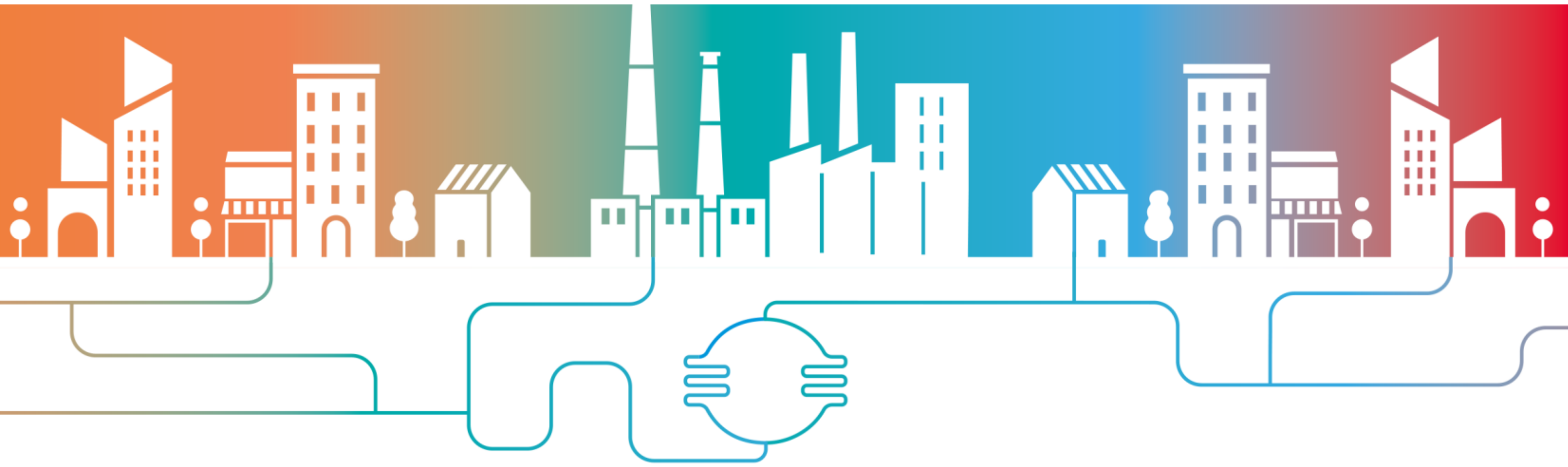
LIFE 4 HEAT RECOVERY

Implementation of the waste heat recovery measures at Ospitaletto DH network – Action C.1



Low temperature, urban waste heat into district heating and cooling networks as a clean source of thermal energy

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Project Title: Low temperature, urban waste heat into district heating and cooling networks as a clean source of thermal energy

Project Acronym: LIFE4HeatRecovery

Deliverable Title: Implementation of the waste heat recovery measures at Ospitaletto DH network

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1 INTRODUCTION

This deliverable describes the installation and commissioning of the LIFE4HeatRecovery demonstration case located in Ospitaletto, Italy.

In 2018 COGEME implemented a cold district heating network of approximately 2.3 km in length in the town of Ospitaletto. The company is currently operating the system, using energy sources such as geothermal energy and waste heat from the steel mill ASO (situated approximately 1 km from the town centre) to meet the heating requirements of public and private buildings.

ASO is a factory producing steel from scrap, which is selectively collected through a recycling process.

The metal is melted into a liquid which is poured into moulds, where it takes shape and hardens after the cooling process. The materials used are aluminium and cast iron.

The site operates 5 days a week with three daily shifts, so that heat can be drawn from Monday afternoon until Saturday morning.

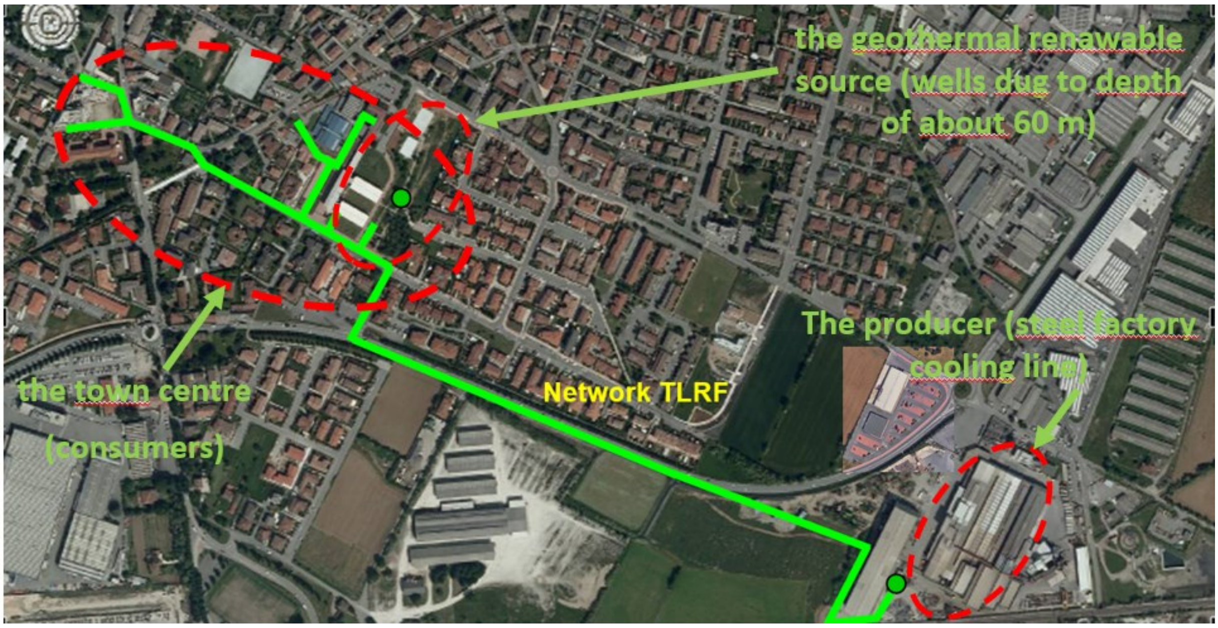

Figure 1 - The network, location of consumers, wells and ASO.

Since July 2018, ASO has been transferring heat recovered from the cooling circuit (cooling towers) to the district network through a heat exchanger. The network supply temperature is approximately 25°C, whereas the temperature on the primary side, i.e. the temperature reached by the liquid in the cooling towers, can fluctuate up to 28-29°C or even higher in summer.

The thermal energy available at the ASO factory is much greater than 2 GWh, the daily heat requirement of users connected to the network. Moreover, the previously existing heating and domestic hot water system for the changing rooms and the canteen at ASO was supplied with methane gas with inefficient, outdated heat generators. As a result, COGEME and ASO agreed to develop a prototype system to collect waste heat from the cooling circuit and use it to meet local ASO heating requirements, as well as to transfer any additional excess heat to the network. At the beginning of the study in 2017, it was estimated that only domestic hot water requirements would be satisfied. ASO subsequently expressed a need to completely eliminate domestic methane services, asking COGEME to take over indoor heating as well.

COGEME decided to implement the waste heat collection point within a pump room away from the production area, and therefore the furnaces, to eliminate interference with the production cycle and ASO employees during implementation phases, and when managing the system in years to come. The production site along the north-east/south-west artery stretches for approximately 200 metres, whereas the distance as the crow flies between the pump room and the building housing the canteen and changing rooms is approximately 130 m. This distance is not negligible for the considered power (about 130 kW of peak power).

Figure 2 - the productive plant and the place of pumping room and canteen and changing room building, the distance is about 130 m.

Figure 3 - location of the former ASO thermal plants

The project involved the following key elements:

1. studying the installation solution that reduces heat losses between the collection point and users;
2. analysing whether or not it is necessary to have storage for waste heat available;
3. sizing the heat exchanger and developing operational logic;
4. choosing heat pumps required to increase the temperature to the 50-55°C necessary for the production of domestic hot water;
5. adopting methods that ensure modularity and repeatability.

Given the complexity of the local geometry, the skid-mounted components of the heat recovery system have been split into two parts, with the heat recovery exchanger installed on the roof of the pump room, and the heat pump plant (in the following often called "geothermal plant", as the network is supplied by both waste heat and ground source heat coming from aquifer wells) installed on the roof of the changing rooms.

Moreover, in order to reduce realization costs, which after the tendering phased turned out to be higher than estimated during design, some plant modifications have been made.

In particular, only one heat pump (HP) has been included, instead of two (with the reduced modulation capability accommodated by a more intense use of the buffer); moreover, heat supply for both the canteen and the changing rooms has been guaranteed. Sanitary hot water (SHW) production is instead covered only for the changing rooms (where it is used for showers at shift change), SHW production for the canteen being covered by a separate air-source heat pump.

Due to the foundry process schedule, heat supply and local demand overlap completely except for Monday. Storing heat during the weekend (at least in conventional water tanks) seems not feasible, due to the low available temperature.

