Factsheet T.2.2

In depth analysis of the case study in Acqui Terme

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SEN	Sensitive, limited under the conditions of the Grant Agreement	☐
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R	Report, document	☒
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DATA	Datasets, microdata, etc.	☒
DMP	Data management plan	☐
ETHICS	Deliverables related to ethic issues	☐
SECURITY	Deliverables related to security issues	☐
OTHER	Software, technical diagram, algorithms, models, etc.	☐

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1. INTRODUCTION

The district heating system in Acqui Terme is developed and managed by Acqui Energia S.p.A., based on the agreement signed between the Municipality of Acqui Terme and the company on 7th May, 2009.
The plant has become operational in the fall of 2009 and has undergone progressive network expansions in various areas of the city, accompanied by a corresponding increase in the production capacity of the cogeneration plant. In addition to the district heating system in Acqui Terme, located in the province of Alessandria, EGEA is the service company that manages district heating networks in the provinces of Turin, Asti, Cuneo, and Savona, employing a total of 30 people within the company.

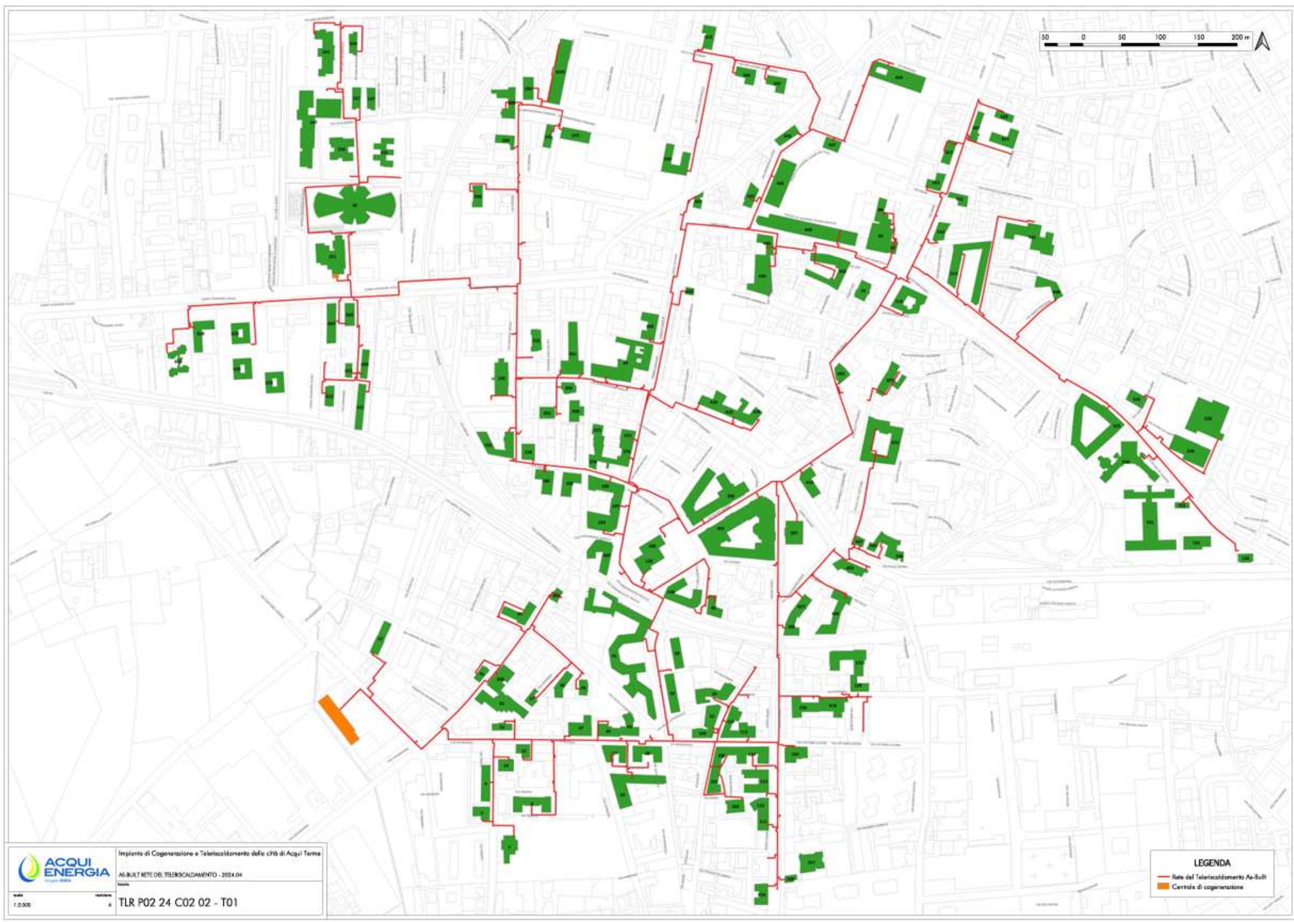

Figure 1 – Map of Acqui Terme's district heating system

2. THE DISTRICT HEATING SYSTEM (AS IS)

2.1 Energy generation

The heat for the system in Acqui Terme is generated at a single thermal plant located in Via Capitan Verrini 7, within the municipality of Acqui Terme. This plant was built in 2009 and expanded in 2012, covering a total area of approximately 3,500 square meters. Currently, heat production leverages on two cogeneration units and three boilers. Table 1 below summarises the key characteristics of these machines.

