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TOWARDS SMART ZERO CO_2 CITIES ACROSS EUROPE
VITORIA-GASTEIZ + TARTU + SONDERBORG

Deliverable 3.4: District heating network deployed and in use

WP3, Task 3.5

Date of document

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[1] PU = Public
PP = Restricted to other programme participants (including the Commission Services)
RE = Restricted to a group specified by the consortium (including the Commission Services)
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Abbreviations and Acronyms

Abbreviation/Acronym	Description
SmartEnCity	Towards Smart Zero CO2 Cities across Europe
DH	District Heating
KPIs	Key performance indicators
CO2	Carbon Dioxide
DHW	Domestic Hot Water
RES	Renewable Energy Sources
WP	Work Package
EC	European Commission
DoA	Description of Action
EU	European Union
CO	Community of Owners

Table 1: Abbreviations and Acronyms

0 Publishable Summary

The renovation works of the Vitoria-Gasteiz demo site are carried out in Coronación neighbourhood, a city located in the north of Spain, a region where winters are cold, with frequent foggy days and frosts. The interventions include the retrofitting of the façades and the construction of a new district heating system to supply heating and Domestic Hot Water (DHW) to 312 dwellings in the neighbourhood.

The deployment of the district heating network (design + project + construction) is carried out by Giroa-Veolia and it is included as a part of an energy services contract between this company and the different Community of Owners added to the project, together with the energy management, operation & maintenance, full guarantee and financing of the interventions.

Before the project, the energy system of the neighbourhood was heterogeneous and different for each building. Most Community of Owners had individual energy system for each dwelling. Recently, some other building with central energy system has added to the district heating, as a consequence of the replication effect of the project.

The new heating system is formed by two biomass boilers with a total heating power of 1MW and two gas boilers of 3MW that provide the dwellings with thermal energy available for heating and DHW. In this way, it is guaranteed that energy will come from renewable source of energy. The energy which is produced in the boilers room is distributed by the heating network which is developed through the streets of the neighbourhood to each substation located in each building.

At the time of writing this document, construction works are about to finish and the district heating is operating by supplying heat to the dwellings.

1 Introduction

Deliverable 3.4 aims to describe the district heating network deployment carried out in Vitoria-Gasteiz. In the following sections it will be described the process by which the different Community Owners have joined to the project along the time, the equipment installed in the boiler room, the outline of the heating network, and the main characteristics of the substations.

1.1 Contribution of partners

Participant short name	Contributions
GIR	Overall content of the document
CEA	Review and comments to the document
VIS	Review and comments to the document
TEC	Review and comments to the document

Table 2: Contribution of partners

1.2 Relation to other activities in the project

The following Table 3 depicts the main relationship of this deliverable to other activities (or deliverables) developed within the SmartEnCity project and that should be considered along with this document for further understanding of its contents.

Deliverable Number	Contributions
D.3.1.	Vitoria-Gasteiz Diagnosis and Baseline Report - provides the overall description of the current state of the lighthouse city area and provides a comparison in future after demo actions have been implemented
D.3.2.	Vitoria-Gasteiz integrated planning report- describes the management procedures and deployment plans leading to the successful implementation of the foreseen demonstration actions in
D3.3.	Building retrofitting interventions completed
D7.1	It gives a description of Key Performance Indicators (KPIs) as tool for planning strategic interventions to transform cities into Smart Zero CO2 cities and monitoring the improvements achieved over the time
D7.2.	Intends to define a set of KPIs to be used in the SmartEnCity project for assessing the interventions, District heating among them. It establishes the protocols of evaluation (D7.3) and monitoring programs (D7.6, D7.7, D7.8)

Table 3: Relation to other activities in the project

2 Objectives and expected Impact

2.1 Objective

- Reducing energy demand through the use of innovative technologies.
- Maximizing the supply of renewable energy, using locally available sources.
- Demonstrating that current available technologies pave the way for the "Smart Zero Carbon City" concept.
- Social, environmental, and economic impact on a European scale.
- High potential for replicability in Vitoria-Gasteiz in particular and in Europe in general.

2.2 Expected Impact

Environmental impacts

- Estimated saving of CO2: 1089 tn/yr.

- Lower primary energy consumption.

Economic impacts

-Lower spending on preventive maintenance.

-Lower spending on primary energy procurement (used to generate thermal energy).

-Fewer incidents and therefore lower spending on corrective maintenance.

-Savings on the final price of the thermal energy consumed.

2.3 Innovation and impacts

The deployment of the DH network entails several and important benefits for the neighbours. Firstly, the buildings have been connected to the DH network fuelled with biomass, removing the gas installation and improving the energy efficiency of the installation thanks to the benefits due to DH systems. So that, the retrofitting intervention and the connection to the DH system have brought better results for the buildings in terms of performance, comfort, energy efficiency and greenhouse gas emissions.

The monitoring of the intervention will confirm a considerable reduction in their demand and the consumption of non-renewable primary energy is significantly reduced around.

It is also worth to mention the benefits due the DH system. Reduction of CO2 emissions thanks to the DH installation with Biomass energy source, being a considerable decrease of the polluting gases.

Biomass is a renewable source of energy and its use does not contribute to the acceleration of global warming; in fact, it reduces carbon dioxide levels and the waste from conversion processes, increasing the carbon content of the biosphere.

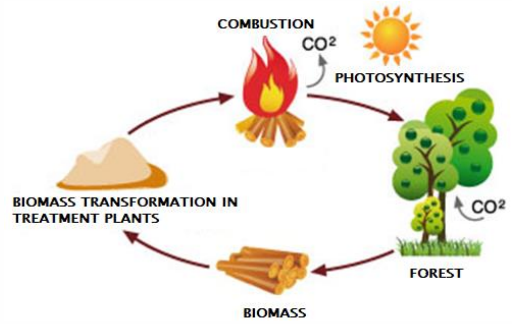

Figure 1: biomass cycle

BIOMASS	FOSSIL FUELS
Biomass	Fossil fuels
Inexhaustible	They run out
Abundant	Limited
Competitive **and** stable prices	Constant price increase
Generates local jobs	Profit goes abroad
Practically zero emissions of harmful gases	Harmful emissions

Table 4: Biomass comparison

Thanks to the centralized production, there is a reduction of operating costs and maintenance costs of the equipment both for the production plant and the neighbours.

As mentioned before, the neighbours change the individual boilers for a much more efficient centralised system that makes the consumption go down and the savings are considerable.

The deployment of the DH ensures that there is an exponential revaluation of homes and, in turn, an improvement in the energy rating of homes. Moreover, adding that they will not have additional charges for maintenance, breakdowns or replacement of equipment.

One important aspect that the neighbours have highlighted in a very positive way has been the importance of the labour done by the partners implied in the communication process to inform about the works progress.

Innovation solution

This intervention is one of the most important implementations in terms of incorporating efficient technologies and renewable energy sources in the project done by the city of Vitoria-Gasteiz, and it is seen as an innovative project for the city and the citizens. It is an important step for the City Council of Vitoria-Gasteiz, as the deployment of this energy network at district level could be replicated in other parts of the city. The intervention has entailed several benefits for the neighbours, cost reduction due to a bigger project, coordination with important stakeholders, integral renovation taking into account all buildings, participation in the neighbour transformation, etc.