Concerning the heat pump purchase, the corresponding market and the distribution of support centres throughout the territory were analysed. Two important factors emerged:

- support centres are not distributed uniformly throughout national territory;
- among the brands that are the most reliable and guarantee high-performance levels, there are different models for different applications (operating temperatures, size required, source temperatures i.e. cold district heating network, refrigerant gas used).

During the second half of the project, COGEME therefore decided to develop the large-scale production of the on-site heat exchanger kit, consisting of a heat exchanger, valves, pumps, and anything else required for its operation, which can interface intelligently with the network and the prosumer via a programmable multi-regulator and three hydraulic connections - one cold district heating network in/out, one heat recovery (and circuit cooling) in/out, and one user in/out (water-water heat pump selected by the user/designer/installer).

As mentioned above, the skid system has been split into two parts as follows:

- on-site heat exchanger kit (heat exchanger, operational logic) on the roof of the pump room;
- geothermal plant on the roof of the changing rooms.

Added to this is a hydraulic connection with PPR pipes, mostly (about 80 %) extending along an underground tunnel already used to distribute electricity, with a constant temperature throughout the year.

Consequently, the prototype skid has three mechanical and electrical elements (the two containerized plants and the connection pipe) united in their aim but split according to function.

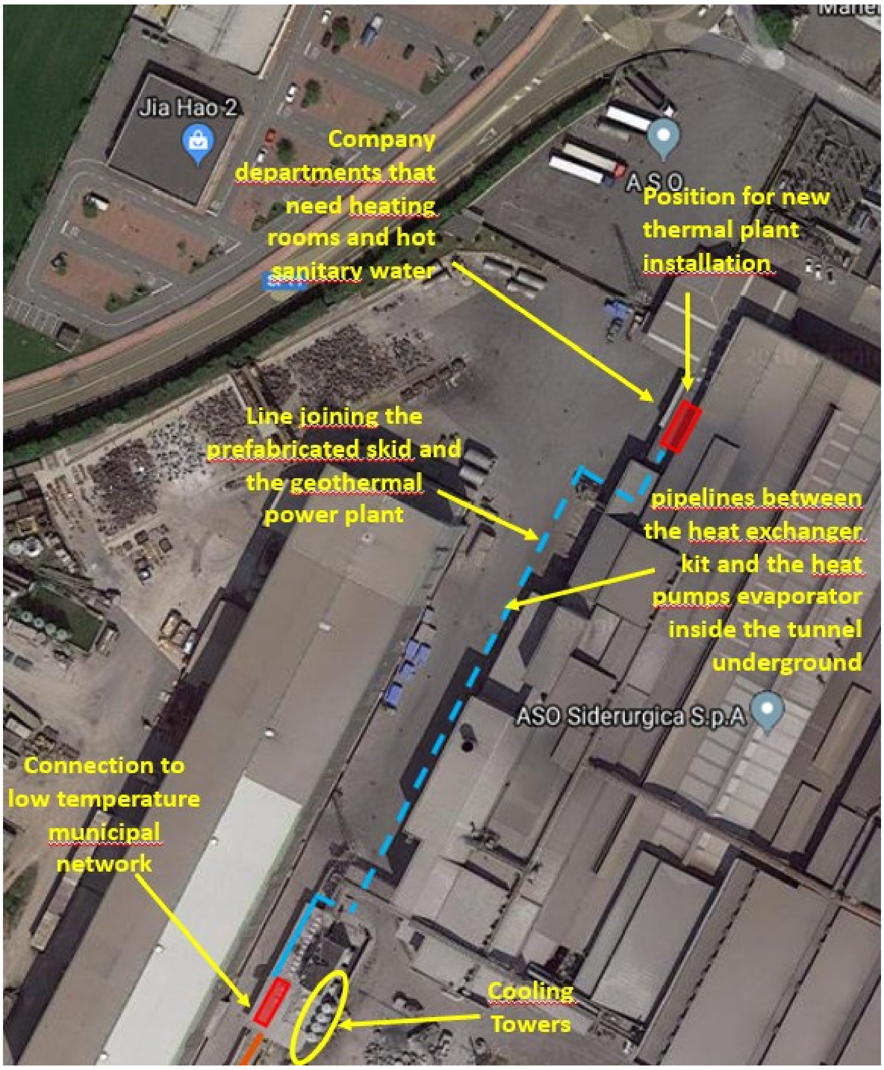

Figure 4 - the various parts of the project.

The prototype made for the on-site heat exchanger occupies a container measuring 6 (L) x 3 (D) x 3 (H) metres, long enough to contain all measurement and control instrumentation required to assess its performance in a variety of set conditions.

Figure 5 – heat exchanger kit container.

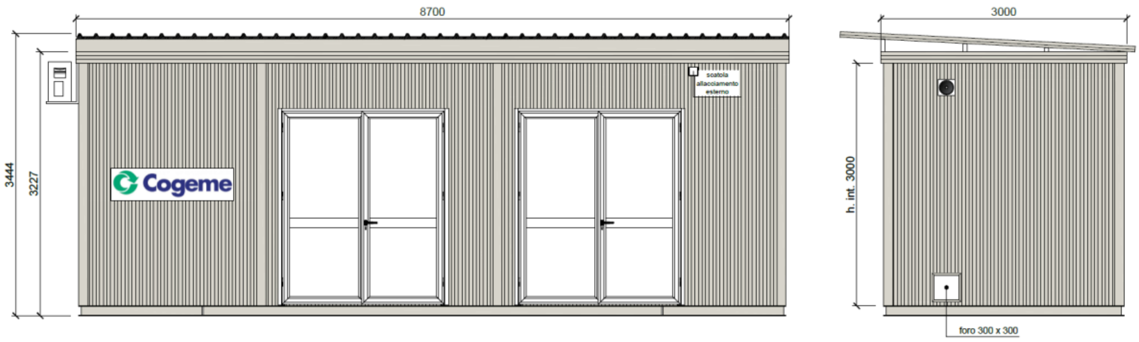

Figure 6 – geothermal plant container.

This kit could therefore be defined as a 'laboratory kit' that has all the components necessary for achieving the following objectives:

- the interface with the heat pump system at a distance of approximately 130 m rather than a few dozen centimetres, as will be the case with most future installations, where its natural location will be the prosumer's geothermal plant;
- the correct calculation of the efficiency of the entire skid system, using the consumption to calculate the electricity used to push the water from the exchanger kit to the heat pumps, and calculating the heat energy dissipated in the cycle.

On the basis of the figures in the initial months of the analysis, the prototype for large-scale production will be developed.

COGEME will aim for modularity by choosing a power level of 50 kW, and the base model will be made of the following parts to be assembled according to the situation:

- on-site heat exchanger kit: for all prosumers able to guarantee normal operation with users operating under hot conditions;
- heat disposal accessory: for prosumers requiring the network to dispose of heat, even when their summer cooling requirements determine an increase in the temperature of the water supplied to the network.

Easy installation is ensured by a small, closed-box design, which can be transported and easily connected hydraulically (three connections - network, waste source, user), and electrically (power supply only). Control will be via a programmable multi-controller in the same way as currently happens for domestic heat pumps or boilers.

2 CIVIL ENGINEERING WORKS

As outlined in the introduction, the skid has been split into two parts:

- the on-site heat exchanger kit, to recover heat from the site circuit upstream of the cooling evaporation tower, installed on the roof of the existing pump room;
- the geothermal plant, required to increase the temperature of the heat transfer fluid used to heat and produce domestic hot water for the changing rooms, implemented on the roof of the changing room area.

The on-site heat exchanger kit, consisting of the heat exchanger, valves, and control and measurement instrumentation, has been installed on the roof of the pump room and enclosed in a prefabricated container/cabinet, to protect the equipment from atmospheric agents. The dimensions of this container are 6 (L) x 3 (D) x3 (H) m.

The geothermal plant has been positioned above the current roof, to conserve the existing roof and enable normal water flow.

The building work required for the geothermal plant is outlined below.

1. Site preparation: includes the implementation of enclosures and site access, setting up a storage area, and places to store materials and assemble fall-protection parapets for work carried out at height.
2. Building work to construct the support for the container housing the geothermal plant: includes the container's metal substructure with the dimensions of 8.72 (L) x 3 (D) x 3 (H) m. Guardrails for the walkway are ensured and gratings are positioned in front of the shelter doors to guarantee the accessibility. An external access to the station has also been provided.
3. Dismantling the site: including the dismantling of fall-protection parapets and general cleaning of the site area once commissioned.

An axonometric projection and tables are shown below to enable comprehension of the current setup and final setup after implementing the geothermal station.

