REPLICATE	Project no. 691735 REPLICATE PROJECT Renaissance of Places with Innovative Citizenship And Technology	This Project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N° 691735

REPLICATE PROJECT

REnaissance of PLaces with Innovative Citizenship And Technology

Project no. 691735

H2020-SCC-2015 Smart Cities and Communities

Innovation Action (IA)

D3.1 Buildings retrofitted

Due date of deliverable: 15/05/2020

Actual submission date: 15/05/2020

Start date of project: 01/02/2016 Duration: 60 months

Organisation name of lead contractor for this deliverable: Giroa

Status (*Draft/Proposal/Accepted/Submitted*): Submitted

Project co-funded by the European Commission within the 7th Framework Programme		
Dissemination Level		
PU	Public	X
CO	Confidential, only for members of the consortium (including the Commission Services)	

Editor/Lead beneficiary :	Giroa
Internall reviewed by :	FSS / SPES

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1. EXECUTIVE SUMMARY

This document describes the Building Retrofitting intervention implemented in the lighthouse city of Donostia-San Sebastian consisting of the retrofitting of 156 private dwellings and 34 commercial premises distributed along 10 doorways, totalling 18.350m2. The project included: façade retrofitting (thermal isolating and windows metalwork), roof and basements. The intervention also included the general connection of the buildings to the District Heating system and all the individual and common installations within the buildings.

The buildings of the retrofitting intervention were constructed between the years 1.965 and 1977, which means, they have not been subject to any regulations of thermal conditions in buildings (the national regulation NBE-CT-79 which included thermal regulation came into force in 1981). As a result, the constructive solutions that were carried out in those years did not include any type of insulating material.

The District Heating system is promoted and coordinated by Fomento San Sebastian and it distributes and supplies heat for Domestic Hot Water and heating generated in a centralized location through a system of insulated pipes for the new residential area Txomin-Enea in Donostia - San Sebastian. The heat is obtained burning biomass and with the support of two gas boilers. The District Heating scheme has been sized to meet the needs of 1500 dwellings, including the connection of 156 retrofitted houses.

This retrofitting intervention in Txomin-Enea neighbour is part of a comprehensive transformation of the Urumea Riverside district towards a Smart City model through several actions in the energy field, sustainable mobility, ICTs and infrastructures. This transformation has been deployed under the framework of the Replicate project implementation where further actions are being carried out with the aim of becoming the Txomin-Enea neighborhood a smart district.

The Citizen engagement has been one of the key factors in the success of this retrofitting intervention in Txomin-Enea. The neighbour association was involved from the beginning of the project; in the preparation stage they showed a great interest in the retrofitting intervention and presented a letter of commitment. The project has created and developed strong links with the neighbour association and the local residents, which helped raising awareness of the project and a total agreement of participation of all dwellings. During the project duration multiple meetings have been held with all stakeholders (neighbour associations, presidents, administrators, tenants, etc.) to maintain fluid communication in all stages.

The retrofitting intervention entailed several and important benefits for the neighbours. Firstly, the buildings have been renovated and insulated in the façade, roofs, basements and windows, which have improved the comfort in the houses in terms of inside temperature and noise reduction, and have reduced the energy consumption, the energy bill and the CO2 emissions.

Secondly, all 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.

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2. REPLICATE

The main objective of REPLICATE project is the development and validation in three lighthouse cities (**Donostia / San Sebastián** – Spain, **Florence** – Italy and **Bristol** – UK) of a comprehensive and sustainable City Business Model to enhance the transition process to a smart city in the areas of the energy efficiency, sustainable mobility and ICT/Infrastructure. This will accelerate the deployment of innovative technologies; organizational and economic solutions to significantly increase resource and energy efficiency improve the sustainability of urban transport and drastically reduce greenhouse gas emissions in urban areas.

One of the REPLICATE goals is to build a sustainable city business model to promote the transition to a smart city. In this way, it will be possible to accelerate the deployment of innovative, organizational technologies and economic solutions to increase resources and energy efficiency, improve the sustainability of urban transport and drastically reduce the greenhouse effect in urban areas.

REPLICATE project aims to increase the quality of life for citizens across Europe by demonstrating the impact of innovative technologies used to co-create smart city services with citizens, and prove the optimal process for replicating successes within cities and across cities.