In this sense, we must point out that this project, in addition to responding to the Smartencity project of retrofitting and connection of dwellings to the heat network of the Coronación neighborhood, aims to be a pilot that allows testing the development in the city of Vitoria-Gasteiz of an efficient and sustainable model of energy supply with the use of the infrastructure of municipal buildings such as civic centres. After the changes made in the Project, the use of existing infrastructure in municipal civic centres can be a fundamental lever for the replicability of the Project in other areas of the city of Vitoria-Gasteiz in particular, and other European cities in general.

In addition, the District Heating is the first action of this kind for the city, with an innovative public-private management model which guarantees quality of service and energy prices stability for final users.

This building retrofitting intervention, the DH, the improved connectivity and fibre connection, the electric mobility measures as well as the repopulation of the neighbourhood have definitely revitalised the district in all senses.

Other important topics in this intervention are the following:

- Energy saving and efficiency
- GEH Emission Reduction
- Economic savings on energy bills
- Energy certification of buildings: A.

Environmental impacts

This project improved significantly the environmental quality of the old buildings and so the neighbourhood in two main ways. Both the energy retrofitting of the envelope of all buildings and the connection to the DH system fuelled by biomass improved highly the energy efficiency and reduced drastically GEH emissions, with an important reduction of CO2. The retrofitted buildings consume less energy and this energy is renewable, so the environmental improvement of this intervention is huge. Another important factor that causes environmental impact is the reduction of noise by suppressing the gas boilers.

3 District Heating deployment plan

3.1 Preliminary works

In June 2017, the City Council of Vitoria-Gasteiz, Visesa, EVE (Basque Energy Agency) and Giroa signed a commitment agreement setting out the conditions to set up the mixed company (public-private) with the aim of promoting the realization of a District Heating in the neighborhood of Coronación with the planned accession of 750 homes.

After an informative period to the communities that make up the neighborhood, the number of accessions to the project at the end of 2017 was lower than expected despite the commercial effort made.

In December 2017, a press conference announced the partner's decision to extend the term of accessions until May 31, 2018. The decision was also taken to expand the perimeter of the total housing area to include the dwellings located on the opposite side of the limit of the initial perimeter, going from 1305 to 1913 homes.

After several discussions about the constitution of this Company, it was decided that said Company be constituted exclusively with EVE and GIROA, with a 50% participation. The process of incorporation of the Company took a long time because, although the EVE´s administration board gave its approval, the final approval of the Basque Government was lacking.

On these dates, the conformity of 369 homes to the complete rehabilitation project and heat network was registered and 16 dwellings exclusively to the connection of the heat network.

In addition, all the buildings from the perimeter were analyzed and it was decided to include those that could be connected to the heat network and thus increase the number of equivalent homes. Tertiary buildings identified and contacted were:

- Aldabe Civic Center It is a civic center of municipal ownership located next to the boiler room. This building represents a consumption of 1,116 MWh / year and 5,110 m2, which is equivalent in demand to 189 dwellings.
- Atlas Gym It is a building dedicated to sports, which currently has its own facilities. The consumption is 1,086 MWh / year and 3,600 m2 of constructed area, which is equivalent to 184 dwellings in demand. This building signed its adhesion will.
- Church. This building signed its adhesion will, with a 79 MWh demand, equivalent to 13 dwellings.
- Simone de Beauvoir Center. Municipal ownership building that has a demand of 126 MWh / year and the commitment of the municipality for its membership.
- Egibide. This is a training center with which GIROA currently has a maintenance and energy management contract with a 380MWh demand.

Finally, these two last buildings will not be connected to the network.

The viability of the project is worked together with the EVE, with the evolution of accessions and the forecast of future buildings inclusion, mainly with a centralized boiler room.

Given the extension of the scope of action in the neighbourhood, it was decided to strengthen the effort throughout 2018 in marketing the project. This effort was based on 2 phases mainly: From July to October and from November to December. These phases were defined to follow the line of the deadline for accessions, on December 31, 2018.

Face-to-face marketing takes place at the offices of 22 Aldabe Street. The greatest effort was made to reach the possible maximum number of communities, answer telephone calls, send emails, personal interviews, etc. GIROA values this effort as satisfactory, since many neighbours had many doubts and outdated information.

In order to reach the dwellings of the communities affected within the project and in order to get more accessions, the necessary steps were taken to broadcast advertising on different local radio stations. For this, the design and elaboration of radio slots texts was carried out.

Figure 2: Commercial leaflet

To this commercial management was also added the printing and distribution of 1650 advertising cards in the mailboxes of the dwellings of communities located in the neighborhood of Coronación.

On the other hand, the necessary steps were taken to develop an information panel in order to place it in the office of Aldabe 22 and in the Aldabe Civic Center.

It stands out in this commercialization phase that 416 people came to the premises. The visits mostly demanded information about the grants and subsidies and what documentation was required to request them.

More than 400 telephone contacts were made to speak with the different owners of Coronación's dwellings. Finally, it is necessary to highlight the difficulty of this phase given that contact attempts are made to homes in which there is a prior rejection to joining the project.

From the technical point of view and in the project definition, the boiler room activity project was approved in August 2018. Likewise, the City Council began to draw up the specifications based on the defined project in order to publish the tender for the construction of the boiler room, the heat network and its operation.

The drafting of the heating network project was carried out, dimensioning the network for the new potential area, recalculating the ditches and pipes and coordinating thus the technical requirements for implementation with the municipality.