PROSPETTO OVEST
Stato di Progetto

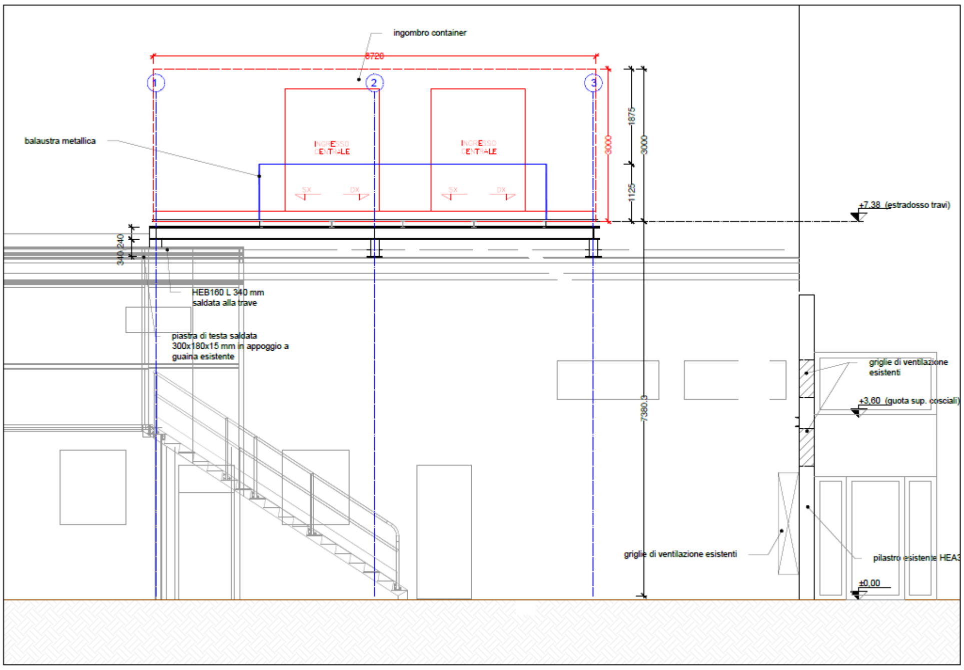

Figure 7: Implementation of the new raised geothermal plant - western side – current and future setup.

To be able to complete the new raised geothermal plant, it was necessary to design the base at the bottom of the new plant access ladders, and the substructure of the new technical room in structural steelwork.

The metal substructure of the container housing the new geothermal plant has been constructed as follows:

- Vertical HEB160 beams, secured to the loadbearing structure of the building via 4 M10 threaded bars with chemical anchoring, and welded to the main HEB160 beams;
- main frame made from HEB240 profiles;
- secondary frame made from HEB160 profiles;
- substructure with grating made of IPE160 and UPN160 profiles at the edges, secured to the secondary frame;
- electro-welded metal grating base.

The diagrams below illustrate the descriptions above.

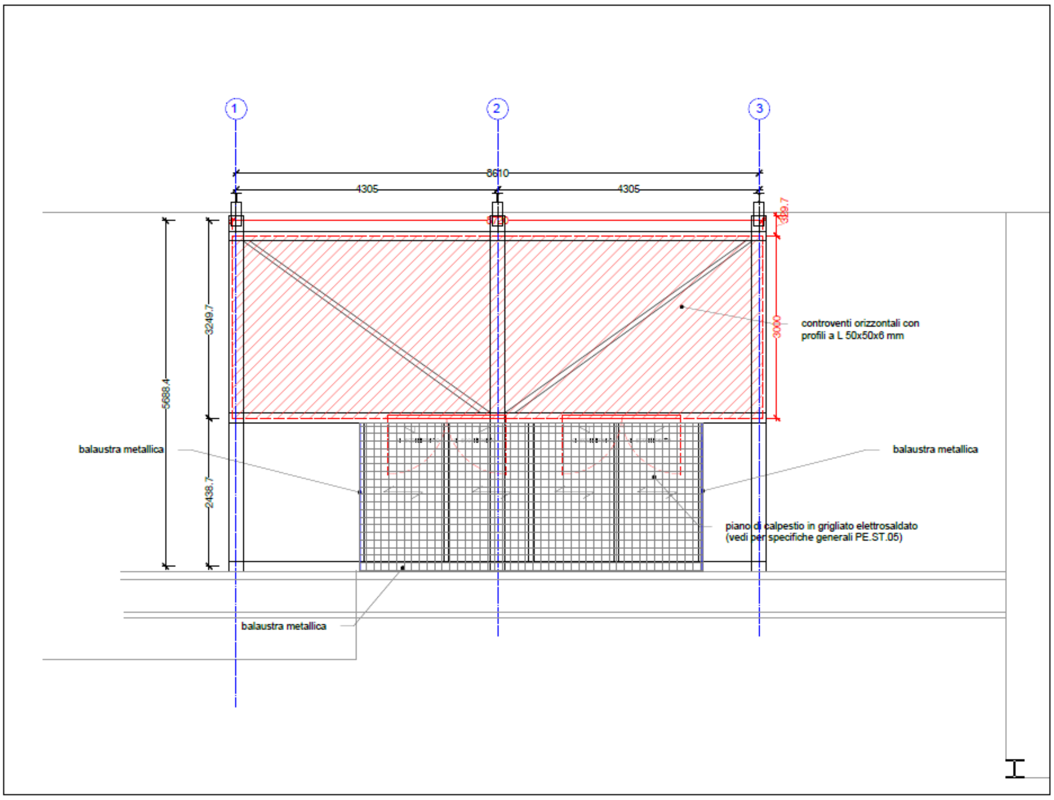

Figure 8: Plan view of the metal substructure for the new geothermal plant.

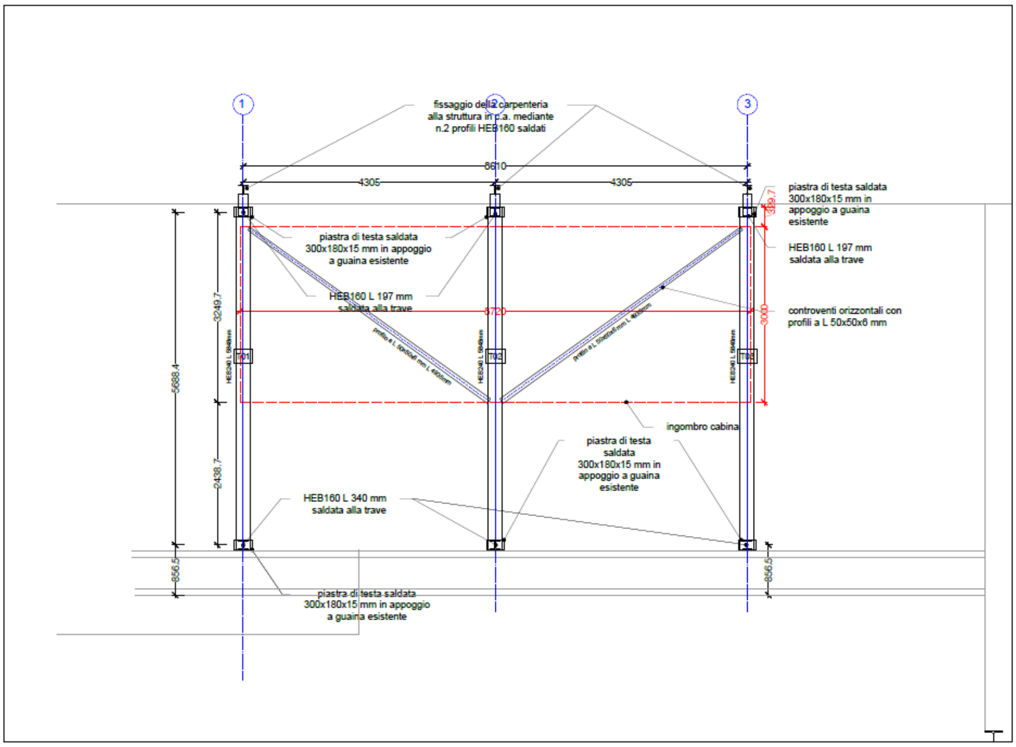

Figure 9: View from below of the main frame of the metal substructure for the new geothermal plant.