The Business Models that are being tested through large-scale demonstrators at the three cities are approached with an integrated planning through a co-productive vision, involving citizens and cities' stakeholders, providing integrated viable solutions to existing challenges in urban areas and to procure sustainable services. Sustainability of the solutions is fostered in three areas: economic and environmental and finally, fostering transparency in the public management.

In addition, the Model features the replicability of the solutions and their scale up in the entire city and in follower cities, particularly in three follower cities (**Essen** – Germany, **Laussane** – Switzerland and **Nilüfer**-Turkey) that are involved in the project and therefore, have access to know-how and results achieved on the project so they can apply the developed model. At the moment, there are 2 observer cities, Guanzhou (China) and Bogota (Colombia).

3. INTRODUCTION

3.1 Relation to other project documents

This document is related to the deliverable D3.3 *"Report on District Heating construction including the maintenance program"* which describes the construction of a District Heating station in the Txomin -Enea neighbourhood in San Sebastian. This DH system supplies thermal energy to the retrofitted houses for heating and domestic hot water.

3.2 Reference documents

This document is based in the following projects level documents:

Ref.	Title	Description
REPLICATE Grant Agreement signed 240713.pdf	Grant Agreement	Grant Agreement no. 691735
DoA REPLICATE (691735)	REPLICATE Annex 1 – DoA to the GA	Description of the Action
REPLICATE Consortium agreement signed December 2015 (7th December version)	Consortium Agreement	REPLICATE project – Consortium Agreement
REPLICATE Project Management Plan	D1.1 Project Management Plan (v.1) (29/04/2016)	REPLICATE Project Management Plan
REPLICATE District Management Plans	D1.4 District Management Plan San Sebastian D1.5 District Management Plan Florence D1.6 District Management Plan Donostia-San Sebastián	REPLICATE District Management Plans
REPLICATE Communication Plan	D11.1 Communication Plan	REPLICATE Communication Plan

Table 1 Reference documents

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Where there are contradictions, the documents listed above supersede this deliverable. The Grant Agreement is the contract with the European Commission so takes precedence over all other documents.

3.3 Abbrevations list

GA	Grant Agreement
CA	Consortium Agreement
DoA	Annex I–Description of the Action
EC	European Commission
GEH	Greenhouse emissions
H2020	Horizon 2020
PC	Project Coordinator
PL	Pilot Leader
PMP	Project Management Plan
TC	Technical Coordinator
WP	Work Package
WPL	Work Package Leader

Table 2 Abbreviations list

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4. DELIVERABLE DESCRIPTION

This deliverable describes in detail the retrofitting intervention of the 156 dwellings and 34 commercial existing premises in the neighbourhood of Txomin-Enea and its connection into a new District Heating (DH) energy system. Both measures improve significantly the general comfort and quality of life of the citizens of the neighbour.

Section 5 describes the partners involved in the whole process since the beginning of the intervention and marks which are their roles during the different steps of the intervention. It also defines the different levels of management the retrofitting.

Section 6 describes importance of citizen engagement during the whole process of the retrofitting intervention, involving from the beginning of the project all relevant stakeholders.

Section 7 covers the whole building retrofitting process, from the preliminary studies to the final execution, including the connection of the retrofitted houses to the District Heating installation. In this section the construction works faithfully describes all the works developed mentioning each particularity within the process and effort carried out by all the partners involved.

Section 8 shows the lessons learnt in the implementation of the retrofitting intervention. As in any construction works, things have been learned as the process progressed.

Section 9 covers the innovations and impacts of the retrofitting and DH connection intervention. It evaluates not only the different benefits that the neighbours have obtained once the work has finished, but also what it represents, in global terms for the neighbourhood and the whole city, a change to a neighbourhood with a biomass District Heating. This generates an impact on society, but also at an environmental level.

Section 10 describes the conclusions after the completion of the project.

5. PARTNERS INVOLVED & MANAGEMENT MODEL

Giroa is the leader and main responsible of the implementation of the retrofitting intervention. Fomento San Sebastian has a key role in the project (San Sebastian lighthouse pilot leader and Replicate project Coordinator) and in the citizen engagement process, as well as a coordinator for communication porpoises with the Municipality. Fomento San Sebastian is also the responsible of the District Heating system developed in the neighbourhood, which supplies DHW and heating to the retrofitted dwellings. In addition, the architecture studies, the constructor company of the retrofitting, the neighbours, and the agents of the new urbanisation development are part of the intervention. The work carried out by each of the parties is detailed below.