Figure 3 :Executive project

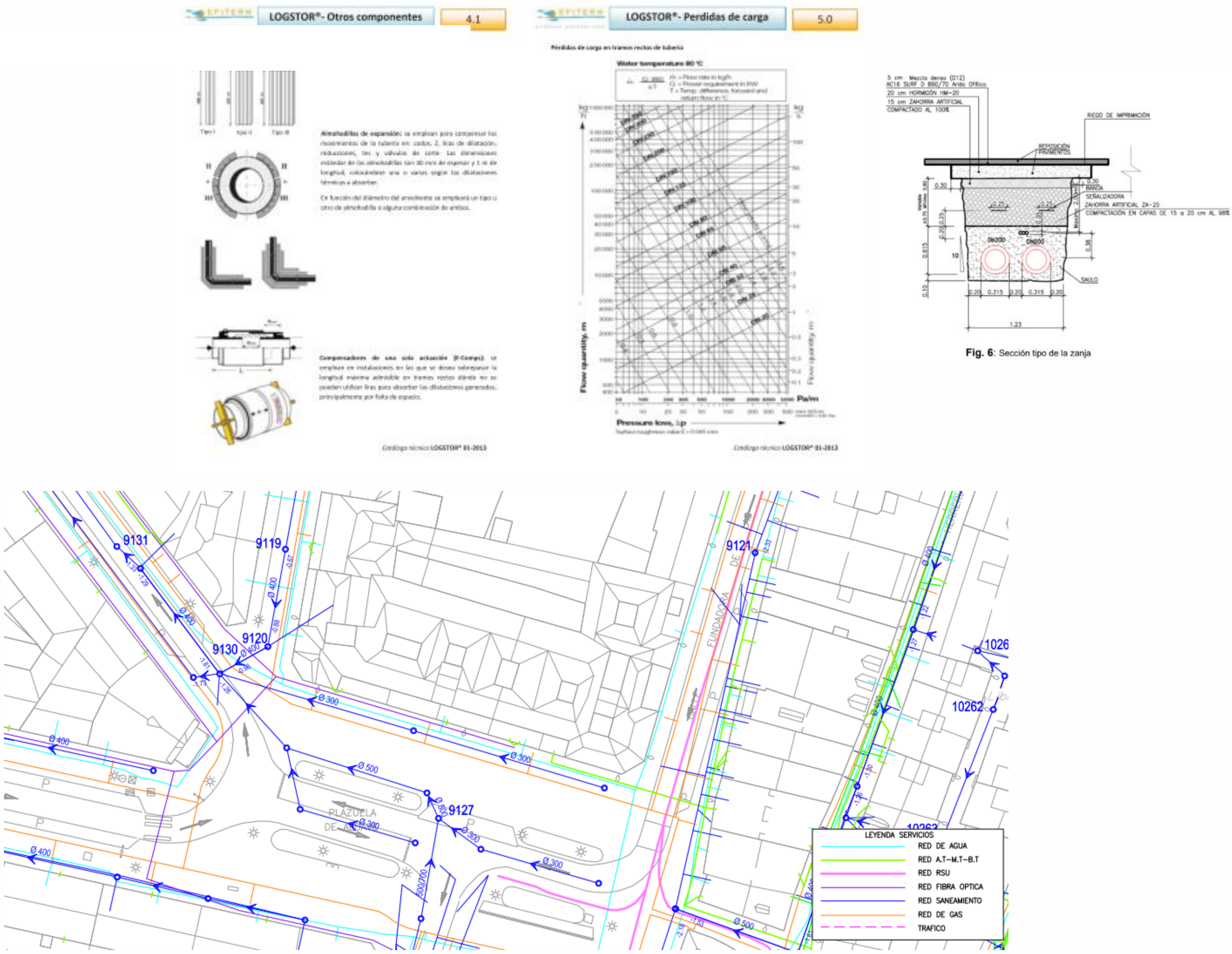

Figure 4: Piping distribution map

On the other hand, the follow-up of the rehabilitation works that were carrying out was done, defining the modules of heat exchange of the dwellings and the execution of the ducts in the buildings.

In 2019, the number of accessions registered at the beginning were 377 dwellings (31 doorways), being 386 dwellings at the end of January.

M37- February 2019

In February, meetings with the council's legal services were held to re-analyse the need to call for a public tender for the construction and operation of the building that houses the new boiler room. The idea at the end of 2018 was to publish the tender for the construction of the building on the one hand and the DH operation on the other.

For the concessionary exploitation tender, the building would have to be already under construction, which complicated the approach, since GIROA would not invest in the construction of the building without being sure of being the subsequent concessionaire of the operation.

After analysing the situation, it was established that the most appropriate legal figure was the granting demanial for the private use of the entire public domain indicated in the current Special Plan for the Coronation District approved by the City Council in the Plenary Session of 21 July 2017, published in the Official Gazette of the Historical Territory of Álava on 18 August.The construction of the new boiler room, the network and the operation of the boilers were included in the same concession. Throughout the month of March, the City Council worked on the drafting of the specifications.

M39 – April 2019

On 1 April 2019, local elections were called for 26th of May, so there were delays in the procedures and the publication of the specification could not be carried out, being delayed until the beginning of the summer.

Meanwhile, the commercial activity to obtain new accessions to the heating network continued, fundamentally in the communities and doorways with centralized boiler rooms, as it was probably easier to join the network despite not having carried out the integral rehabilitation and therefore, not being part of the integral action that the Smartencity project establishes. Nevertheless, these network accessions were essential since the number of accessions was approximately 50% of the 750 initially planned. The following were contacted:

- Coronación Parish church. Confirmed willingness to connect to the network, pending the signing of the contract. It had a heating demand of 79 MWh, equivalent to the annual demand of **13 dwellings**.

- CP Kutxa 9-11 **(16 dwellings)**. They did not want to reform the facades but were interested in joining the heating network. The economic offer for connection was being prepared, pending a decision.

- CP Plaza de Zaldiaran 9-13 **(72 residents).** Building that is outside the initial scope of the project but given the number of dwellings, the interest shown and the proximity of other potential consumers, an economic proposal was to be made.

- CP Bethoven 2-4 (**40 residents**). Also outside the area of Coronación but close to the previous one. Pending the economic connection study.

M41 – June 2019

In June, a community of 62 dwellings leaved the project, bringing the number of adhered dwellings down to 324. This made necessary to modify the specifications that indicate the number of dwellings that were part of the project, causing a further delay in its publication.

M42 – July 2019

Finally, on July 10, the tender for the "Granting of the private use of the public domain delimited by the special plan for Coronación district and possible extensions for the execution and operation of a renewable thermal energy distribution system" was published, with a deadline of August 9.

M44 – September 2019

In September, the tender was declared void as only the company REBI presented itself, which was eliminated, as it did not comply with the conditions of the specifications. GIROA, together with EVE (with whom it was intended to form the joint operating company) decided not to apply for the tender for the following reasons:

- the decrease in the number of homes attached to 307 and their strong dispersion as can be seen in the attached drawing complicated the economic viability of the project in its current approach

Figure 5: Phases dwellings engagement

- The specification, following the usual rules and procedures for this type of tender, incorporated conditions such as rates, fees and tariffs applicable to housing that were lower than those agreed in 2016, which further undermine the economic and technical viability of the project.

However, both entities (EVE and GIROA) decided to explore specific solutions for the group of dwellings that had joined the District Heating network project, based on maintaining the principles of sustainability and efficiency of the original project. In October, negotiations began on possible alternative solutions to the project.

M45 – October 2019

Throughout the months of October and November, new options were studied in order to reduce the investment and adapt to the number of adhered homes as they were:

- In October, a new study was carried out on the execution of two District Heating networks; one with the boiler room in the civic centre and the other with a new boiler room located in premises on Badaya Street 4, with a lower power than the one planned until now, more adapted to the number of dwellings attached. This option was rejected.

Figure 6: Boiler rooms location

M46 – November 2019

- In November, another new option was studied that could represent a new energy model for the city of Vitoria-Gasteiz, as it would involve taking advantage of the infrastructures of the civic centres to create heating networks with biomass, being the heating network a pilot test to be developed from the Aldabe civic centre. This solution had a lower cost of execution and greater viability so it was committed to the new solution that meant a lesser impact in the execution of the boiler room. However, this could not be carried out with a direct award to GIROA-EVE, so a new call for tenders was considered

- The new network would be deployed exclusively to the areas of the district of Coronación where the dwellings have been attached, with the possibility of extending it to other areas if other dwellings want to be connected