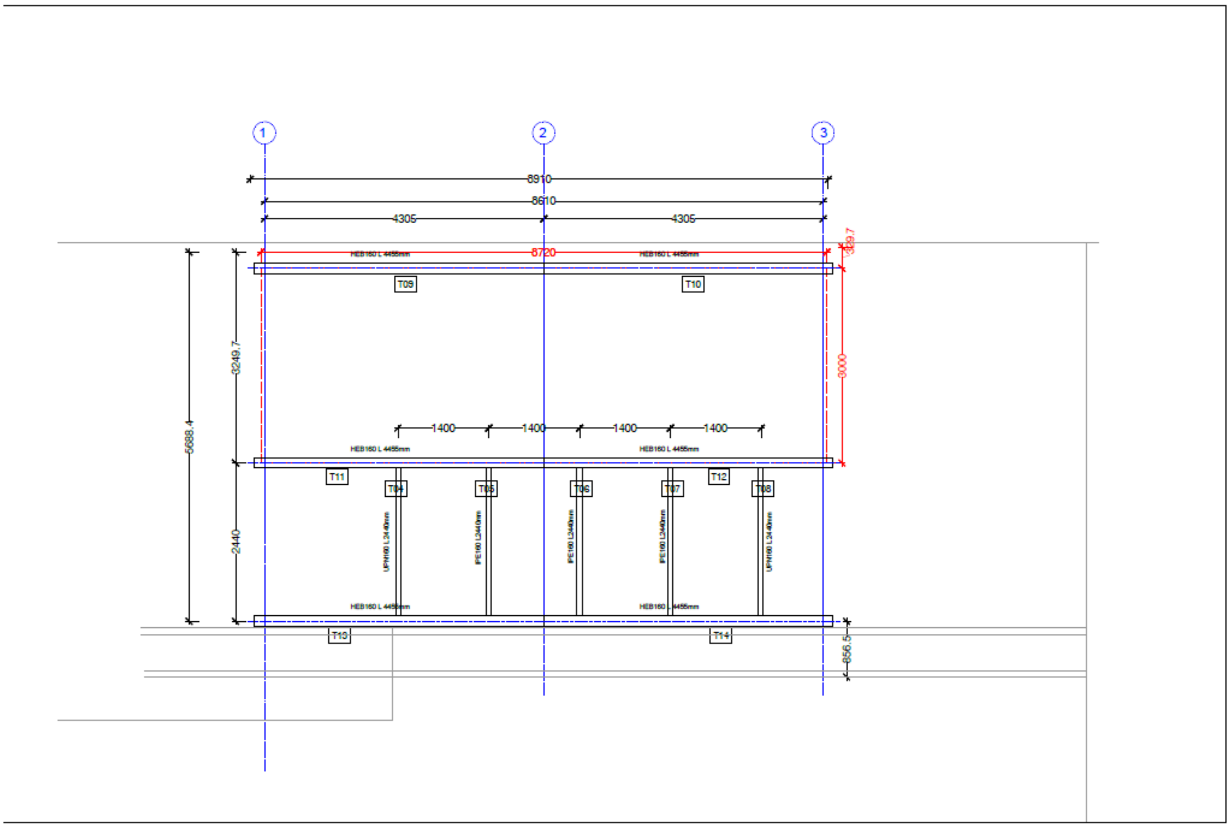

Figure 8: View from below of the secondary frame of the metal substructure for the new geothermal plant.

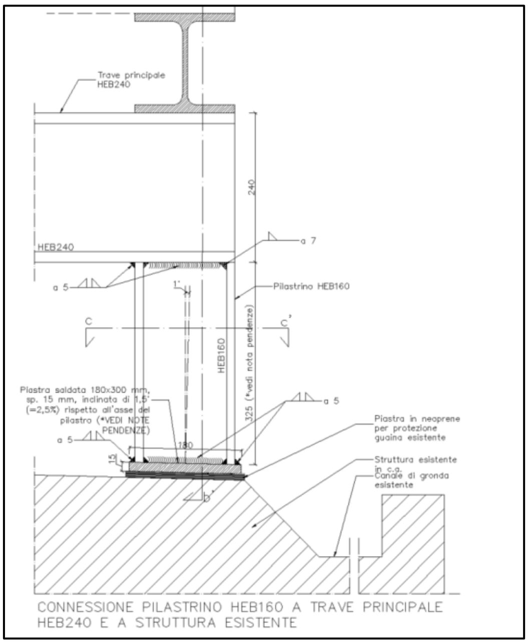

Figure 9: Detail of the connection between the main frame and the existing structure.

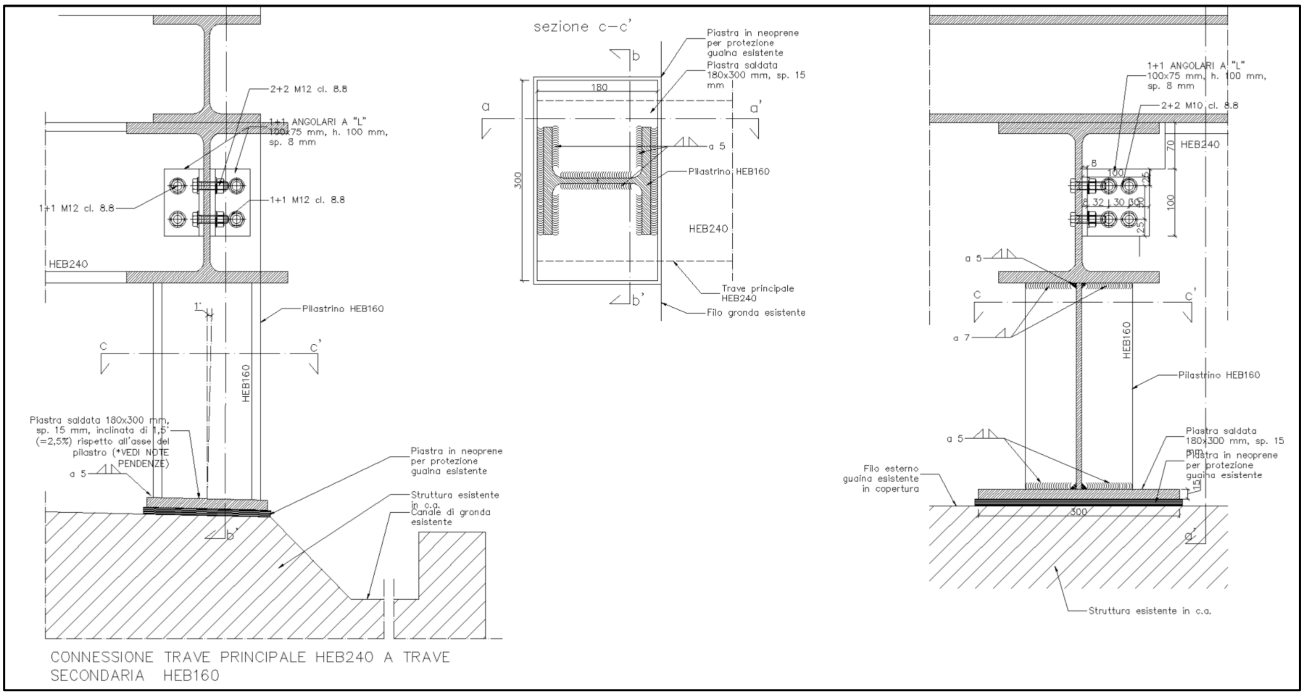

Figure 10: Detail of the connection between the main frame and the secondary frame.

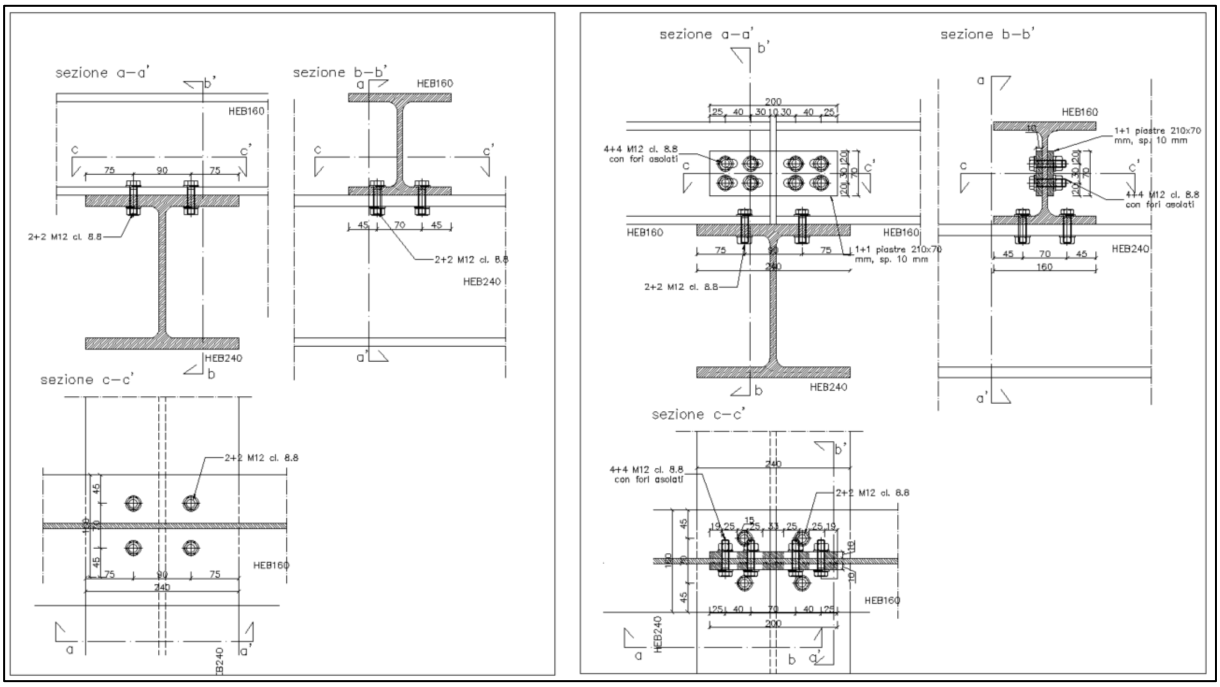

Figure 11: Detail of the connection between the main frame and the secondary frame.

