SDH solar district heating

Case study : Milan (Italy)

Name of the project:	MILANO
Adress of the project:	MILANO
Name and type of the owner:	A2A - private company
Owner contact person:	Lorenzo Spadoni - lorenzo.spadoni@a2a.eu Marco Camussi - Marco.Camussi@a2a.eu

Context of the study

The DH company is asked to link a new urban area in the city of Milan to the network. On this occasion, a solar integration as a heat source is considered since:
- the new district will be characterised by low energy and high performance buildings
- the company is looking towards the future in order to prepare itself for upcoming new regulation on the renewable share of district heat

Support

Since the subject of this study is a new possible DH that will be concerned by future law, no incentives are taken into account. The actual legislation, Conto Energia DM 28/12/2012 incentivizes the production of energy by renewables, but large solar thermal plants with a gross area >1.000m2 are not involved.

SDH plant

SDH system concept

With hyopothetical energy demands of the new district and an available surface of 21.000 m2, 3 different alternative solutions are investigated:

Solution 1 A – "cold hydronic circuit", solar plant with daily storage:
A new two-piping DH network ("cold hydronic circuit") is maintained with a Tsupply of 20 °C all over the year. Each building is provided with a reversible space heating/cooling Heat Pump (HP) and a DHW Heat Pump with a DT on the DH of 5°C.
Winter: HP benefit from 20°C temperature as heat source to reach high COPs. Heat supply occurs via a large solar thermal plant and, when solar energy is not sufficient, via existing DH network at high T used as backup. (20-15°C)
Summer: DHW HP works as in Winter. Space heating/cooling HP works in chiller mode, benefitting from 20 °C temperature as heat sink to reach high COPs. As cooling loads are significantly higher than DHW loads, the hydronic circuit tends to warm up and must be therefore cooled down by centralized cooling tower and chiller . (20-25°C) During summer the solar thermal plant charges a daily storage, which covers night loads (DHW), but the major part of solar heat is not used (the solar plant does not reach 90°C to feed-in into existing DH network)
Solution 1 B – "cold hydronic circuit", solar plant with seasonal storage :
Same as 1 A, except for solar plant: during summer the solar thermal plant charges a daily storage, which covers night loads (DHW), and, with excess heat, a seasonal storage. Such stored energy is used during winter to increase renewable share of DHW and space heating.

Solution 2 – Low temperature DH:
A new low temperature DH network (e.g. 70 °C) delivers heat for DHW production and low temperature heating (e.g. radiant floor, fan coils…).
Each building is equipped with an air cooled chiller for the cooling season (e.g. air cooled, no need for cooling towers).
A large solar thermal plant delivers heat to maintain the DH network at 70 °C all year long. Existing DH network is used as back up.

SDH technical data

- Existing District Heating (DH) run by A2A can already be considered efficient according to Energy Efficiency Directive, that is 50% of the heat is produced by a mix of renewables, high efficency CHP and waste heat.
- Aperture collector area: 21.000 m2 (available area) for alternatives 1A-1B; 4.500 m2 for alternative 2
- Solution 1 A: new two-piping DH network Ts=20 °C; Tr =15°C. Daily solar storage. + HP for DHW, Heating and Cooling.
- Solution 1 B: Same as 1 A, but with seasonal storage of approximately 31.500 m3.
- Solution 2: the DH network (Ts=70 °C; Tr =40°C) delivers directly heat for DHW production and low temperature heating (e.g. radiant floor, fan coils…). No storage, ST directly delivers heat in the DH network.

SDH energy balance (MWh)

- Hypothetical loads for new distric:
Annual heating demand: 7.000 MWhth
Annual cooling demand: 6.800 MWhfr
Annual Domestic Hot Water (DHW) demand: 7.000 MWhth

Solution 1 A
Delivered solar thermal energy: 3.700 MWh => big share of available solar heat is not used
Thermal energy delivered by existing DH network: 5.170 MWh
Required cooling power of tower: ca. 5 MW
Required recooling energy via cooling tower: 1.600 MWh
Required centralised chiller power: 10 MW
Required cooling energy via chiller: 5.700 MWh
Efficiency energy ratio of Solution 1A: ca 40%
Renewable energy ratio of Solution 1A: ca 25%
Solar Fractional Savings of Solution 1A: ca 40% (comparison with same plant scheme but without the solar field)

Solution 1 B
Delivered solar thermal energy: 7.700 MWh => large share of available solar heat is now used
Thermal energy delivered by existing DH network: 5.170 MWh
Required cooling power of tower: ca. 5 MW
Required recooling energy via cooling tower: 1.600 MWh
Required centralised chiller power: 10 MW
Required cooling energy via chiller: 5.700 MWh
Efficiency energy ratio of Solution 1B: ca 50%
Renewable energy ratio of Solution 1B: ca 45%
Solar Fractional Savings of Solution 1B: ca 80% comparison with same plant scheme but without the solar field)