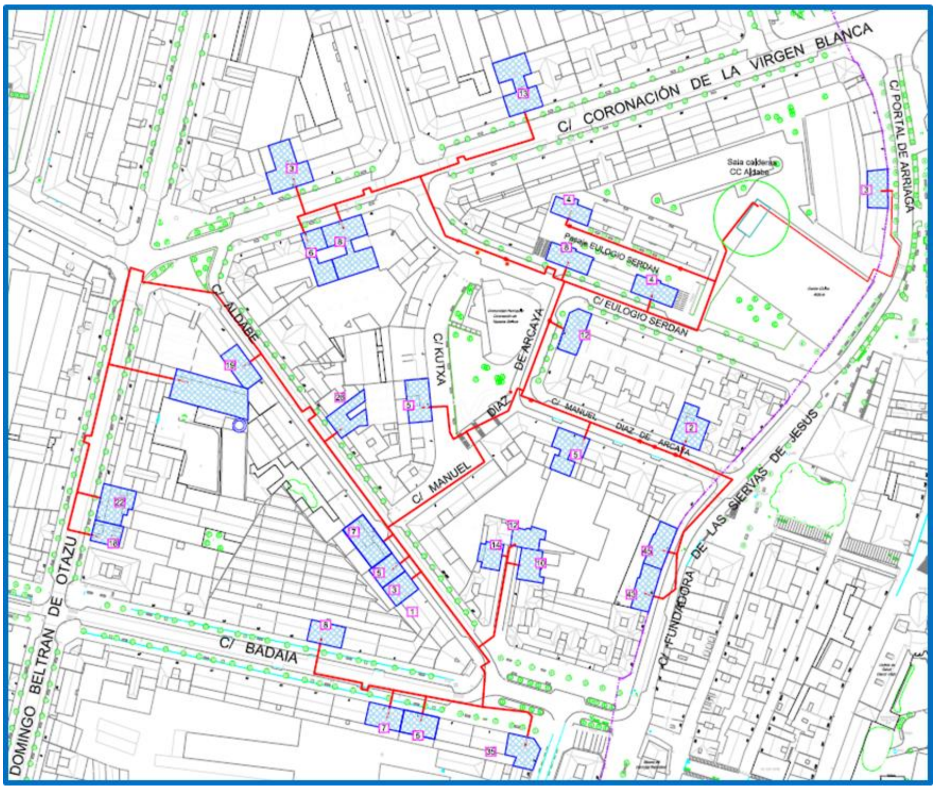

Figure 7: Distribution network

- The new project also proposed the incorporation of photovoltaic solar energy on the roof of the civic centre, although it was finally discarded.

- The new biomass boiler room required a small extension of the civic centre to incorporate the biomass boilers and auxiliary elements

Figure 8: Biomass boiler room location

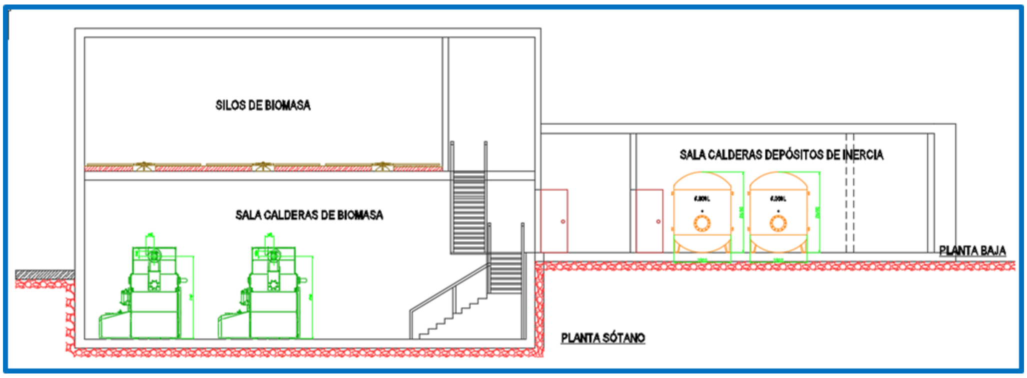

Figure 9: Inside of the boiler room

M47 – December 2019

The specification was published on 13 December with a delivery date of 13 January 2020.

M48 – January 2020

GIROA was the only candidate of the tender, which finally seemed to clear the way for the deployment of the project in accordance with local regulations. The expected execution time was 14 months from the award of the project and the approval of the corresponding building permits (approximately April or early May 2020)

3.2 Energy requirements legislation

Below is a list of the main regulations that apply to the District Heating project.

- UNE-EN ISO 17225:2014 Solid Biofuels – Fuel specifications and classes.

- Royal Decree 1042/2017, of 22 December, regarding the limitation of emissions of certain pollutants from medium combustion facilities, updating appendix IV of Act 34/2007, of 15 November, regarding air quality and protection of the atmosphere. The purpose of this Royal Decree is to incorporate into Spanish law EU Directive 2015/2193 of the European Parliament and the Council of Europe, of 25 November 2015, on the limitation of emissions of certain pollutants into the air from medium combustion facilities.

- The Regulation for Thermal Installations in Buildings (RITE) sets out the conditions required for the installations designed to meet the demand for thermal comfort and hygiene through heating, air-conditioning and hot water installations, to achieve a rational use of energy.

- The Technical Building Code, current regulation in the period of definition and development of the DH project, approved by Royal Decree 314/2006, of 17 March. The Technical Building Code (TBC is the regulatory framework that establishes the requirements that must be met by buildings in relation to the basic safety and habitability requirements established in Act 38/1999 of 5 November, regarding Building Regulations (LOE). The basic quality requirements with which buildings must comply relate to matters of safety and habitability. The TBC also addresses accessibility as a result of Act 51/2003 of 2 December, regarding equal opportunities, non-discrimination and universal accessibility for persons with disabilities, LIONDAU.

- The Energy Performance of Buildings Directive 2010/31/EU adopted by the European Parliament and the Council on 19 May 2010

- Additional Building Regulations specific to Vitoria-Gasteiz City Council

3.3 Boilers room

The boiler room is the plant where the thermal energy is produced. From there, it is distributed to the different buildings through the district heating network. In this case, the energy is produced by two biomass boilers Herz Firematic 501 of 500 kW each.

Figure 10: Biomass boiler

The rest of the energy demanded by the final users is produced by two gas boilers HOVAL of 1,500kW each. They are mainly used for the starting and peak loads.

Figure 11: Gas boiler

The energy is stored in two inertial water tanks of 4,000L, showed in the following figure, and then pumped into the network at 80ºC of temperature by WILO pumps.

Figure 12: Water tanks

Below it is shown the diagram of the thermal production system in the boiler room.