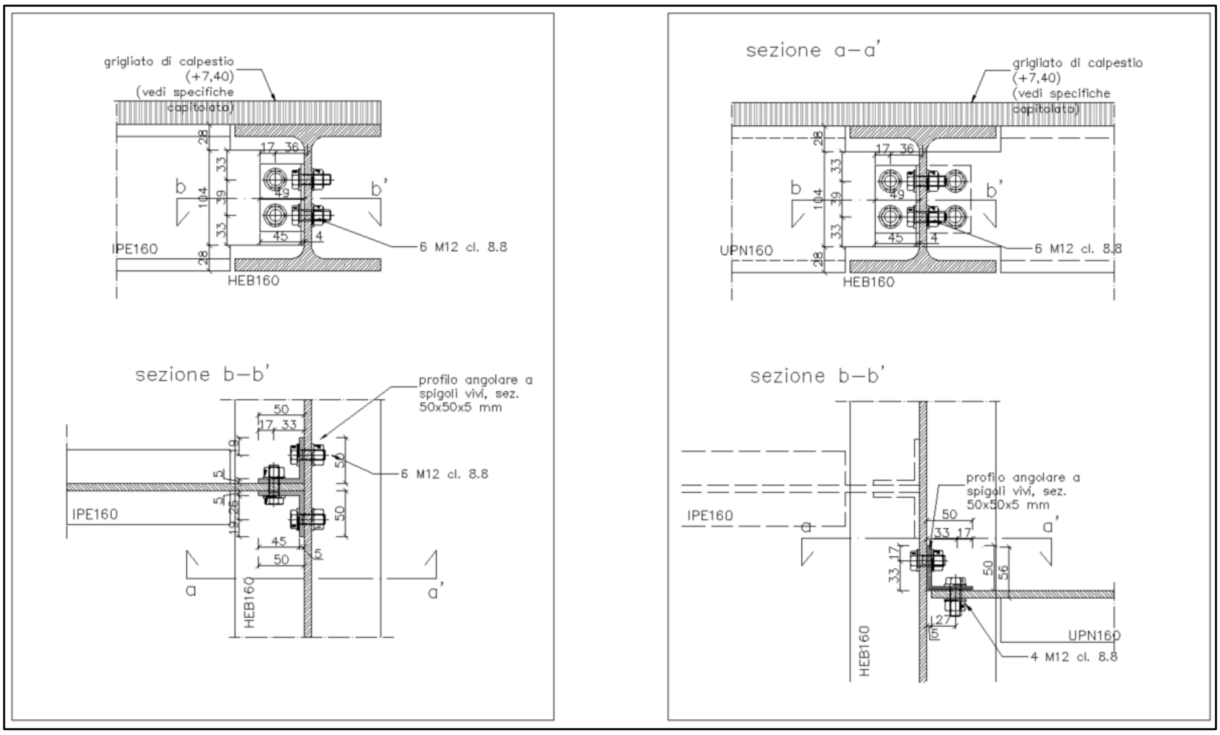

Figure 12: Detail of the connection between the grating substructure and the secondary frame.

The Technical Specifications attached to the Building Design outline in detail the materials and products required for structural use, and the requirement for CE marking and a Declaration of Performance.

The following are also detailed:

- permitted size tolerances;
- the concrete specifications, form stripping specifications, the samples that must be taken to check that the concrete used complies with design requirements and legislation;
- the specifications of the steel for reinforced concrete and steelwork, with protective treatments to be applied;
- the specifications of the nuts and bolts, with bolt tightening specifications;
- welding methods and specifications;
- the mechanical specifications, design resistance and seismic resistance of the anchoring systems.

The Building Design also has a Maintenance Plan along with the structural design, setting out project maintenance activities to ensure the functionality, quality, efficiency and financial benefit of the work in the long term.

The following is outlined for the technological units, reinforced concrete base structure for the external staircase, raised steel structures (container substructure and external staircase), and joints (bolts and welds):

- correct methods of use;
- potential faults or possible causes, effects, level of severity of faults and possible solutions;
- checks and maintenance to be carried out and how often.

Figure 13 construction works for the steel structure sustaining the heat pump container.

3 PIPING WORKS

As outlined in the introduction, the skid system is split into two parts:

- the on-site heat exchanger kit, to recover heat from the site circuit upstream of the cooling evaporation tower, installed on the roof of the existing pump room;
- the geothermal plant, required to increase the temperature of the heat transfer fluid used to heat and produce domestic hot water for the changing rooms, implemented on the roof of the changing room area.

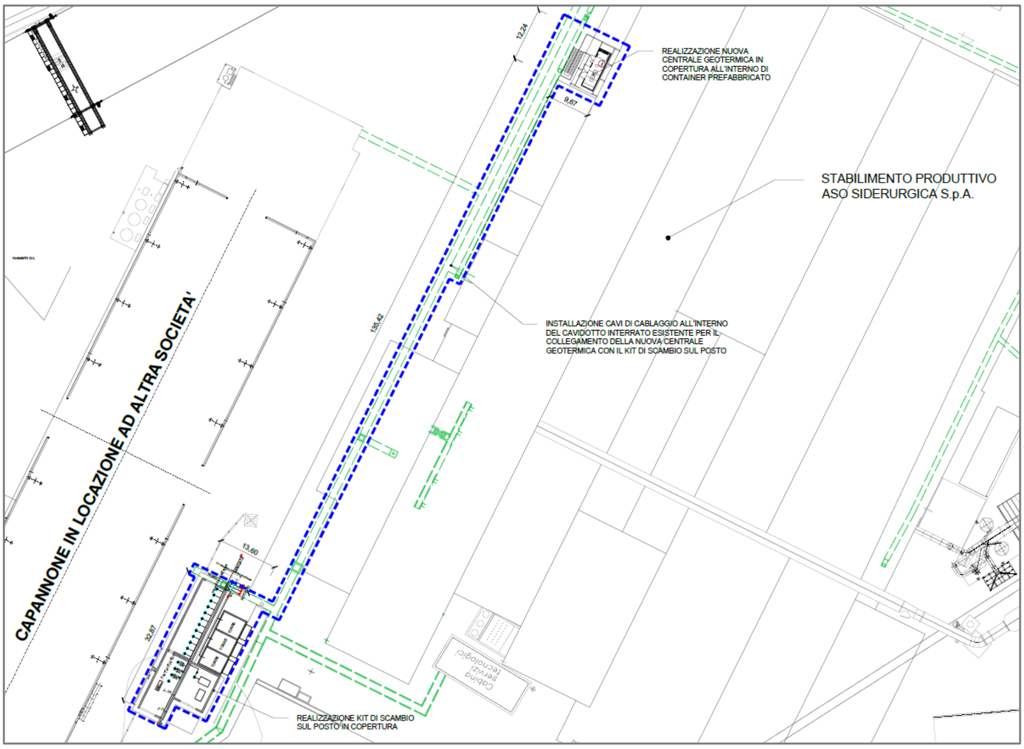

Figure 14: general plan showing position of on-site heat exchanger kit and geothermal plant.

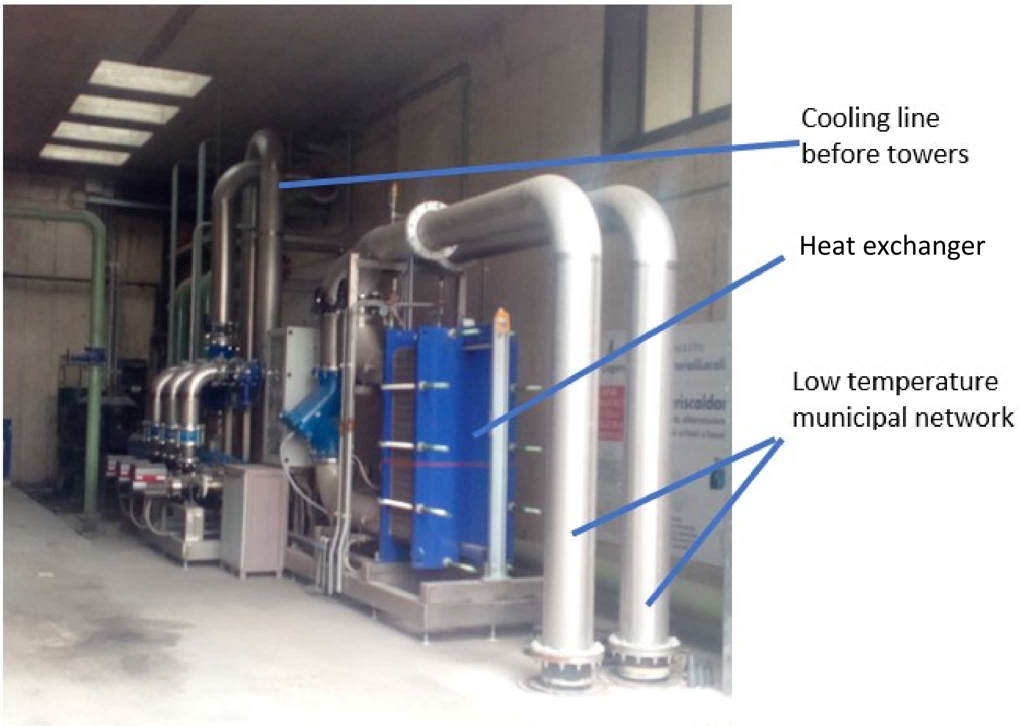

Figure 15: ASO pump room.