5.1 Partners involved

5.1.1 Giroa

Giroa is the responsible of this intervention and its task leader in the REPLICATE Project. Giroa has had several tasks within this intervention: definition of the project, preliminary studies, contract of companies and architects for the project, daily contact with tenants, presidents and administrators, execution of the work, coordination of all stakeholders, monitoring of the intervention, etc.

Giroa has also placed and assembled the substation of the District Heating system and installed the heating pipes from the substations to each of the retrofitted dwellings. This installation done in the retrofitting dwelling is part of the District Heating system of the neighbourhood managed by Fomento San Sebastian and the Municipality of San Sebastian. Giroa will perform the maintenance of the substations and heating network of the retrofitted dwellings for 5 years.

These types of interventions are really challenging and require a great effort in different levels: technical execution, communication with tenants, coordination with all involved agents, etc. The coordination with the new urban development works in the same time as the retrofitting execution has required an extra effort to align all different interest and work progress and it has been a complicated task where FSS has played a key management role.

5.1.2 Architecture studies

The architectural firms (AGM Architects and BASA Architects) contracted by Giroa have been in charge of the elaboration of the preliminary studies and execution follow up. After neighbour's acceptance of the project and before starting all the work, AGM and BASA contacted the Municipality of San Sebastian to get all necessary permits to implement the work, building permits, occupation of the road, etc. Fomento San Sebastian facilitated the management and required information to obtain all permits.

They also had meetings with the Urbanism department of the Municipality of San Sebastian and Fomento San Sebastian to find an adequate location for the substations in the community. In fact, this task required deep analysis in each building to find a good location that meet all requirements, which is very complicated compared with a new building that a specific location is designed from the beginning to place the substation.

The architects coordinated and carried out the projects for the implementation of accessibility improvements in some communities. In some dwellings, taking advantage of the retrofitting execution, some other works were done thanks to extra funding of Regional Government and out of the scope of Replicate project, which entailed additional benefits for the neighbours.

5.1.3 Retrofitting Construction Company

The construction company ANDRASA contracted by Giroa has been in charge of executing the retrofitting project of facades, roof, basements, etc. Under the coordination and monitoring of the architects and Giroa, Andrasa carried out all works during execution and held monthly and weekly meetings to inform about the progress of the work, delivery dates, etc.

5.1.4 Neighbours

Final beneficiaries of the project, from the beginning they showed great interest to participate in this retrofitting intervention in the framework of the REPLICATE Project. In fact, there was unanimity to participate in the project, all neighbours agreed to be part of this intervention and the innovative transformation of the Urumea Riverside District.

During the intervention continuous meetings have been done in all steps of the project with them in order to explain the work, specific details, the connection to the DH, etc. Giroa, Fomento San Sebastian, and the Architects have participated in those meetings.

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5.1.5 Fomento San Sebastian

Fomento San Sebastian is the coordinator of the REPLICATE Project and the pilot of San Sebastian lighthouse city. FSS has a strong commitment with this intervention being an active part of the Urumea Riverside District transformation promoting, fostering and coordinating several implementations and deployments as the retrofitting, District Heating system, etc.

FSS has maintained a very active role from the beginning of the project to involve the neighbour association and local community as well as obtaining funds for the intervention. FSS has participated in most of the meetings with the neighbours when the project was presented and explained in order to facilitate the engagement and agreement of the residents.

They have also coordinated and facilitated the communication with the Municipality departments to find the best solutions and to speed up some of the procedures and licences in different steps. FSS established a coordination follow-up of the progress of the intervention through weekly meetings with Giroa and the architects to find out the status of the work, trying to anticipate problems, proposing solutions, etc.

5.1.6 Urbanisation agents

In the Txomin-Enea neighbourhood, a new urbanisation and construction of about 1500 new homes is being carried out. This work has been executed in parallel to the retrofitting intervention, which in many cases brought interferences in the development of the work.