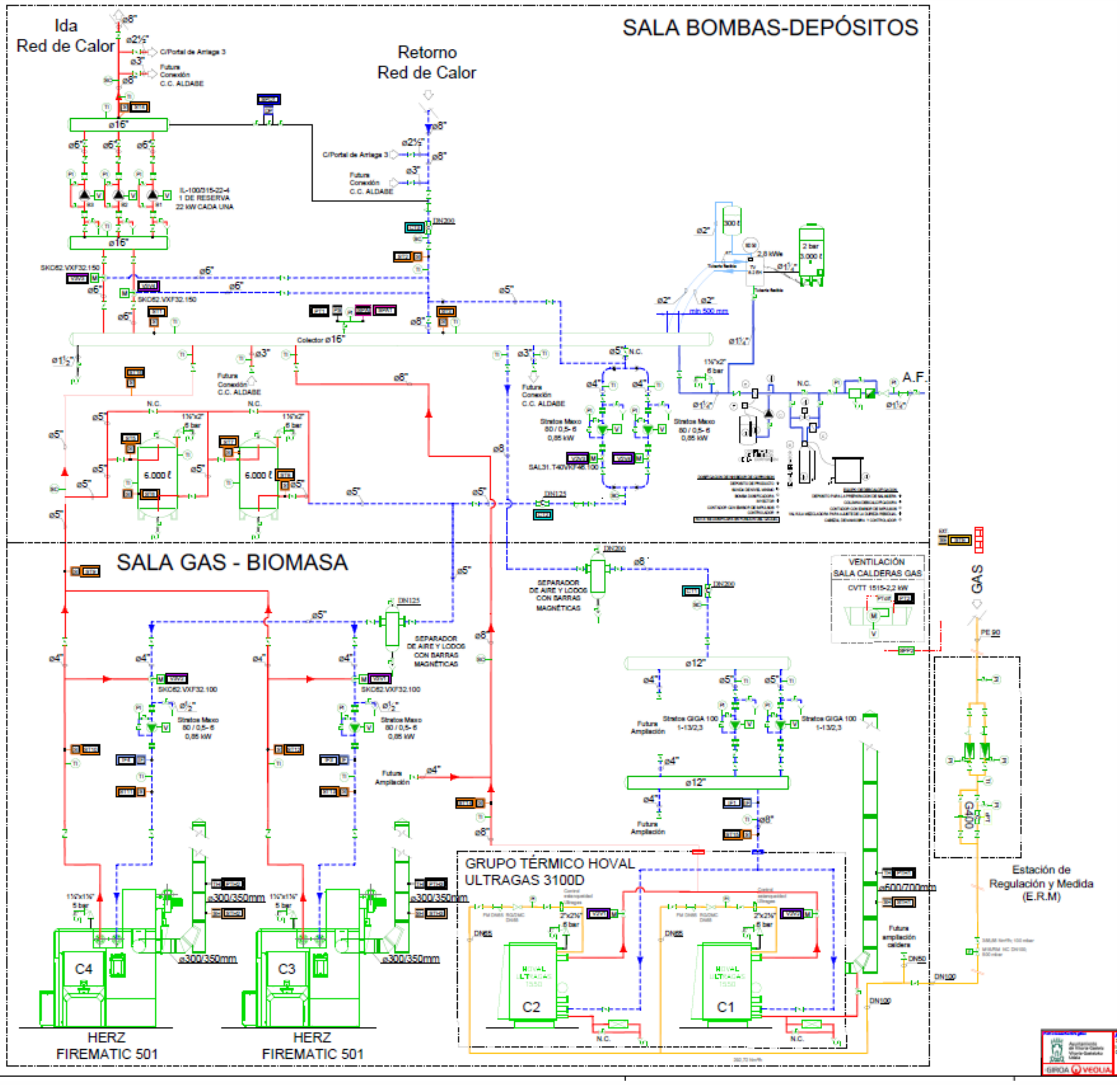

Figure 13: Thermal production diagram

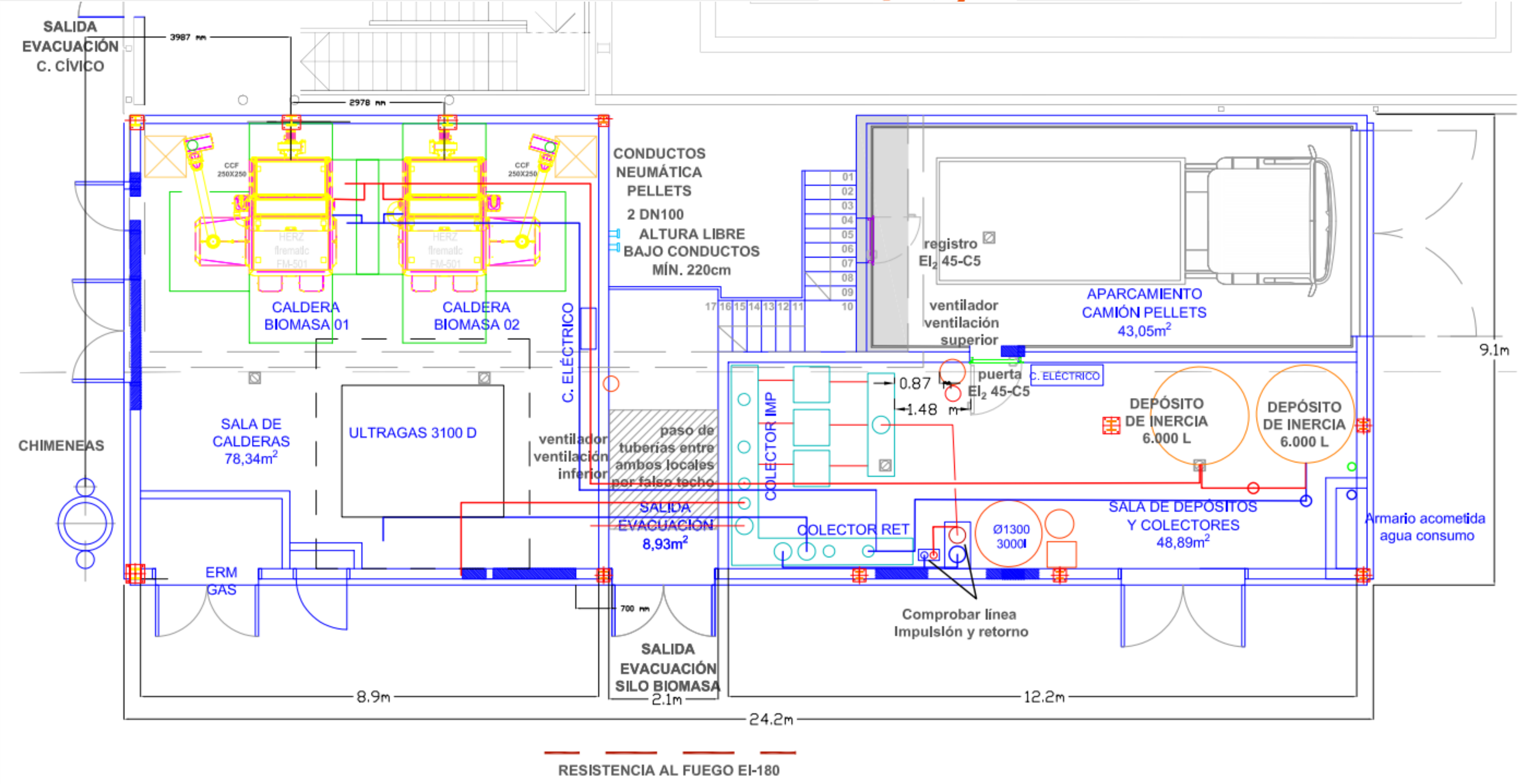

Figure 14: Boiler room diagram

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The fuel used by the biomass boilers is pellet. It is stored in the biomass silo, located underground, under the boiler room. It has a capacity of 46.6m^3. The pellet is supplied by trucks of pneumatic unloading. After this, the pellet is supplied to the boilers by two different screws, one for each boiler. The silo has a leaning floor so that the screws can gather the pellet easily. The framework of the silo is waterproof and it has two sensors to measure the immediate capacity of pellet available.