Two new ports have been implemented to supply the heat exchanger kit - one from the cooling circuit of the evaporation towers and one from the network, upstream of the current heat exchanger. The new heat exchanger kit is situated inside a container on the roof of the existing ASO pump station, therefore the pipes have been channelled on the roof via a specially created opening, and a structure has been built to prevent water infiltration in the technical room.

The work needed to connect to the existing network has involved the current pump station for the cold district heating network, and the ASO pump room.

A summary of the corresponding work is outlined below.

The design involves the heat exchanger kit drawing/supplying heat via the same pipe used currently by the cold district heating network to draw from the ASO cooling circuit.

Before the installation of the new system the network was similar to a “user bypass” and it was activated hydraulically only when it was possible to recover waste heat from the cooling circuits. In other words, the regulation and control system inhibited circulation between the central pump station and ASO if the temperature of the cooling circuit did not reach the set value (25-28°C).

However, the new skid system must always be able to draw/supply via this network, which hence needed to be enabled.

As a result, it must be possible to transform the "user bypass" into a network to guarantee circulation, even when the conditions for drawing from ASO do not exist.

Hence:

1. The hydraulic kit has a pump and two three-way valves fitted. If waste heat is not available, the control system activates the pump to circulate the amount required to meet the skid requirements (this pump will not be included in the kit performance measurement, as it is only present to transform the ASO user bypass into a network). If there is no waste heat, the skid system will behave like any other geothermal plant that interfaces with the cold district heating system.
2. The central pump station for the cold district heating network has been fitted with a bypass and a two-way valve, which will still be activated by the regulation and control system, to enable reverse flow.

Figure 16: piping works.

4 ON-SITE HEAT EXCHANGER KIT POWER SUPPLY (KIT)

A **Hydraulic Separator SI.01.01** (see code in design P&ID, deliverable "Design of prefabricated skid for waste heat recovery at Ospitaletto") on the input to the **Geothermal Plant** has the function to hydraulically separate the **Heat Exchanger Kit** hydraulic circuit from the hydraulic connection/supply of the Heat Pump manifold circuit.

The **Hydraulic Separator** prevents mutual disturbances between the pump for the **Heat Exchanger Kit** circuit and pump P.01.01 for the hydraulic circuit for **Heat Pump PdC.01.01** (see supply circuit connected to the **Source Side Heat Pump Manifold)**.

Motorised valve EV.01.01 modulates the flow of the source side fluid coming from the **Heat Exchanger Kit**. The combined action of SI.01.01 and EV.01.01 controls the temperature and maximum flow rate of the source side fluid that will supply the heat pumps, such that the input temperature at the Source Side Heat Pump Manifold is never greater than the maximum value permitted by the Heat Pump for its operation.

The temperature of the source side fluid varies and depends on the type of source, which may be groundwater or be produced from cooling industrial processes/waste water.

Material and energy parameters concerning the source side system on the input to the Geothermal Plant, used when sizing the system and resulting from the size of the heat pumps installed, can be summarised as follows:

Source Side - Groundwater		**Source Side - Waste water**	
Thermal power	88.6 kW	Thermal power	123.7 kW
Source heat capacity	15.239 l/h	Source heat capacity	21.276 l/h
ΔT In/Out Source Temperature	13/8°C	ΔT In/Out Source Temperature	25/20°C

The flow rate, power and energy of the source side fluid are continually monitored via **Ultrasonic Meter CU.01**

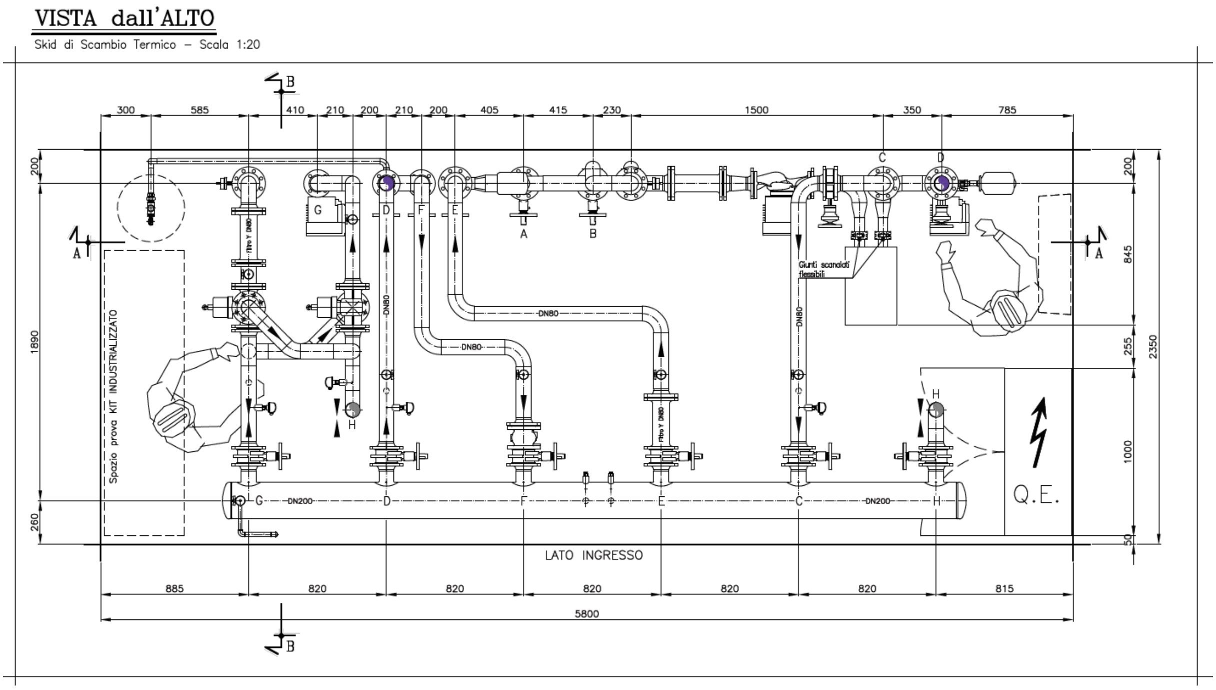

Figure 17: hydraulic kit plant drawing, top view.

Figure 18: construction works. Delivery of the containerized hydraulic kit.

Figure 19: construction works (hydraulic kit).

Figure 20: construction works (hydraulic kit).

5 NEW GEOTHERMAL PLANT POWER SUPPLY (NCGT)

Heat is generated by **a heat pump, PdC.01.**, which offloads the power produced into **Storage Tank AT.02.01** (including ports at different heights) and regulates the storage temperature of the technical water.

The heat pump switches on and off as a function of the temperature measured by the probe as follows: **ON 55°C → Storage Tank AT.02.01 Midway** and **OFF 50°C → Storage Tank AT.02.01 Low.**

The thermal cascade is regulated by two temperature probes, one fitted on the heat pump supply manifold and the other on the heat pump return manifold on the Primary Heating Side.

The **Source Side** connection for the **Heat Pump** is implemented via a dedicated circuit with a port on the **Source Heat Pump Manifold**. The drain-off flow rate, proportional to the thermal power produced, is regulated by the Heat Pump itself, which regulates the operating speed of the circulator connected to it (**PdC.01.01 →P.01.01**).

The **Primary Heating Side** connection for the **Heat Pump** is implemented via a dedicated circuit with a port on the **Primary Heating Heat Pump Manifold**. The drain-off flow rate, proportional to the thermal power produced, is regulated by the Heat Pump itself, which regulates the operating speed of the circulator connected to it (**PdC.01.01 →P.02.01**).