The municipality of San Sebastián has promoted this new urbanisation project, and numerous agents have participated on it. In addition to the municipal technicians, the architects in charge of the execution management and the construction company of the urbanization are the main agents involved.

The coordination works between both projects have been carried out between all the parties, coordinated by Fomento San Sebastián, Giroa and the City Council itself.

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5.2 Management model

Three general levels of management had been established to coordinate the intervention and the follow up.

5.2.1 Communication with neighbours:

From the early stage of the project Giroa and FSS participated and coordinated multiple meetings with the local community, starting with the neighbour association, then with the presidents and administrators of the buildings, and finally with all neighbours. The communication and meetings have been maintained during the project duration. Most of the meetings with the residents were organised at 6:00 p.m., when more neighbours were available to attend meetings. The neighbours posed numerous issues and questions about the work and all of these have been addressed and solved, and it required an important effort.

5.2.2 Technical and economic follow-up

The follow-up of this intervention in all stages has been done very deeply. Weekly meetings have been carried out since the beginning of the project between Giroa, the architects and FSS to monitor the progress of the work.

The exhaustive monitoring has allowed detecting possible risks and taking the necessary measures to mitigate them when possible or to minimise their effects. This effort has been necessary due to the complexity of the intervention, the coordination of all the stakeholders involved, the execution of all the works in parallel in the 10 blocks, the coordination with the new urbanisation works of the neighbourhood, etc.

The economic monitoring has been carried out from the beginning in order to maintain the budget approved by the neighbours, minimise and avoid extra costs or deviations for residents.

5.2.3 Giroa follow-up

Giroa's follow-up on this project has been intensive, since it has managed the signature of the contracts with the neighbours. Therefore, it has been in charge of holding meetings with architects, construction companies, supervising the delivery date of materials, modifying the work according to the materials, and managing project resources to fulfil agreements and intermediate dates.

Going into detail about the meetings, Giroa maintained on-demand meetings with neighbours to answer questions about:

1. Work progress
2. Work team changes
3. Pipe layouts modifications due to the neighbour's requests
4. Date of scaffolding dismantling
5. Selected materials
6. Date of scaffolding removal
7. Other issues

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6. CITIZEN ENGAGEMENT

The citizen engagement is one of the key factors in the success of this retrofitting intervention in Txomin-Enea. There is a fundamental basis in this type of projects that makes neighbourhood engagement essential. It is necessary to reach agreements with neighbours and to be transparent with all the information about the project with them. The communication has to be fluid from the beginning and take care of it to maintain a proper relation during the project execution. It is also very important to be flexible in some parts of the project (façade solution, colours and finish of the façade, etc.).

It is important to mention that the retrofitting intervention in Txomin-Enea is part of a comprehensive strategy and transformation of the Urumea Riverside district towards a Smart City. Communication and dissemination activities about this transformation have been carried out in several ways, including a specific public briefing of the Replicate project and its implementation in the Urumea Riverside District from the local Authorities to all Txomin-Enea´s residents.

Image 1: Public Briefing held in San Sebastian´s town hall

Regarding the communication and engagement for the retrofitting intervention itself, the neighbours association of Txomin-Enea was informed and involved in the project from the very beginning. In the preparation stage of the Replicate project, the neighbour association was informed about the aim of developing a district retrofitting in their dwellings, and they showed its agreement through a letter of interest that was presented with the Replicate proposal.

Once the Replicate project was approved, contact with the neighbour association was resumed and the citizen engagement process with all the neighbours began. Multiple meetings were held to inform about the project and the benefits of participating in the retrofitting intervention and the connection to the DH system for the 156 homes and 34 commercial premises. The presentation of the REPLICATE Project and the retrofitting intervention to the neighbour was received in a positive way.

The meetings with neighbourhood were done in Txomin Enea´s district using a local community space in one of the buildings that was to be retrofitted. This space was chosen to encourage local residents to attend in a friendly and known space environment and create a sharing and participatory environment.

Image 2: Haurtxoko of Txomin Enea

In the first meetings, the project (main goals and vision) and the different interventions were explained in a global way. Giroa and Fomento SS explained the benefits that offer joining to the Replicate project and being able to renovate the homes, achieving significant improvements at an affordable price. In fact, the important benefits that neighbours would obtain were highlighted: improvement of comfort and efficiency, reduction of energy cost and bills, CO2 emissions reduction, houses rise in value, renovation in line with new district transformation, sustainable district image, etc.