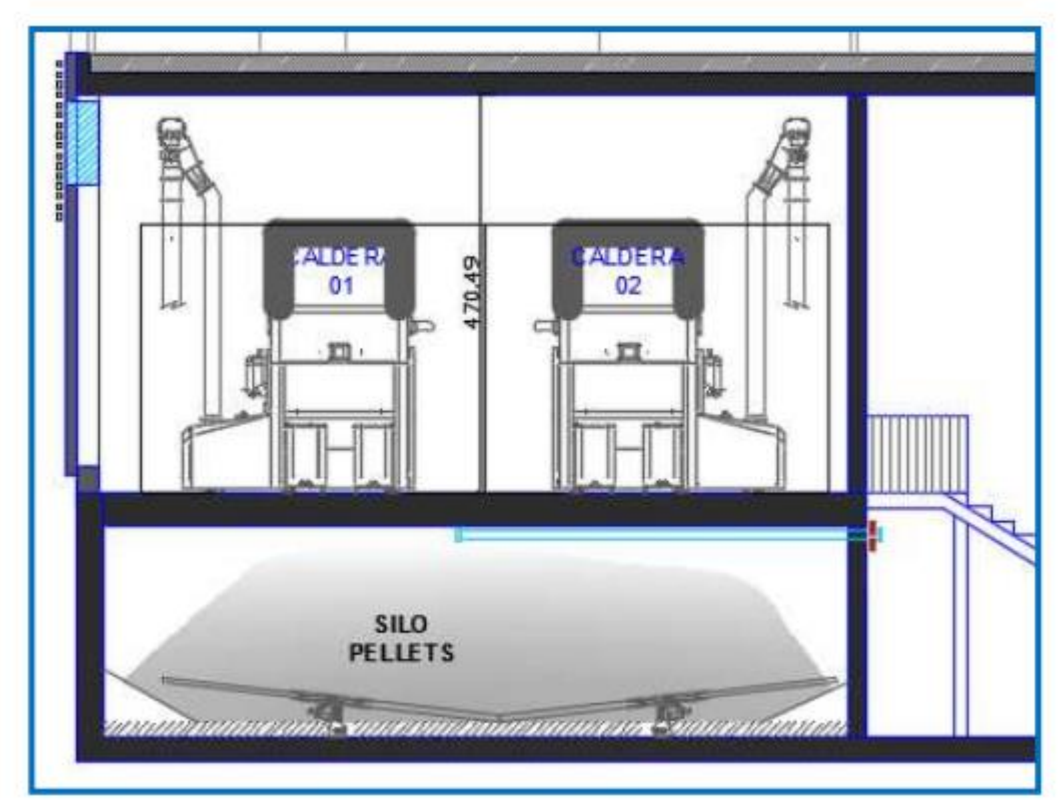

Figure 15: Boilers room

The works in the boiler room started in February 2021 with the civil works next to Aldabe civic centre. Annexed to the building of the boiler room are placed the chimneys, one for both biomass boilers and two others, one for each gas boiler (showed in the pictures below).

Figure 17: Boiler room

Figure 16 : Chimney

District Heating network

The underground heating network is the responsible for the distribution of thermal energy from the boiler room (where the energy is produced) to the substations, from where is distributed to each dwelling.

The heating distribution is done by a network of isolated steel pipes specially designed for the efficiently transportation of thermal fluids in District Heating. These pipes are made by steel, isolated by rigid polyurethane foam and surrounded by a polyethylene covering of high density.

This material has the capacity to work until 140 ºC during 30 years. It has a thermal transmission coefficient of λ ≤ 0,0275 W/(m K) and 70 kg/m³ of density. The pipes are supplied in bars of 6 or 12 m and joined by electrical current welding. The pipes have two cupper threads that allow the detection of humidity in the isolation of the pipe so that leaks could be detected.

In the following figure, different parts of LOGSTOR pipes which are part of the district heating network are shown:

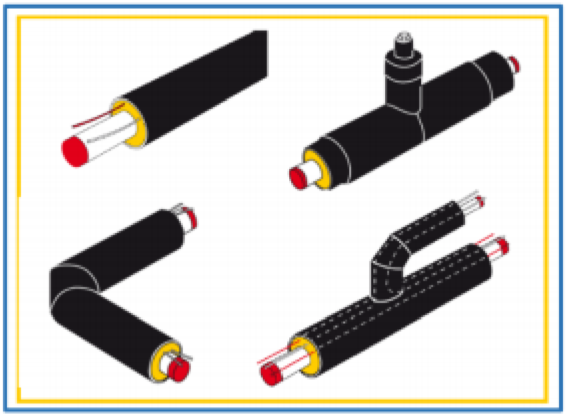

Figure 18: Logstor pipes

In the figure bellow, it is shown a map of the outline of the district heating network developed in Coronación neighbourhood in Vitoria-Gasteiz.

Figure 19: District Heating network

Once the thermal energy is produced in the boiler room, it is distributed to the different buildings through the heating network. This network develops through the following streets of the neighbourhood:

- Pasaje de Eulogio Serdán
- Eulogio Serdán
- Coronación de la Virgen Blanca
- Manuel Diaz de Arcaya
- Kutxa
- Aldabe
- Domingo Beltrán
- Plaza de la Ciudadela
- Badaia

The works began with the excavation of the trenches on June 2020 in the sorroundings of Aldabe Civic Center, in direction to Pasaje de Eulogio Serdán and Eurlogio Serdán. This area is where an old convent used to be placed, so the excavation had to be done carefully in case there were arqueological remains underground.

Figure 20: network deployment

The works of the district heating network have mainly 6 phases. First, the trench has to be excavated. After this, the pipe is introduced in the trench and weld. When this work is finished, the pipe is subjected to mechanical and hydraulic tests to probe there is no leak before filling again the trench. Once the trench is filled, the road is paved again.

Figure 21: Network deployments

Figure 22: network deployment

During the course of the works, several roads and lanes had to be cut off, always trying to interrupt the traffic and daily life of the neighbours the minimum. Along the district heating network there are several catch basins to gain access to the pipes in order to manipulate the valves that supply the different branches of the network. In the following picture, some of these catch basins could be seen.

Figure 23: network deployment

3.4 Substations

One of the main tasks of the execution has been the connection of the heating network from the DH central to the retrofitted buildings and the installation of the substations. This task has been complicated and has required defining specific solutions in each building. In order to provide heat to the renovated buildings and in order to maintain an appropriate aesthetics and to convince the residents of Coronación, each portal has its own substation. Giroa decided to install one substation per portal.

The substation function is to transfer heat from the thermal power plant (primary heat network) to the distribution networks in the buildings (secondary heat network) through a heat exchanger. Once the heat is in the secondary distribution network, the dwellings take heat from this secondary for heating and DHW. An individual transfer module per dwelling has been installed to provide instantaneous DHW and heating. Each substation has an energy meter to measure the overall demand of each portal.

SCHEMATIC DIAGRAM

The following is a schematic diagram of the principle of operation of the substation.

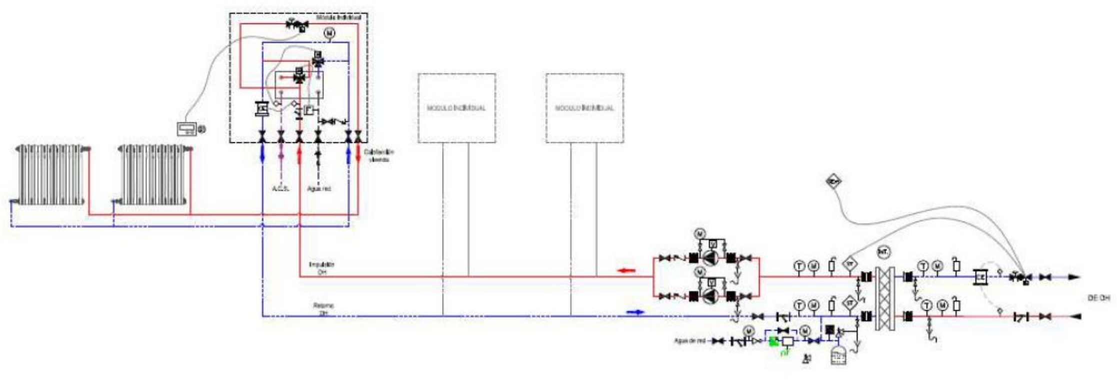

Figure 24: Substation Schematic diagram

The main elements of the sub-stations of the portals are the exchangers to be installed. Temperatures are maintained as follows:

- Winter mode: 80/60 degrees in the primary network and 78/58 degrees for peak heating demand conditions.
- Summer mode: 65/45 degrees in the primary network and 63/43 degrees in the secondary circuit for DHW demand.