Material and energy parameters concerning the system, used when sizing the system and resulting from the size of the heat pump installed, can be summarised as follows:

Values valid for **Heat Pump**:

Source Side – Groundwater conditions		**Primary Heating Side – Groundwater conditions**	
Thermal power	88.6 kW	Thermal power	123.7 kW
Source heat capacity	15,239 l/h	Source heat capacity	21,276 l/h
ΔT In/Out Source Temperature	13/8°C	ΔT technical water temperature In/Out	60/55°C
ΔH Circuit head	6.9 kPa	ΔH Circuit Head	13.60 kPa

Source Side – Wastewater conditions		**Primary Heating Side – Wastewater conditions**	
Thermal power	123.7 kW	Thermal power	159.5 kW
Source heat capacity	21,276 l/h	Source heat capacity	27,434 l/h
ΔT In/Out Source Temperature	25/20°C	ΔT technical water temperature In/Out	60/55°C
ΔH Circuit head	13.9 kPa	ΔH Circuit Head	22.7 kPa

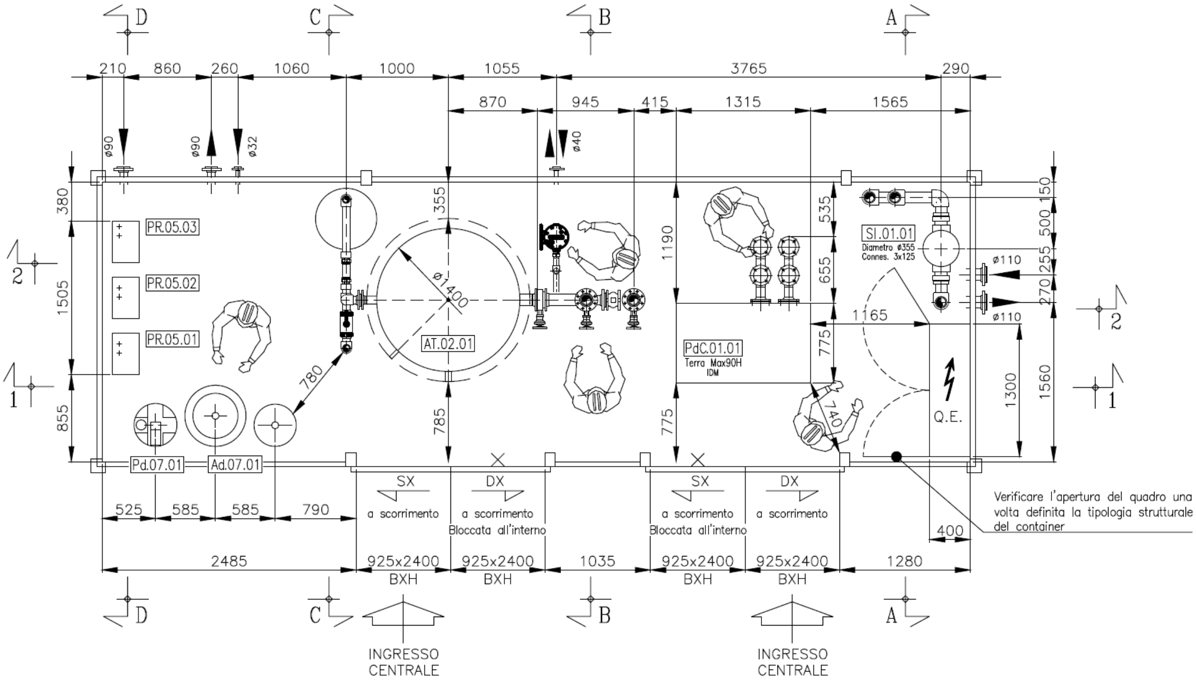

Figure 21. Geothermal heat pump container, top-view drawing.

The **tank** was chosen and customized for the specific design requirements, to enable the optimization of stratification and distribute the technical water continuously within the tank as a function of temperature.

A specific brand was chosen because it fits special patented **cone/plate stratification** features in the storage tank, which exploit the natural tendency of water to stratify on the basis of temperature.

Stratification column was sized in relation to actual design capacities on the primary side and secondary side of the plant.

The **volume of Storage Tank** is calculated using the formula set out in Italian standard UNI 9182:2014 appendix G.2. The design volume is **3.500 liters.**

The main on/off signal of heat pumps arrives on thermal request by storage tank, as required by temperature limits measured by the temperature probes installed on-board of the storage tank.

The storage tank allows heat pumps heating capacity drain and thermal energy storage to manage peak demand in the case of DHW production.

Motorised Valve EV.02.01 manages the return temperature at the **Primary Heating Heat Pump Manifold**, to guarantee a minimum temperature entering the Heat Pump. The return temperature always ensures that the Heat Pump supply temperature is at the value defined in the design phase (*Temperature setpoint EV.02.01→50°C*).

Motorised Valve EV.02.02 manages the return temperature at the **Primary Heating Heat Pump Manifold** to control and increase stratification in **Storage Tank AT.02.01,** and bring the lower parts of the tank to the relevant temperature (*Temperature setpoint EV.02.02→50°C*)

Domestic hot water (DHW) is produced only in one section of the plant, the one destined for the **Changing Rooms** and supplied with cold water from a well. The power and heat energy destined for the total production of DHW are continually monitored by **Ultrasonic Counter CU.03.01**.

Domestic hot water for the changing room is generated by three cascade DHW heaters.

Domestic cold water (DCW) from wells used to produce DHW for the Changing Rooms is treated with a softener (**Softener AD.07.01**), dosed with a product that inhibits corrosion and scaling (**Dosing Pump Pd.07.01**), and a disinfecting, anti-legionella product (**Dosing Pump Pd.07.02**).

The consumption of DCW used to produce DHW is monitored with **Meter CT.07.01** for the Changing Rooms and **Meter CT.06.01** for the Canteen.

The power and heat energy to be used for indoor heating are continually monitored by **Ultrasonic Counter CU.04.01**.

The supply temperature of the heat transfer fluid to be used for room terminals is controlled via **Motorised Mixer Valve EV.04.01**, managed according to a heating curve.

The heating circuit is split into two separate branches controlled by switching three-way, changeover **Motorised Valves EV.04.01 and EV.04.02 on and off.** Each branch is managed on the basis of hour time schedules. The branch separation is to maintain the existing system configuration, with a branch for heating the Changing Rooms and one for heating the Canteen. The material and energy balance for each branch can be summarised as follows:

Changing Room Heating Branch		**Canteen Heating Branch**	
Thermal power	25.0 kW	Thermal power	25.0 kW
Source heat capacity	2,150 l/h	Source heat capacity	2,150 l/h
ΔT In/Out source Temperature	50/40°C	ΔT technical water temperature In/Out	50/40°C
ΔH Circuit head	108.9 kPa	ΔH Circuit Head	109.9 kPa

The use of three-way changeover **Motorised Valves, EV.04.01 and EV.04.02,** enables the continuous, **time-controlled** management of anti-seize **Pump P.04.01** when heating is switched off (*summer*), and the management of cleaning operations for the **Geothermal Plant** via the forced circulation of the heat transfer fluid from **Magnetic Desludging Filter FD.04.01** to Storage Tank AT.02.01. Anti-seize settings and cleaning rates are calibrated via the lockshield valves installed on the bypass section i.e. DT.04.01 and DT.04.02.

During the heating period, circulating heat transfer fluid coming from existing terminals installed in various rooms is forced to pass into **Magnetic Desludging Filter FD.04.01.**

Figure 22: construction works (switchboards, hydraulic separator, stratified tank).

Figure 23: construction works at the containerized geothermal plant (tank, heat pump, sanitary hot water fast heat exchangers). Pictures taken during container prefabrication at Termotecnica Sebina.

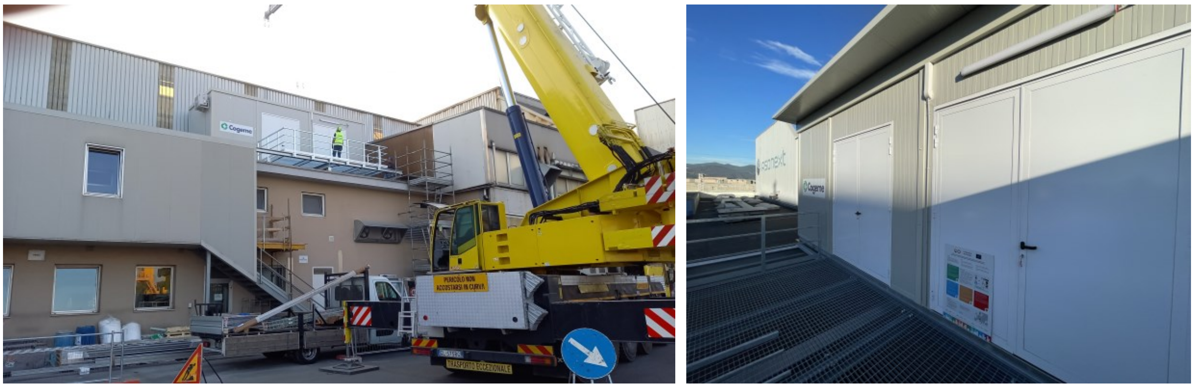

Figure 24: positioning of the containerized geothermal plant.