The first meeting was organised with all the presidents of each block of the dwellings and there was a good understanding between both parts. Afterwards Giroa and FSS met the ten doorways from the communities that belong to the Txomin-Enea neighbourhood, (11,12,13,14,15,16,22,23,31,32).

Several communication materials were prepared to explain the main goals of the Replicate project, the retrofitting intervention benefits, the development of the District Heating system in the San Sebastian pilot using biomass, and highlighting the costs reduction and improvement of the comfort that all this would entail. The following picture shows the commercial brochure distributed to the neighbours.

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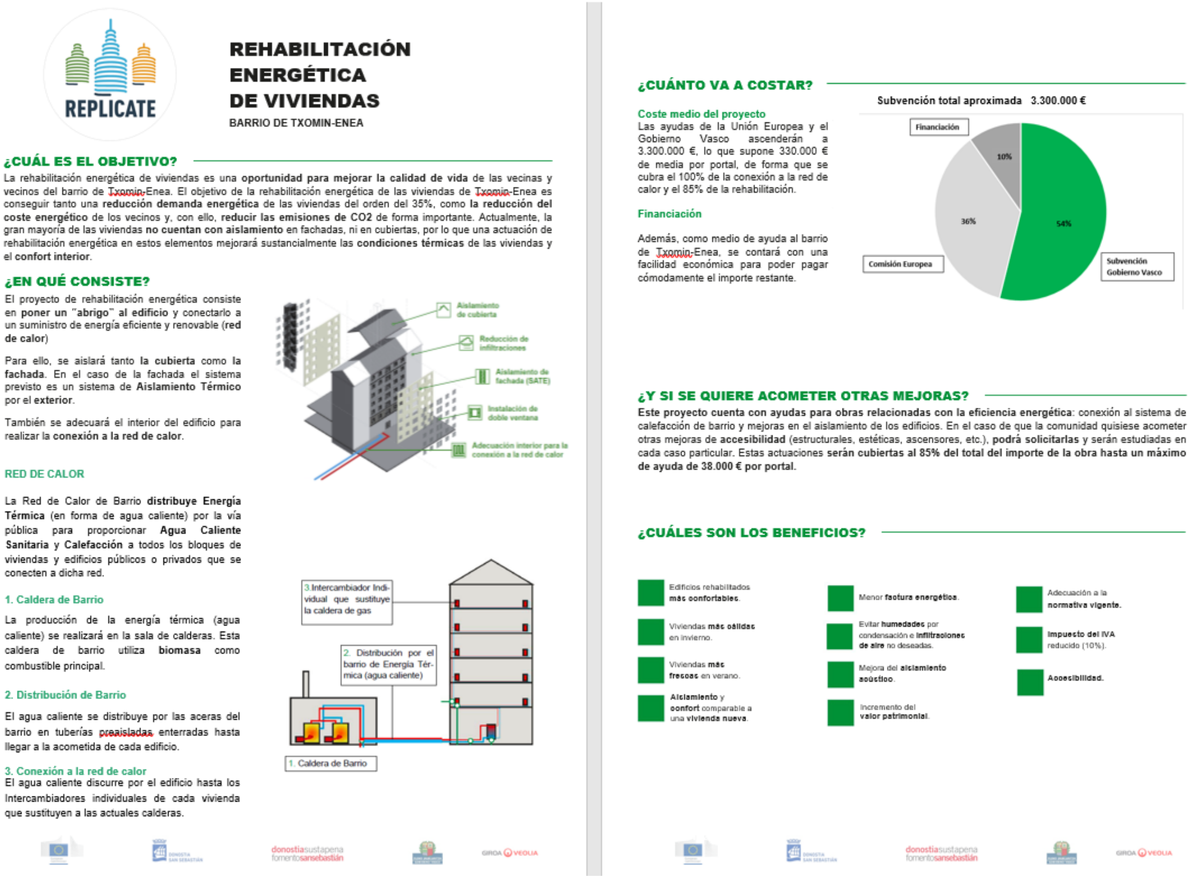

REHABILITACIÓN ENERGÉTICA DE VIVIENDAS

BARRIO DE TXOMIN-ENEA

¿CUÁL ES EL OBJETIVO?