TRANSFER MODULES

A transfer module has been installed in each house, which performs the work of a DHW exchanger, replacing in most cases, the individual boiler of the houses. Each house is connected to the flow and return pipes coming from the sub-central located at the entrance, and a water supply for DHW, and for filling the heating system of the houses.

Each transfer module has an energy meter to count the energy consumption of each dwelling, which is installed inside the module. Each module can be managed remotely to enable the management of the same externally.

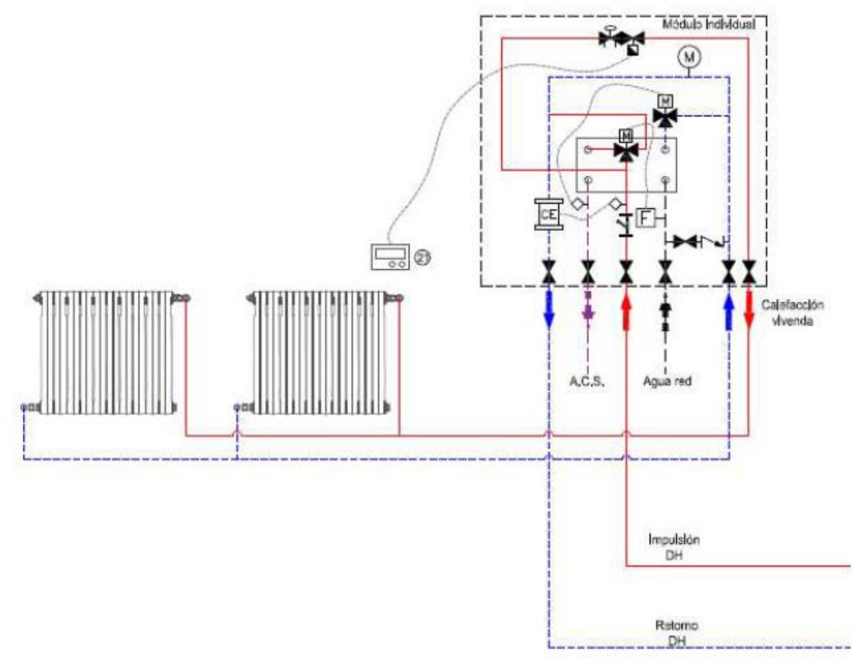

Figure 25: Substation operation diagram

CENTRALIZED CONSUMPTION ACCOUNTING AND MANAGEMENT

In order to provide home users with an automated system for the reading and billing of thermal energy consumption of heating and domestic hot water consumption, which also allows them to have a personalized monitoring via web of their consumption and billing, buildings will be provided with a personalized system via web of their consumption and billing, buildings will be provided with an energy remote reading system for homes, consisting of the following elements:

- Energy meters in the substations installed in each gateway.
- Energy meters in the transfer modules of the dwellings.
- Substation electric meter.
- Bus concentrator switchboards computerized system for data collection and analysis, web application and billing.

This remote reading system is compatible with the consumption system installed in the production plant. It is necessary to add all communications that are made through the European Mbus standard.

3.5 Monitoring

All the electromechanical systems of the project are collected by means of a data acquisition, supervision and control system (SCADA) which, in addition to the correct management and operation of the overall installation, provides the system with the corresponding technical management tools to evaluate the different operating scenarios that generate an improvement in the energy efficiency of the whole.

The system is equipped with data acquisition of thermal energy meter readings from both the production plant and the thermal energy meters in the homes.

HEAT PRODUCTION

The control system fulfils the following characteristics at the level of collection and recording of points:

- Collection and recording of water temperature probes of all circuits in both supply and return.
- Collection and recording of pressure probes and pressure switches to monitor, control and supervise the pressure of the circuits.
- Distribution pumping control, collecting status signals and alarms.
- Control of gas boilers.
- Supply and return temperature probes.
- Smoke probe.
- Control of valves and pumping associated to each boiler.
- Control of boiler ignition and modulation, as well as collection of operating status and alarms.
- Flow control of each boiler.
- Biomass boiler control.
- Biomass level control
- Control of forced ventilation of the boiler room according to the regulations for the prevention and post-ventilation of the room.
- Alarm management of production and distribution

The control system will continuously evaluate the demand of the installation generating the corresponding adjustments in the flow rate and distribution temperature. For this purpose, the boilers will start up or stop, if necessary, to adjust the actual power demand of the installation.

Substations

The control system complies with the following characteristics at the level of collection and recording of points:

- Collection and recording of distribution circuit water temperature probes in secondary and primary.

- Collection and recording of water pressure switch.

- Demand generation and control of valves and associated pumping.

The control system will continuously evaluate the demand of the installation generating the corresponding adjustments in the flow rate and distribution temperature.

Acquisition of consumption data

The control system will collect the following meters:

- Thermal energy meters produced by each boiler (M-Bus).
- Counting of production gas (M-Bus)
- Cold water consumed metering (M-Bus)
- Metering of electrical energy of each boiler (M-Bus)
- Electrical Energy Metering General Power Supply of the production power panel
- Electrical Energy Metering Pumping Distribution
- Thermal Energy Metering at the entrance of each gate or sub-central gate (M-Bus)
- Metering of thermal energy consumed by each neighbour through energy metering of each neighbour’s individual transfer station (M-Bus).

The production room has computer equipment that houses the Unitron Command Centre software package and the Weblink software package, both from Cylon.

The system is equipped with software equipment for sending alarm messages to e-mail accounts via e-mail and to cell phones via SMS, the latter accompanied by the implementation of specific GSM equipment for this purpose.

The communication controllers have the capacity to communicate with the following protocols:

- Ethernet TCP/IP

- LAN for communication with field controllers

- MODBUS-RTU for integration of devices with this operating protocol.
- In addition to these features, the communications controller has an embedded web server to provide HTML connection service against the installation locally or remotely in case the management system is cancelled due to a failure.
- This ensures the monitoring service with the installation.
- The management system software has the following applications:
    - Monitoring application
    - Alarm Manager Application

  - History Manager Application
  - Schedules Manager Application
  - Alarm Sending Manager Application for sending alarms to e-mail and SMS.

- Web Server with unlimited number of **simultaneous connections**

Description of the Technical Management and Data Acquisition System

The following subchapter describes the management system that allows governing the complete installation, as well as the acquisition of consumption data from the producer and consumer elements.

System architecture and integration levels

The scope of the present project includes the total development of the electromechanical subsystem installation, including the corresponding SCADA, as well as the integration of thermal and electrical consumption reading equipment.

The basic functions of the SCADA of the electromechanical installations will be:

- Data acquisition, collection, processing and storage.
- Supervision and dynamic monitoring, in an intelligible and personalized way of such data.

To support the whole, a Building Technical Management software will be implemented. This software will consist of two main modules:

- Development, Engineering and Programming Module:
- Process and Monitoring Module:

The basic SCADA architecture consists of two levels:

- Software:

The head-end, located in the control room of the production room is formed by an ETHERNET network that will allow servicing the SCADA server / central station.

