SDH solar district heating

Case study : ASTEM Lodi (Italy)

Name of the project: Lodi

Address of the project: Lodi

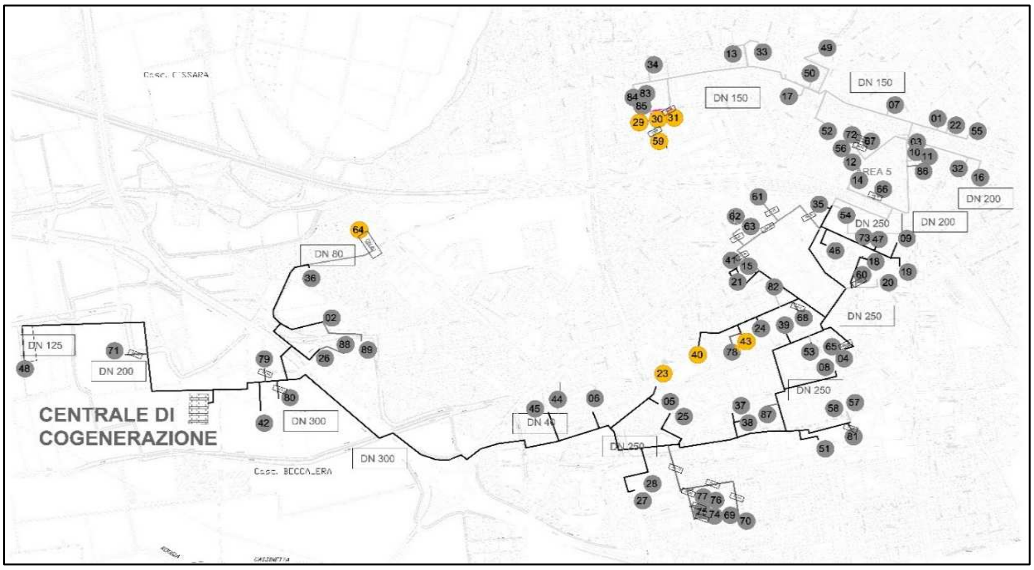
Name and type of the owner: DH supplier

Owner contact person: Luca Vailati (l.vailati@astemgestioni.it)

A/ Context of the study

A.1/ Motivations

ASTEM network has several peripheral branches to whom few DHW users are connected. Operation of such peripheral branches has therfore bad economics in summer, when only DHW need is required. In order to disconnect some sections of the network in summer and reduce pipe losses, ASTEM wants to evaluate the feasibility of installing distributed solar systems on roofs of some peripheral buildings.



A.2/ Description of the existing DH

The district heating pipelines extend for about 25 km (both supply and return pipes). The heating needs of the distict heating is provided by 4 MW of cogeneration plant, 29 MW of natural gas boilers and 4 MW of biomass boiler. The total installed thermal power is 37 MW.

<u>Temperature and flow</u>

in winter:

-Tforward 115 °C

-Treturn 65 °C

-Flow (nominal) 150 m3/h

-Flow (max) 350 m3/h

in summer:

-Tforward 85 °C

-Treturn 65 °C

-Flow (nominal) 25 m3/h

A.3/ Environment data

For what concerns the weather conditions, we used Meteonorm (meteonorm.com) hourly data of air and ground temperatures, air relative humidity and solar irradiation in Lodi. 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	282	300	381	409	465	472	470	449	381	348	297	279
n° Hours Night	462	372	363	311	279	248	274	295	339	396	423	465
T ext. air max [°C]	14.0	16.8	22.8	24.2	31.1	33.6	33.9	34.3	31.0	25.5	19.8	14.6
T ext. air min [°C]	-4.5	-3.8	-1.0	3.0	8.5	13.1	14.9	14.8	10.4	4.9	-1.7	-5.1
T ext. air ave [°C]	2.9	5.0	9.8	12.9	19.0	22.9	24.6	24.5	19.2	14.6	7.9	3.8
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 [%]	81.2	71.1	68.5	70.8	68.1	67.6	66.9	69.8	72.8	81.1	83.5	82.1
Irr max H [W/m²]	446	558	769	926	918	1027	957	895	798	623	423	363
Irr ave H [W/m²]	124	182	261	323	350	378	403	365	298	201	125	103
Rad tot H [kWh/m²]	35	54	100	132	163	178	189	164	114	70	37	29

A.4/ Opportunities and barriers

OPPORTUNITIES: high motivation in solar DH and possibility to disconnect some buildings of the network (in summer), thus reducing pipe losses
BARRIERS: in some cases there is not enough space on roof for solar collectors, and also the panel should be installed on an existing building, that is more expensive than placing them on ground.

