SDH solar district heating

Case study N°6 (ITALY)

A/ Context of the study

A.1/ Motivations

The utility plans a solar integration with the aims of:
- Covering the summer needs to limit gas boilers operations
- Increasing renewable energy share
- Social and political purposes

A.2/ Description of the existing DH

The whole district heating network pipelines extend for about 4,4 km. The heating needs of the district heating are provided by 2 gas boilers of 2,8 MW (total installed power), a gas CHP of 0,75 MW and a heat recovery from a biogas CHP (third party property). The total thermal power installed is about 4,3 MW. Furthermore, an absorption chiller feeds a small district coolig network with 0,43 MW of installed cooling power.

Temperature and flow in winter are:
- Tforward 80 °C
- Treturn 65 °C
- Flow: variable

while in summer are the following:
- Tforward 80 °C
- Treturn 65 °C
- Flow: variable

It is important to note that the return T is affected by the heat recovery from the biogas CHP. The forward T depends also on the chiller operations. The total annual thermal energy consumption has been about 5,8 GWh in 2013.

A.3/ Environment data

For what concerns the weather conditions, data used come from Meteonorm (meteonorm.com): hourly data of air and ground temperatures, air relative humidity and solar irradiation of the location. Here a summarizing table of average monthly conditions:

MONTH	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*
n° Days	31	28	31	30	31	30	31	31	30	31	30	31
n° Hours Day	281	305	378	408	465	474	469	454	380	350	298	280
n° Hours Night	463	367	366	312	279	246	275	290	340	394	422	464
T ext. air max [°C]	12.3	16.7	22.0	23.5	27.2	30.6	33.5	32.8	29.9	23.9	17.8	13.9
T ext. air min [°C]	-5.3	-4.2	-2.9	-0.8	5.4	8.0	11.1	12.2	8.5	4.0	-1.2	-5.8
T ext. air ave [°C]	2.9	4.4	8.3	11.3	16.2	19.6	22.8	22.3	18.8	13.4	7.3	3.6
T ground ave [°C]	7.0	6.5	6.8	8.0	9.7	11.5	12.9	13.5	13.2	12.0	10.2	8.4
Relative Humidity [%]	81.6	75.6	70.7	75.3	72.9	73.4	71.8	72.7	75.1	78.0	80.5	81.2
Irr max H [W/m²]	406	591	740	860	1005	973	963	877	824	655	439	399
Irr ave H [W/m²]	133	197	292	318	367	392	414	368	307	194	127	110
Rad tot H [kWh/m²]	37	60	110	130	171	186	194	167	117	68	38	31

A.4/ Opportunities and barriers

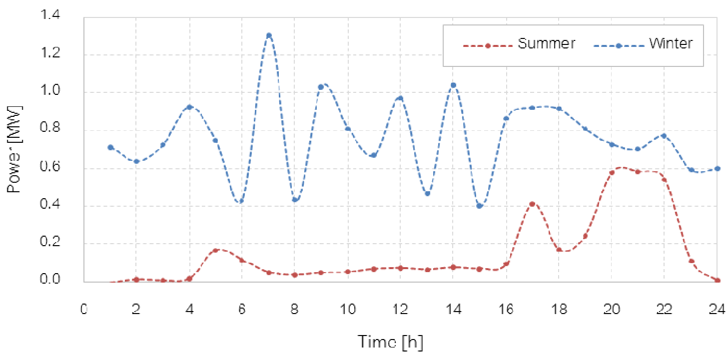
OPPORTUNITIES:
- High motivation and interest in solar DH
- Significant ground availability near the DH generation plant
- Low convenience of operating cogeneration means higher use of boilers
- The small network allows high solar fractions even with small solar fields (under 1000 m2, which is the incentive scheme limit)

HURDLES
- Hard integration with biomass recovery because of high return temperatures (low solar efficiency)
- Absorption chiller operations unknown

B/ Methodology and tools used in the study

B.1/ DH load profile

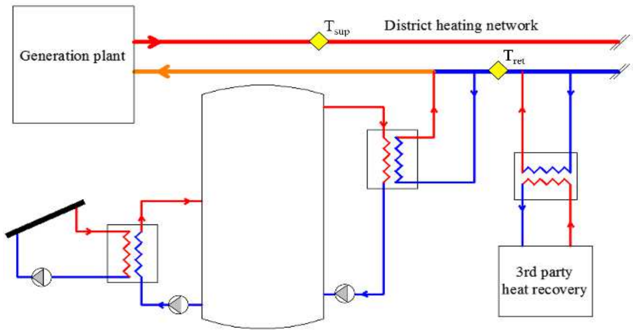
An example of load profiles in winter (blue) and summer (red), with a hourly timestep, has been provided directly by the DH supplier. Actually, the calculated heating needs are much variable, so the reported trends are intended to be simple examples.



B.2/ SDH design and sizing, energy balance

The integration of the solar plant into the DH grid is "feed-in return-->return".
TRNSYS has been used because it is more flexible than other softwares (e.g. TSOL): it's easier to insert input meteo data and load profiles. hesis. The goal of the solar integration is to exploite the maximum available incentivized surface (1'000 m2) with the help of the installation of a storage tank of 70 m3.

The used energy performance indicators are:
- *solar energy produced by the solar thermal system (Esol);*
- *efficiency of the plant (Eta plant);*
- *solar fraction(fsol).*



B.3/ Economics

All the following economic indicators have been calculated internally by the utility according to technical results provided by the case study.
- Pay-back time,
- Internal rate of return (IRR)

C/ Results of the study

C.1/ SDH system design, energy balance and performance

In the following table, main energy results from TRNSYS simulations:

Esol	MWh	343
$\eta_{impianto}$	%	32
f_{sol}	%	5,9

C.2/ Heat production management at network level

Solar energy is mainly used in summer in order to avoid the use of expensive natural gas boilers. The biomass heat recovery has the priority on the solar.

C.3/ Economics at SDH level and at network level

The total investment cost (with 1'000m2 of solar collector field and a storage tank of 70 m3) is about 352'000€. This value is between 200€/m2 and 400€/m2 that represents the unit cost of typical ground installation in Europe.
The O&M costs are estimated in 2'500€/year (0,7 % of the investment, 0,73€cent/kWh solar production).
Also national incentives are considered 228'800€ distributed in 5 years. (Conto Termico for 1'000m2 of solar collector-with the limit of 65% of the total investment)
Considering the presented values, the utility calculated the following indicators:
- Pay-back time is about 11 years.
- IRR is 5,05%

Authors

Case study and factsheet have been performed by Alice Denarie, Matteo Muschera (POLIMI) in June 2015

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