Figure 25: containerized geothermal plant after positioning (roof mounting).

6 ELECTRIC WORKS

6.1 Overview

The project involves the development of two new technological units on the ASO premises in Ospitaletto, in the form of a prototype of an on-site heat exchanger kit and the new geothermal plant.

The new installation is electrically powered and the units incorporated within the data processing/exchange network for the existing cold district heating network.

6.2 Electric power lines

6.2.1 On-site heat exchanger kit power supply *(KIT)*

The prototype of the on-site heat exchanger kit is situated on the roof of the pump room, which also houses the skid system implemented by COGEME to recover waste heat produced by the steel mill for feeding into the cold district heating network.

There is a dedicated electricity line to power the skid system. This line branches from one of the electrical switchboards forming part of the internal low voltage distribution network for the production facility and reaches a disconnection board (Q.SEZ) on the wall behind the skid. The supply line for the main electrical switchboard for the technical Q.SKID unit comes from this board.

A new electricity line coming from the aforementioned Q.SEZ board was connected: passing through a metal cable tray secured to the wall, it reaches the roof area where the kit container is situated. A new dedicated Q.KIT board has been installed in the container, which houses the power elements and PLC regulation and control system. The Table 1 below shows the Q.KIT sized supply line parameters.

Q.KIT POWER SUPPLY LINE								
Parameter	Config.	$V_{nom.}$	Freq.	P_{max}	cosϕ	I_{max}	L	
Value	3P+N+PE	400 V	50 Hz	12 kW	0.9	19.25 A	20 m	
CABLES - capacity								
Parameter	Config.	$V_{nom.}$	Type	$V_{nom.}$	T	Laying	Circuits	$I_{red.ed}$
Value	5G6 mm^2	0.6-1 kV	FG16OM16	48.00 A	50°C	Open air	1	39.36 A
CABLES - voltage drops								
Parameter	Spec. ΔV	ΔV	ΔV %					
Value	6,61 mV/Am	2.54 V	0.64%					
UPSTREAM PROTECTION								
Parameter	Poles	I_{dc}	Curve	$I_{nom.}$	$I_{diff.}$	Type		
Value	4	10 kA	C	25A	0.5 A	A		
MAIN SWITCHBOARD								
Parameter	Poles	I_{dc}	Curve	$V_{nom.}$	$I_{diff.}$	Type		
Value	4	-	-	40 A	-	-		

Table 1 – Q.KIT sized power supply line parameters.

Downstream of the main switch, the Q.KIT board has supply line start switches for the various electrical users in the container with the heat exchanger kit.

Table 2 shows the various users with sized electrical parameters.

Q.KIT ELECTRICAL USERS									
Id	**Config.**	**P_{max}**	**L**	**Cable**	**Magn. Prot.**	**Therm. Prot.**	**M.T. Curve**	**Diff. Prot.**	**Diff. Type**
TLRF R pump	L1+N+PE	1.5 kW	5 m	3G2.5 mm^2	10 kA	16 A	C	0.3 A	A
PREC R pump	L2+N+PE	1.5 kW	5 m	3G2.5 mm^2	10 kA	16 A	C	0.3 A	A
CS M pump	L3+N+PE	1.5 kW	5 m	3G2.5 mm^2	10 kA	16 A	C	0.3 A	A
Extra KIT pump	L1+N+PE	2.0 kW	10 m	3G2.5 mm^2	10 kA	16 A	C	0.3 A	A
Motorized valves	L2+N	0.4 kW	10 m	2x1.5 mm^2	10 kA	6 A	C	0.03 A	AC
Heat meters+flow rate	L3+N	0.4 kW	10 m	2x1.5 mm^2	10 kA	6 A	C	0.03 A	AC
PLC+data collection	L2+N	0.7 kW	5 m	2x1.5 mm^2	10 kA	10 A	C	0.03 A	AC
Lights	L3+N+PE	0.5 kW	20 m	3G1.5 mm^2	10 kA	10 A	C	0.03 A	AC
Sockets	L2+N+PE	1.5 kW	20 m	3G2.5 mm^2	10 kA	16 A	C	0.03 A	AC
Air-conditioning unit	L3+N+PE	2.0 kW	10 m	3G2.5 mm^2	10 kA	16 A	C	0.3 A	A

Table 2 – Electrical users connected to Q.KIT.

6.2.2 New geothermal plant power supply *(NCGT)*

The new geothermal plant, replacing the two existing thermal plants, is positioned on the roof of the building housing the company employee changing rooms.

A new dedicated power supply line has been implemented, coming from one of the electrical switchboards forming part of the internal low voltage distribution network for the production facility. In particular, it branches from the board located on the ground floor of the building adjacent to the changing rooms.

Starting from the aforementioned board, the cables pass inside the building in a metal cable tray secured to the wall, and reach the middle of the roof over the changing room area. From here, the line proceeds inside through a cavity in the perimeter wall in a metal cable tray, until it reaches the container with the new geothermal plant. A new dedicated Q.NCGT board has been installed in the container, housing the power elements and PLC regulation and control system.

Table 3 below shows Q.NCGT sized supply line parameters.

Q.NCGT POWER SUPPLY LINE								
Parameter	Config.	$V_{nom.}$	Freq.	P_{max}	cosϕ	I_{max}	L	
Value	3P+N+PE	400 V	50 Hz	70 kW	0.9	112.26 A	30 m	
CABLES - capacity								
Parameter	Config.	$V_{nom.}$	Type	$V_{nom.}$	T	Laying	Circuits	$I_{red.ed}$
Value	3x50+1x35 mm^2	0.6-1 kV	FG16OM16	190.00 A	40°C	open air	1	172.90 A
CABLES - voltage drops								
Parameter	ΔV spec.	ΔV	ΔV %					
Value	0.82 mV/Am	2.76 V	0.69%					
UPSTREAM PROTECTION								
Parameter	Poles	I_{dc}	Curve	$I_{nom.}$	$I_{diff.}$	Type		
Value	4	16 kA	D	130A	1.0 A	A		
MAINSWITCHBOARD								
Parameter	Poles	I_{dc}	Curve	$I_{nom.}$	$I_{diff.}$	Type		
Value	4	-	-	160 A	-	-		

Table 3 – Q.NCGT sized power supply line parameters.

Downstream of the main switch, the Q.NCGT board has supply line start switches for the various electrical users in the container housing the heat exchanger kit.

Table 4 shows the various users with sized electrical parameters.

Q.NCGT ELECTRICAL USERS									
Id	**Config.**	**P_{max}**	**L**	**Cable**	**Magn. Prot.**	**Therm. Prot.**	**M.T. Curve**	**Diff. Prot.**	**Diff. Type**
Heat pump 1	3L+N+PE	25.6 kW	15 m	5G25 mm^2	10 kA	63 A	D	0.3 A	A
PdC auxiliaries 1	L1+N+PE	2.0 kW	15 m	3G2.5 mm^2	10 kA	16 A	C	0.3 A	A
HEAT.M pump	L3+N+PE	1.5 kW	15 m	3G2.5 mm^2	10 kA	10 A	C	0.3 A	A
DHW circuit	L1+N+PE	3.0 kW	15 m	3G2.5 mm^2	10 kA	16 A	C	0.3 A	A
24V AC aux+meters	L2+N	0.3 kW	15 m	2x1.5 mm^2	10 kA	6 A	C	0.03 A	AC
12V DC adjustment+TLC	L3+N	0.3 kW	5 m	2x1.5 mm^2	10 kA	6 A	C	0.03 A	AC
Lights	L1+N+PE	0.5 kW	20 m	3G1.5 mm^2	10 kA	10 A	C	0.03 A	AC
400 V sockets	3L+N+PE	4.5 kW	20 m	5G6 mm^2	10 kA	16 A	C	0.03 A	AC
230 V sockets	L2+N+PE	1.5 kW	20 m	3G2.5 mm^2	10 kA	16 A	C	0.03 A	AC
Air-conditioning unit	L3+N+PE	2.0 kW	15 m	3G2.5 mm^2	10 kA	16 A	C	0.3 A	A

Table 4 –Electrical users connected to Q.NCGT.

6.3 Communication lines

A new data exchange network had to be implemented to manage plant components and check system behaviour.

This network aims to enable communication between the on-site heat exchanger kit and the new geothermal plant, and between both of them and remote external operators.

As a result, a direct wired connection between the heat exchanger kit and the new plant has been implemented, by installing a **fibre optic cable** that follows the route of the water pipes running from one component to another. The use of fibre optic instead of data cables with copper cores ensures reliability and high-performance levels at considerable distances, as in the case in question, where two areas 130 m apart have to be connected.

The ends of the aforementioned fibre optic cable are butted to a dedicated network switch. The network switch is placed inside the new geothermal plant and connected to the Internet via the existing company connection, by placing a cat. 6 Ethernet cable between it and the network switch on the nearest ASO network. Via this connection it is possible to extend the company network to the area with the heat exchanger kit.