Solution 2
Delivered solar thermal energy: 2.150 MWh
Thermal energy delivered by existing DH network: 11.900 MWh
Air cooled chillers SPF: 3
Efficiency energy ratio of Solution 2: ca 50% (with 21.000 m2 Qr = ca. 55%)
Renwable energy ratio of Solution 2: ca 20% (with 21.000 m2 Qr = ca. 30%)
Solar Fractional Savings of Solution 2: ca 15% comparison with same plant scheme but without the solar field)

SDH economics

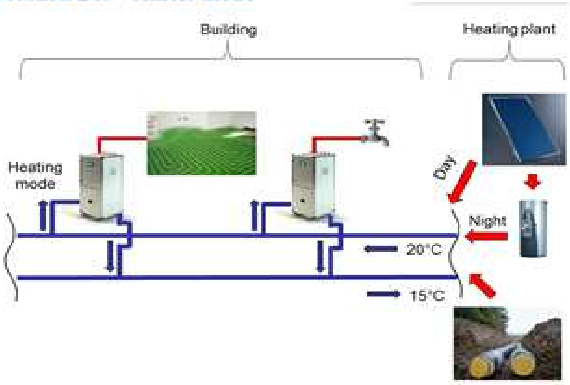
Approximate investment costs (just for the ST integration and cooling tower, not considering DH network, heat pumps and ground prices):
- Solution 1 A: € 6,5 ml
- Solution 1 B: € 11,2 ml
- Solution 2: € 1,4 ml

SDH plant opportunities & threats, benefits & limits

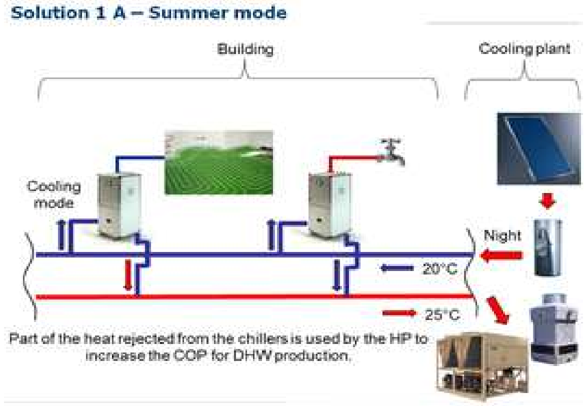
- Solution 1 A: With a big solar field but with just a daily storage a big share of available solar heat is not used.
- Solution 1 B: Big solar field and seasonal storage allow a large share of available solar heat use, solution with highest fractional savings. But this solution is the most expensive and it's difficult to find a place for the storage since in the area it's not possible to use underground because of polluted ground
- Solution 2: Solution with lowest fractional savings, but also with the lowest investment costs, and still with high efficiency energy ratio.

Photos

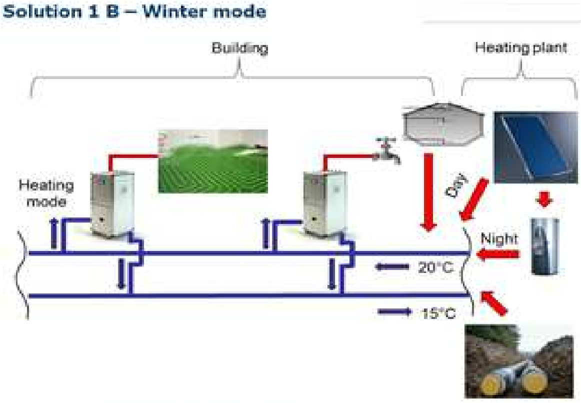
Solution 1 A – Winter mode



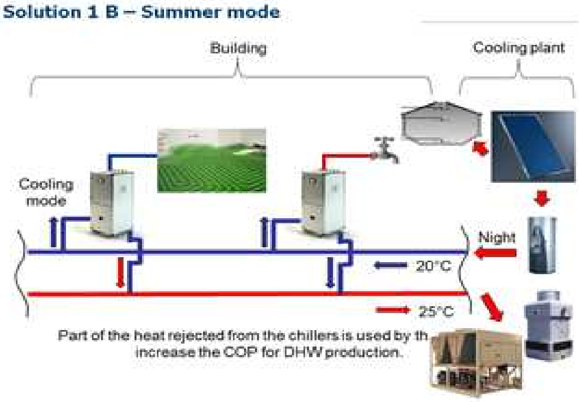
Solution 1 A – Summer mode



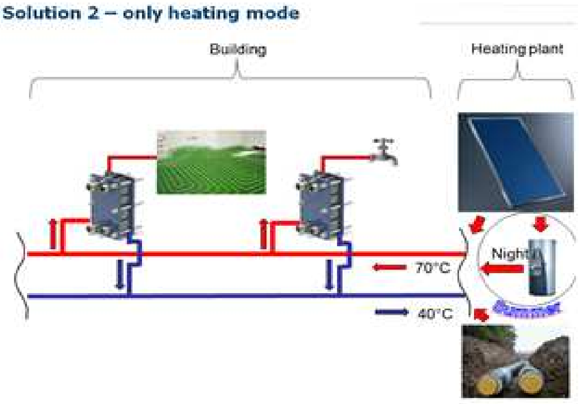
Solution 1 B – Winter mode



Solution 1 B – Summer mode



Solution 2 – only heating mode



Authors

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