Component	Electrical Power	Thermal Power	η_{el}[1]	η_{th}[1]	Year of Construction
CHP Unit 1	2,677 kWe	2,614 kWt	0.44	0.43	2012
CHP Unit 2	2,000 kWe	1,904 kWt	0.45	0.43	2023
Boiler 1	-	9,300 kWt	-	0.95	2009
Boiler 2	-	5,300 kWt	-	0.95	2009
Boiler 3	-	7,800 kWt	-	0.95	2012

Table 1 – Central plant's component

The baseload is supplied by the two CHP units in parallel, while the boilers are normally activated when the heat demand exceeds the CHP capacity. The system does not feature a thermal storage.

In 2023, the system generated **34.8 GWh** of thermal energy, primarily using natural gas (**5.8 million Sm^3**), resulting in approximately **11,500 tons of CO_2 emissions**[2].

The annual maintenance costs of the plant amount to approximately **170,000 euros**, mainly linked to the cogeneration units. For the energy balance assessments, EGEA uses an optimization software developed by the Politecnico di Torino. The software utilizes a MILP (Mixed Integer Linear Programming) formulation to determine the optimal plant configuration and asset sizing, serving primarily strategic purposes by assessing the feasibility of integrating an asset into the plant portfolio.

1. η_{el} and η_{th} are the electrical efficiency and the thermal efficiency, respectively.
2. CO_2 emission factor for natural gas: 1.972 kg_{CO2}/Sm^3

2.2 Energy Distribution Network and Consumers

The network in Acqui Terme is **8.9 km** long (**12.8 km** including connections) and most piping is pre-insulated. The first **3.5 km** was constructed in 2009, progressively expanded in the following years.
The pumping system features **five units** (859 kWe) at the central plant and is regulated by VSD (Variable Speed Drivers) and the consumption related to the pumps amounts to **1.331 MWh**.
The operation logic varies between winter and summer and follows mainly a pressure-based regulation.
In winter, the pressure differential (Δp) between the supply and return lines ranges from **0.7 bar at 18°C to 2.7 bar at -5°C** from 5 AM to 11 PM, while is set to **0.5 bar** from 11 PM to 5 AM.
In summer the Δp is steadily set to 0.5 bar.
The network operates with a supply/return temperature regime of around **85°C / 65°C** and the thermal losses is around **15%**.

The district heating users in Acqui Terme are mostly residential, as shown in Table 2 below.

Number of customers	Type	Volume	Thermal Demand
134	Residential	1,035 m^3	27,500 kWh/y
	Tertiary	443 m^3	6,700 kWh/y

Table 2 – Breakdown of consumption

In total, there are **180** substations, and the total heat sold to consumers amounts to **34.2 GWh/y**.
The substations range from 80 kW to 1,400 kW (500 kW on average), and are plate heat exchangers that can be monitored and controlled for temperatures, pressures, and flow rates (following a campaign that deployed Smart Meters across the whole customer base). Temperature regime on the secondary side is **70°C / 50°C** (supply / return).

A SCADA system is in place, enabling to collect, monitor, and analyze real-time data from the network.
Cartographic data is available in digital form (.shp file format), which is used for thermohydraulic simulations, using dedicated softwares (MARTE and INFOWORKS).
Maintenance activities utilize thermal mapping tools, checks and updates of thermostatic valves, as well as the monitoring of water reinjection and treatment at the plant. The annual maintenance costs amount to approximately **30,000** euros.

The contracts with customers are valid for one year and follow a **bimodal tariff** structure. A bimodal tariff consists of two components: a fixed charge, which is due regardless of their energy consumption and typically covers infrastructure, maintenance, and other fixed costs, and a variable charge, based on the heat consumption.

3. UPGRADING MEASURES

In 2020, EGEA presented a project to harness a local low-enthalpy geothermal resource. Geological studies identified an area where the well could reach a depth of 500 meters, where water at 70°C is found. However, to avoid problems related to the soil, it was decided to limit the depth to 150 meters, where the temperature is 40°C. The project involved the construction of an extraction well, thermal exchange through plate heat exchanger, and re-injection into the groundwater via a reinjection well. The heated fluid was to be sent to two water-to-water heat pumps with a thermal capacity of **3.82** MW and a COP of **3.5**.
This initiative could help EGEA establish itself as an efficient district heating provider by achieving the following percentages (**before** and **after**):

- Heat from cogeneration: **48.3%** vs **29.6%**
- Heat from RES: **0%** vs **54.1%**
- Heat from boilers: **51.7%** vs **16.3%**

The project has been suspended for two reasons: the first concerns the risks associated with well perforation, which could potentially cause hydrogeological issues. The municipality has requested guarantees to ensure that the groundwater sources remain undisturbed. The second reason is that the municipality has lost the control of the thermal baths, which are now managed by a private entity, and is actively working to regain the concession.

In EnableDHC, what-if analyses will be conducted to assess the benefits of integrating these heat pumps and a storage tank to optimize the use of water extracted from the geothermal wells, as well as to explore the possibility of utilizing the wastewater from the thermal baths.

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