villeneuve : SDH Economics

- First estimation of the project costs :
  - **Investments :**

Solar system	788 400 €
Solar substations	150 000 €
Additional cost 3rd pipe and control	102 000 €
Storage	750 000 €
Engineering	134 280 €
Total investment	1 924 680 €
Subsidies (local, regional, national)	1 325 000 €



  - **The Levelized Cost of Solar Energy (LCOE) is:**
    - $LCOE_{without\ subsidies}$ = 142 €/MWh
    - $LCOE_{with\ subsidies}$ = 59 €/MWh
  - **It should be noticed that the cost of heat corresponds to a pilot plant to achieve a solar fraction of 40%**

Ecodistrict Villeneuve : Next steps

- Housing area :
  - Phase 1 (120 housing) : 2015-2016
  - Phase 2 (130 housing) : 2016-2017
  - Phase 3 (120 housing) : 2017-2018
  - Phase 4 (90 housing) : 2018-2019

- Solar district heating :
  - Finalize the financing : Summer 2014
  - Design and detailed studies on DH, solar collector and storage : 2014-2015
  - Network and storage construction : 2015-2016

Conclusions

Opportunities and barriers for the project initiation

- Opportunities having helped initiate the project :
  - creation of a new district with low consumption buildings
  - will of the city and the utility company to develop renewable energy heat, and decrease the CO_2 content of the network
  - choice of a low temperature district heating to provide energy to the ecodistrict
  - requirement for buildings in the ecodistrict to provide 50% of the DHW by solar energy

- Many obstacles have also been apprehended :
  - pressure on land and lack of availability to establish a centralized solar plant
    - *-> decentralized solar system with collectors integrated on the buildings*
  - large initial investment with a very low operating cost
  - lack of a fixed framework for subsidizing solar installations connected to DH
  - lack of knowledge and motivation of urban planners, architects and real estate developers for the integration of large solar area on buildings and also the integration of a large storage tank within the ecodistrict

Conclusions

- **Replicability :**
  - **Representative example for the implementation of solar energy on an existing high temperature district heating**
  - **Could be replicated in most of existing high temperature district heating in France with the development of new eco district in suburbs of town**
    - *Solar collector area and storage tank volume should be adapted to the solar fraction.*

- **Innovation :**
  - **an innovative approach that leads to a solar fraction of 40%**
    - *Specific network design, large storage and distributed solar collectors*
  - **a multi-use of the large storage tank**
    - *Use the storage all the year (solar energy, carbon free energy, avoid peak boilers)*

- **Demonstration ?**
  - **The realization is under discussion at the utility company**

- This work was realized in collaboration with :
  - **SCDC : Utility company**
  - **ITF Engineering company**

- And supported by :
  - **ADEME through the Program of Renewable Energy Investments for the Future (Project Smart Grid Solaire Thermique)**
  - **Intelligent Energy Europe program through SDH+ project (project IEE/11/803/SI2.616372)**

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Thanks for your attention !

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