La rehabilitación energética de viviendas es una **oportunidad para mejorar la calidad de vida** de las vecinas y vecinos del barrio de Txomin-Enea. El objetivo de la rehabilitación energética de las viviendas de Txomin-Enea es conseguir tanto una **reducción demanda energética** de las viviendas del orden del 35%, como **la reducción del coste energético** de los vecinos y, con ello, **reducir las emisiones de CO2** de forma importante. Actualmente, la gran mayoría de las viviendas **no cuentan con aislamiento** en fachadas, ni en cubiertas, por lo que una actuación de rehabilitación energética en estos elementos mejorará sustancialmente las **condiciones térmicas** de las viviendas y el **confort interior**.

¿EN QUÉ CONSISTE?

El proyecto de rehabilitación energética consiste en **poner un "abrigo" al edificio** y conectarlo a un suministro de energía eficiente y renovable (**red de calor**)

Para ello, se aislará tanto **la cubierta** como **la fachada**. En el caso de la fachada el sistema previsto es un sistema de **Aislamiento Térmico** por el **exterior**.

También se adecuará el interior del edificio para realizar la **conexión a la red de calor**.

RED DE CALOR

La Red de Calor de Barrio **distribuye Energía Térmica** (en forma de agua caliente) por la vía pública para proporcionar **Agua Caliente Sanitaria** y **Calefacción** a todos los bloques de viviendas y edificios públicos o privados que se conecten a dicha red.

1. Caldera de Barrio

La producción de la energía térmica (agua caliente) se realizará en la sala de calderas. Esta caldera de barrio utiliza **biomasa** como combustible principal.

2. Distribución de Barrio

El agua caliente se distribuye por las aceras del barrio en tuberías preaisladas enterradas hasta llegar a la acometida de cada edificio.

3. Conexión a la red de calor

El agua caliente discurre por el edificio hasta los Intercambiadores individuales de cada vivienda que sustituyen a las actuales calderas.

¿CUÁNTO VA A COSTAR?

Coste medio del proyecto

Las ayudas de la Unión Europea y el Gobierno Vasco ascenderán a 3.300.000 €, lo que supone 330.000 € de media por portal, de forma que se cubra el 100% de la conexión a la red de calor y el 85% de la rehabilitación.

Financiación

Además, como medio de ayuda al barrio de Txomin-Enea, se contará con una facilidad económica para poder pagar cómodamente el importe restante.

¿Y SI SE QUIERE ACOMETER OTRAS MEJORAS?

Este proyecto cuenta con ayudas para obras relacionadas con la eficiencia energética: conexión al sistema de calefacción de barrio y mejoras en el aislamiento de los edificios. En el caso de que la comunidad quisiese acometer otras mejoras de **accesibilidad** (estructurales, estéticas, ascensores, etc.), **podrá solicitarlas** y serán estudiadas en cada caso particular. Estas actuaciones **serán cubiertas al 85% del total del importe de la obra hasta un máximo de ayuda de 38.000 € por portal.**

¿CUÁLES SON LOS BENEFICIOS?

- Edificios rehabilitados **más confortables**.
- Viviendas **más cálidas** en invierno.
- Viviendas **más frescas** en verano.
- **Aislamiento** y **confort** comparable a una **vivienda nueva**.
- Menor **factura energética**.
- Evitar **humedades** por condensación e **infiltraciones de aire** no deseadas.
- Mejora del **aislamiento acústico**.
- Incremento del **valor patrimonial**.
- Adecuación a la **normativa vigente**.
- **Impuesto del IVA** reducido (10%).
- **Accesibilidad**.

Image3: commercial brochure

In these meetings, a general discussion was made about the costs that rehabilitation works would entail. The estimations about the costs was presented for a house of 70m2 on average, taking into account thermal energy and fixed terms and what each neighbour would save annually by doing the retrofitting and connecting to the District Heating.

After those meetings, a preliminary project was carried out in order to make a proper evaluation of the intervention in terms of technical solutions and detailed budget. The architectural companies visited the buildings (roofs, garages, common areas) and the dwellings to study in detail the intervention and the possible structural deficiencies in order to elaborate this preliminary project.

