Case study : Chateaucreux district (42) - France

Name of the project: integrating a solar plant in the district heating of the Chateaucreux development zone (FR)

Adress of the project: VIA CONFORT District Heating - rue de la Montat - City of Saint-Etienne (42) - France

Name and type of the owner: The district heating is own by the city of Saint-Etienne but the service is delegated to the VIA CONFORT consortium (DSP), bringing together COFELY GDF SUEZ and CORIANCE

Context of the study

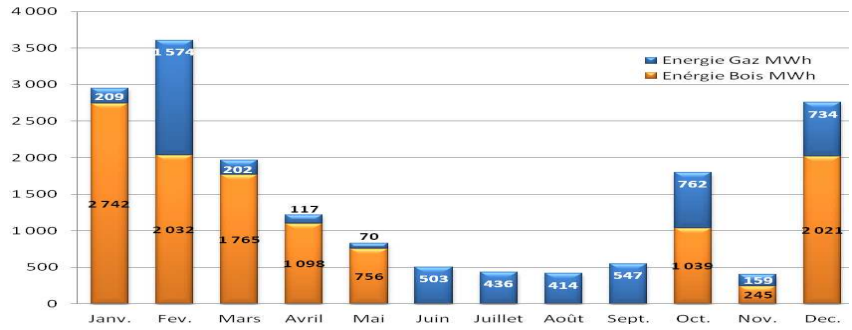
Since 2008, the Chateaucreux District Heating has been in operation under a DSP contract with the consortium VIA CONFORT, which is 51 % controlled by COFELY and 49% by CORIANCE. In 2012, the annual delivery of heat was about 17 GWh, mainly provided by a biomass boiler sustained by natural gas boilers. Heat consumers are mostly new housing, office buildings and public educational institutions. Counting 21 suscribers in 2012, the Chateaucreux DH has been expanding continuously and will continue to grow until 2020.
However, the Chateaucreux area has not expanded as quickly as expected, and so the wood-burning furnace cannot be used in summer, which significantly degrades the share of renewable energy in total primary energy consumption. To improve this situation, VIA CONFORT is thinking about a solar plant to supply the DH and to balance the heat price increase. The aim is to cover the needs in heating by solar energy in summer without installing a too expensive storage.

SDH plant

DH technical data

Technical data :
- Biomass boiler : 5.5MW - 2
gaz boilers : 5 and 7 MW (auxiliary and in case of failure)
- Network : 9 km, 21 substations (2012)

DH energy balance (2012) :
Heat supplied : 13 950 MWh
Estimated losses : 3 475 MWh
DH efficiency : 80%
Boiler room production : 17 425 MWh
Energy mix : 70% biomass / 30% gas
Biomass + gas consumption : 20 694 MWh
Boiler room efficiency : 84,2%



Operating principle:
- **Control** : BOILER ROOM : variable flow rate based on the return flow temperature / SUBSTATION : two-way valve
- **Operating temperature** : in theory, about 90/70°C in winter and 80/60°C in summer. In reality : 95/80°C in winter and 90/80°C in summer.

Solar plant system concept and technical data

The solar plant is centralized and ground-mounted , with solar termal collectors facing south and tilted at 30 degrees. The plant could be connected on the main return flow and a collector net area of about 1000 m² could be installed on the site of the boiler room.

A wilderness about 1.3 ha, porperty of the city, could be used to implant an aditionnal collector net area of about 4000m². This ground is located in front of the site of the boiler room.

Two collector technologies have been studied : Flate plate high temperature (FPHT) and evacuated tubes (ETC).

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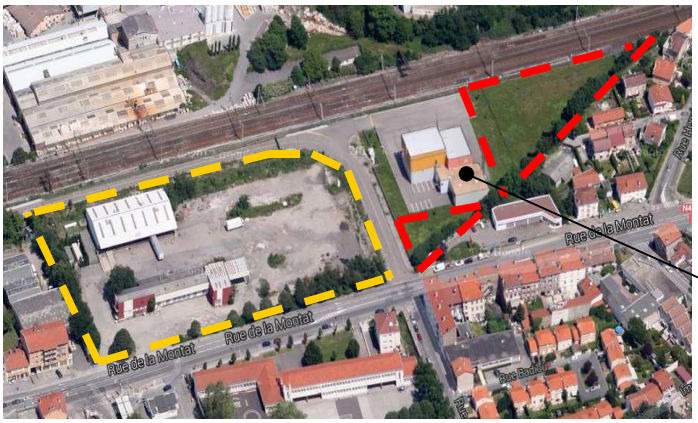