The SCADA server, which runs the management software, is located in the head-end. It consists of a computer equipment that contains the process software and also the web server software.

- Hardware:

It shall be formed by each subsystem, being totally autonomous from the SCADA. The detailed topology and elements of each of these subsystems will be defined in the following points.

Operating system:

It is based on a platform whose operating system has a high graphic performance environment, with networking capability with the most widespread technologies in communications (Ethernet, TCP/IP, Novell, RS-232, RS-422, RS-485...) and commonly used in the field of management (Windows 7 Pro) with real-time work capacity.

Technology standards:

- Database access technology: SQL (Structure Query Language), standard protocol for relational database queries.

- Communication technologies: Most common protocols (TCP/IP, RS-232, MODBUSRTU, MBus).

Features:

- Graphical power:
- Point and alarm management
- Historical management
- Access security

3.6 SmartEnCity Replication process

There is an important commercial work behind the success of this project. After a first process of information to the Community of Owners of the district of Coronación, at the end of 2017, the dwellings added to the project were less than the expected.

After this, it was decided to increase the action perimeter and try to join other buildings to the heating network and some public buildings of the surroundings, as the civic center, the Atlas gymnasium and the church.

The commercial strategy involves different actions. Firstly, there was an office at the neighbours' disposal to carry out face-to-face meetings. In addition, information was sent via mail and email and some advertisements were published in the local radio.

At the beginning of 2019, the number of dwellings joined to the district heating network was 386 dwellings. The last phase of commercial task, involve mainly the Community of Owners, which already had central thermal system, because their connection is easier and more profitable, even if they do not carry out the façades retrofitting.

The works of the district heating network started in June 2020. By this date, the total number of dwellings added to the project was 302 dwellings. Due to a replication objective, the heating network has been designed with a growing potential so that other buildings could be added to the network in the future.

In the next figure, it is shown a map with the outline of the network and in blue all the dwellings added to it. In red, are shown the buildings which may be added in a near future to the district heating.

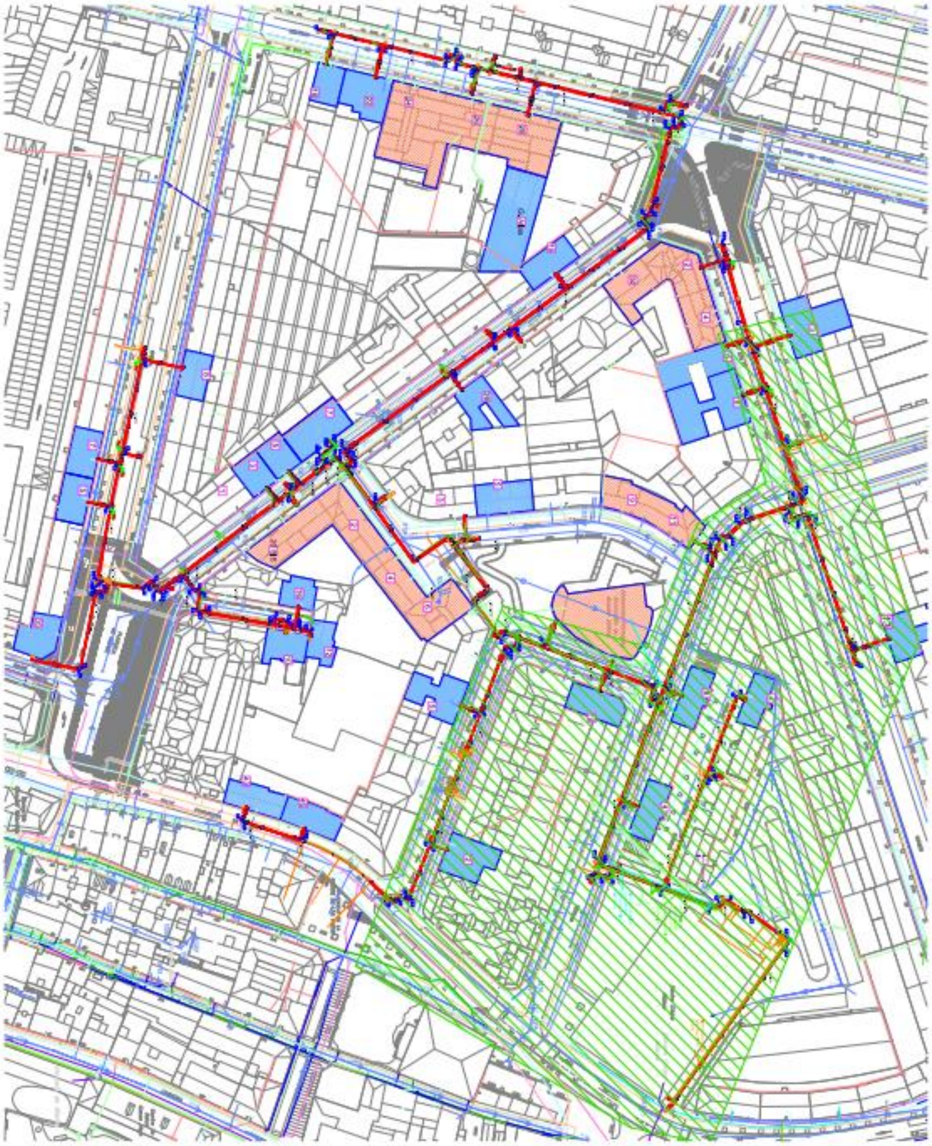

Figure 26: DH distribution network

Thanks to the commercial work, recently, 32 more dwellings have been added to the heating network:

- Kutxa 3-5 (16 dwellings)
- Kutxa 9-11(16 dwellings)
- Church of Coronación (13 equivalent dwellings)

However, the replication process is still ongoing and Giroa is working to sign an agreement with three other buildings:

- Plaza Zaldiaran 9-12 (72 dwellings)
- C.P. Coronación 2-4, Aldabe 34 (37 dwellings).
- Colegio presentación de María (737 Mwh, 130 equivalent dwellings)

Most of the Community of owners that are being added now to the district heating are buildings with a central heating system, which is more favourable to do the connexion than individual heating dwellings. In buildings with central heating systems, the actual boiler room is substituted by a substation where a heat exchanger acts as the boiler, connecting the previous building installation of pipes to the district heating network.

4 Deviations to the plan

There have been few significant deviations to the plan regarding district heating works.

The area near the civic centre where the boiler room has been built is where an old convent of the city used to be placed. The excavation had to be done carefully and under the supervision of a professional archaeologist in case there were some remains underground.

Indeed, a wall of this ancient convent was found during the excavation of the trenches and the works were paralyzed until the archaeologist did the appropriate actions and allowed continuing with the excavation. This fact caused a delay in the original plan of about two weeks.

In addition, the process for the obtaining of the necessary licenses in order to interrupt the traffic in the affected roads also took more time than the expected. It was necessary to coordinate the simultaneous works in different roads so that it affects the minimum to the course in the neighbourhood.

On the other hand, regarding the number of dwellings joined to the project, there was also a deviation from the original plan. At the beginning of 2019, as it is said before, the number of dwellings added was 386 and when the works began, 312 dwellings were joined. This fact made necessary to give a different approach to the project in order to conserve its profitability.

However, the replication process is still ongoing, and several Community of Owners and public buildings have recently joined the district heating network. The laborious commercial work is being hard, but it is finally producing results.