On the one hand, the architects determined where the modules of the District Heating should be installed in the dwellings, which insulation work and change of carpentry works would be necessary. They also studied the neighbourhood requirements in terms of accessibility. The architects and Giroa worked together to define in which areas the substations of the DH could be installed. On the other hand, they detected structural deficiencies in the building due to antiquity.

After all these visits, studies, and preparation of ITE (Building Technical Inspection) the preliminary projects were elaborated. Those documents described formal, constructive and economical aspects and characteristics of the work, as well as the different points of improvement, that is, rehabilitation of the envelope, accessibility, etc.

The preliminary projects were presented to all neighbours organising several meetings. In these meetings, the conclusions drawn by the architects were explained: technical solutions in the façades, roofs, basements and carpentries, and economical proposal. Improvements regarding some deficiencies due to antiquity were also presented. The level of comfort and quality of life to be obtained after the project was highlighted.

The response of neighbour was positive in general, but it was necessary to work hard because there was a small sector of neighbours who were not really interested in the project and it was important to make an extra effort in the engagement process. Finally, all residents decided to participate in the project and 100% of agreement was obtained.

The good disposition from the beginning by the neighbours was translated into neighbourhood proposals, improvement options, and the budgets took shape taking into account the limitations and suggestions of the whole neighbourhood.

During the execution, regularly meetings with presidents and neighbours have taken place. Continuous contact has maintained with the presidents of the communities and neighbours, giving information, answering questions, explaining technical and economical details, progress of the works, etc.

The communication and contact with presidents and neighbours during the execution has been a very important task in the project. Giroa, FSS and the architects have taken care of maintaining the communication fluid and it required a great effort.

7. BUILDING RETROFITTING

This section explains in detail the work done in all tasks of the retrofitting intervention execution. The Preliminary Studies paragraph covers the initial studies of the project done internally, including the energy demand study and the District Heating study. After that, the execution is described deeply in the Construction Works paragraph, including project design task, retrofitting execution and District Heating connection. The information regarding the engagement process with the local community of the retrofitted dwellings is explained in the previous section Citizen Engagement.

7.1 Preliminary studies

Initially, a preliminary study of the area and the buildings to be retrofitted was made in order to analyse the dimensions of each block, the construction features of the buildings and ultimately, to evaluate the possibilities of the works and costs of the rehabilitation and connection of the DH to the households.

The thermal consumption of the buildings before the retrofitting was also analysed, in order to establish a baseline to compare the future savings after the intervention. The District Heating system and future maintenance costs to be expected were studied in detail too.

<u>**Study of dwelling´s retrofitting**</u>

The scope of action consisted of 10 portals and 156 dwellings and 34 commercial premises in total. Although the constructive characteristics of all the buildings were similar, it could be subdivided into three different groups:

- Portals 11,12,13,14,15,16 – 109 dwellings
- Portals: 22,23 – 12 dwellings
- Portals: 31,32 – 35 dwellings

The following pictures illustrate easily the reason why the ten portals were divided into three different areas. The Antzieta 11-16 Group consists on 6 building with very similar constructive characteristics, which are at the same time a building block. The Antzieta 22-23 group consists on two identical buildings, on the left side of Image 5. The Antzieta 31-32 Group consists on two buildings joined with almost the same characteristics.

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Image 4: Group 1 Aintzieta 11-16