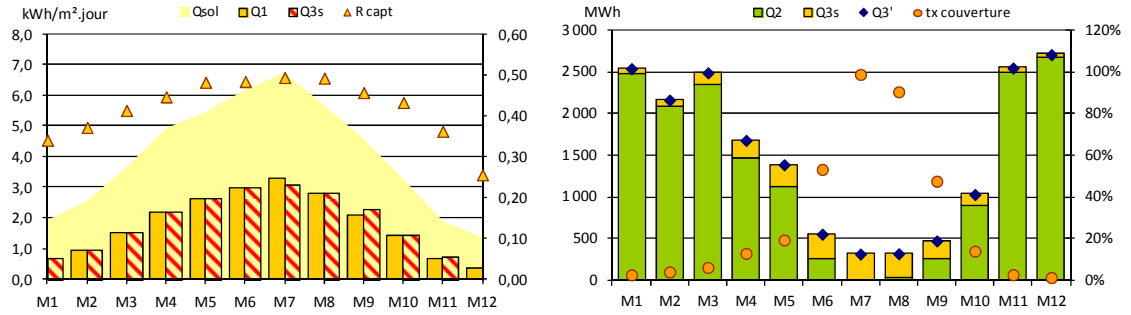
	Capteur 1	Capteur 2
Surface unit.	12 m²	9,35 m²
h0 (-)	0,817	0,71
a1 (W/m².K)	2,205	0,95
a2 (W/m².K²)	0,0135	0,005
Dimensions	2,3m x 6m	2,4m x 4,5m

Aerial Photgraphy - Available sites to implant solar thermal

SDH energy balance

Two scenarios have been considered and submitted to the DH's operator (VIA CONFORT) :

- a low cost scenario, with a collector net area of 1100 m² and wihtout storage (the distict heating capacity will be used as a short terme storage). The solar fraction is about 3,5% of the total heat demand for a solar output of 600 MWh/year.
- a "100% solar fraction" scenario in summer. This concept needs a collector net area between 3300 and 4300 m² (according to the collector technology) and requires a storage capacity of 400m^3. The annual solar fraction could reach 12 % of the total heat demand for a solar output of 2150 MWh/an.



Qsol : solar irradiation on collectors , Q1 : Solar energy collected (before storage), Q3s : solar output, Q2 : production of auxiliary energy (gas, biomass), Q3': District heatingconsumption (losses included), Rcapt = Q1/Qsol, Tx couv = Q3s / Q3'

SDH economics

The solar heat cost should be about 90 € /MWh for both FPHT and ETC technology (calculated with LCOE method w/o VAT and grants).

To hope for a 50 €/MWh solar heat cost, the solar plant would have to got subsidies about 6700€/Toe (Tonnes of oil equivalent), which be equivalent to 50% of the solar investment.

	SCENARIO 1		SCENARIO 2	
Collector Technology	Flat-plate high temperature (FPHT)	Evacuated tubes Collectors (ETC)	FPHT	ETC
Net Collector area (m²)	1 100	1 100	4 300	3 300
Solar Yield (kWh/m².an)	470	615	495	654
Investment (k€ without VAT)	565	747	2 371	2 412
Exploitation cost (k€ without VAT)	6,2	7,9	22,5	22,9
LCOE over 20 years, without subsidies	**91**	**91**	**92**	**93**

The levelized cost of solar energy has been calculated with : an actualisation rate of 4% / a solar plant lifespan of 20 years / a loan interest of 3,75% / All price are excluding VAT.

SDH plant opportunities & threats, benefits & limits

Opportunities : - a wilderness, close to the boiler room, could be use to implant the collectors ; - without additional investment, the operating temperature could be optimize with simple measures ; - During summer, gaz boiler could be totally stopped ; - The city of Saint-Etienne has suscribed to a DSP contract for 20 years.The DSP contract.

Threats and Limits : the city of Saint-Etienne should accept to lend its ground.

Authors

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Smart Grid Solaire Thermique