B/ Methodology and tools used in the study

B.1/ DH load profile

It was not possible to obtain an hourly load profile, therefore the following hypotesis were considered:

In winter

- From 9 to 22 is the nominal heating requirement period
- From 6 to 9 is the max heating requirement period
- From 22 to 6 is the min heating requirement period

In summer

- Same profile for everyday

TOTAL

USER	TIPOLOGY	DHW NEEDS 15/04 - 15/10
64	Residential building	36 MWh
23	Residential building	42 MWh
40+43	School+(sport) locker room	13 MWh
29+30+31+59	Residential building	83 MWh

B.2/ SDH design and sizing, energy balance

The design of the SDH is "distributed system" where there is both roof-mounted collector field and roof-integrated collectors, depending on the roofs where solar collectors will be install. There are 9 buildings in various part of DH, residential and for school purpose.
The software T*SOL has been used because it is easier to handle for multiple simulations then other dyamic simulation software (e.g. TRNSYS). The solar field size is variable from 40 m2 to 200 m2 with thermal energy storages dimensioned following these criteria:

- Collector area = 0.6 - 1.1 m2 per person
- Storage volume=50-100 l / m2
- Energy saving = 600-900 kWh / (m2 a)
- Energy savings relative to the needs of DHW (yearly) 60-80%

Main target is to cover in summer nearly 100% of the need, DH will be used only for backup, when bad weather conditions occurs. The exact period to be considered as summer has been defined during the study, in order to maximise cost/benefit ratio.

B.3/ Economics

Evaluation based on the calculation of:
- Pay-back time,
- Internal rate of return (IRR),
- Net present value (NPV).

All economic figures have been calculated by ASTEM according to technical results provided by the studies.

C/ Results of the study

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

The results of the various simulations for the 8 building are summarized below. The table shows how many hours of backup (via district heating) are necessary to cover the heat demand, for each simulated building and for three different periods (in summer).

	15-04 to 15-10	*01-05 to 30-09*	*15-05 to 15-09*
Building ID	[h]	[h]	[h]
23	91	49	13
29+30+31+59	374	217	64
40+43	89	66	5
64	78	38	11

Because of the great amount of data is not possible to take all values in this document so, for a complete overview of our work, please refer to the complete feasability study. Here's a summary

USER	Summer needs15/05-15/09	Total energy delivered by DH	Total energy savings
[#]	*[MWh]*	*[MWh]*	*[MWh]*
64	29.7	2.4	51.8
23	62.1	3.9	82.7
40+43	12.1	0.6	45.9
29+30+31+59	26.5	1.5	49.6

C.2/ Heat production management at network level

It is possible to manage the DH network with the control strategy to disconnect some network branches, using the existing control components for the primary loop.

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

The economic results of the study have been grouped for every peripheral branche (a total of 4) of the DH network and they are shown in the table below:

		1	2	3	4
Investment cost solar plant	€	€ 105'000	€ 65'500	€ 246'000	€ 120'000
Operation cost	€	€ 168	€ 96	€ 378	€ 192
Maintenance cost	€	€ 1'680	€ 960	€ 3'780	€ 1'920
Total incentives	€	€ 38'500	€ 23'950	€ 86'625	€ 44'000
Internal Rate of Return (IRR)	€	-€ 71'000	-€ 26'000	-€ 189'000	-€ 87'000
Net Present Value (NPV)	%	-11,2	-€ 1.20	-€ 25.70	-€ 15.40
Payback	y	>20	>20	>20	>20

C.4/ Overview of possible business models

ASTEM figured out a 10% discount on the heat tarif for the buildings where solar collectors are installed, as a revenue for hosting the solar systems, which basically belong to ASTEM.

Authors

This factsheet was prepared by Marco Calderoni and Stefano Agosteo

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