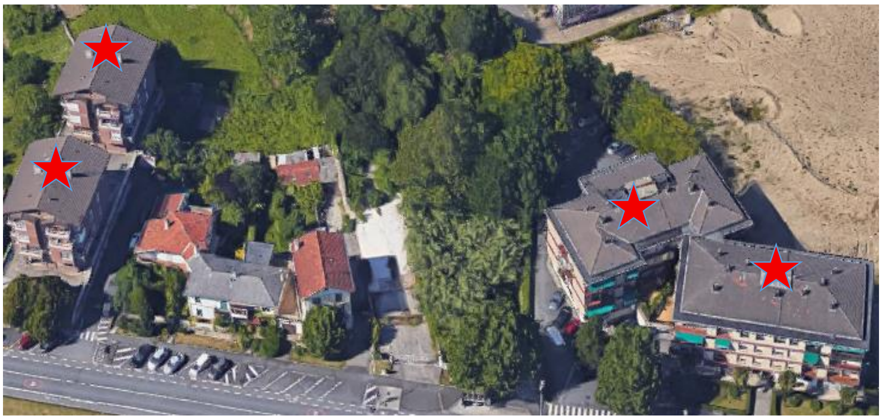

Image 5: Group 2 Aintzieta 22-23 and Group 3 Antzieta 31-21

These buildings were constructed between the years 1.965 and 1977, which means, they have not been subject to any regulations of thermal conditions in buildings (the national regulation NBE-CT-79 which included thermal regulation came into force in 1981). As a result, the constructive solutions that were carried out in those years did not include any type of insulating material.

The proposed solution for retrofitting was the following:

- SATE System or Ventilated Façade with the same insulation features. The main proposal was the SATE system as is the most economical solution, but including also the possibility to chose ventilated Façade.
- The placement of a SATE system on the outside of the façade, incorporating EPS plates of 10 centimetres thick and k = 0.030 W ƒ mK, and a mortar finish. The

result of the transmittance of the new façade solution 0.25 M2K ƒ W. In the case that aesthetically the proposed option does not fit the needs or preferences of the community of owners, other thermally equivalent solution would be studied that would meet the requirements of the project.

- The transmittance obtained with the proposed system improves the maximums indicated in the current Technical Building Code (CTE) of the year 2013 and the values recommended in that standard.
- The roofs of all buildings were constructed in the same way according to the projects consulted: Reinforced concrete slab raised on slabs from the under–floor flooring and finished in Arabian tile.
- The proposal for the insulation work of these enclosures consisted in the installation of rigid plates of extruded 80 mm tongue and groove polystyrene anchored to undercover. As a result, the transmittance of the element complied with the current state regulations, which is 0.38 W ƒ m2K.
- Regarding the exterior carpentry, there were differences between the dwellings, but the objective was to include windows with thermal bridge break. New windows with thermal bridge break and glasses under emissive with argon gas were proposed, which also isolated acoustically.
- In order to insulate the floor of the first floor of the dwellings, a rigid extruded polystyrene board 80 mm thick, anchored to the roofs of the ground floor were analysed to guarantee the adequate insulation.
- The lower floors of the ten buildings to be retrofitted are intended for tertiary use as commercial premises. These premises were analysed in terms of thermal insulation and energy retrofitting according to the building where they were located. In order to maintain the continuity between the buildings and the commercial premises, similar retrofitting solutions were considered regarding the façade insulation and window replacement. It has to be mentioned that each premise showed particularities in terms of enclosures for showcases, different interior environmental conditions depending on the use, etc. Therefore, individual analysis of each commercial premise was necessary for the aesthetic and energetic rehabilitation, and a specific solution for each case.

The ownership structure was also analysed to have a clear idea of each individual case, taking into account behavioural aspects and use, and the number of inhabitants in each dwelling.

In summary, a deep study and analysis of the retrofitting solution and the DH connection was done. Thanks to this detailed study, a complete technical and economic solution was carried out.

Energy demands study

In order to know the impact of this rehabilitation of the heating demand of the dwellings, a simulation was carried out using the software for energy certification of existing buildings: CE3x. One building was selected to perform the simulation.

The simulation ran two scenarios, the heat demand of one building before and after the intervention. The results of the simulation showed that the savings after the retrofitting reached the ones according to those stipulated in the BEST tables of the project.

In order to calculate the influence of the façade insulation improvements, the corresponding proportion of the power ratio between the theoretical calculations of heating loads in the two insulation conditions was applied.

The simulation on the selected building can be extrapolated to the rest of the dwellings of the neighbourhood since, as already explained in the previous point, the envelopes of all buildings had the same energetic characteristics.

District Heating study

District Heating is a centralised system of heat production and distribution. It is based on a technology oriented to the production and supply of hot water, from one or several central plants to various users or buildings. The distribution is done through a network of thermally insulated pipes that normally run underground. In this way, each user independently disposes of the thermal conditioning service in their facilities from the centralised generation.

District Heating basically consists of:

- Central hot water production facility.
- Distribution network buried pipes.
- Delivery points (sub-stations) that feed homes, offices, hotel, companies...

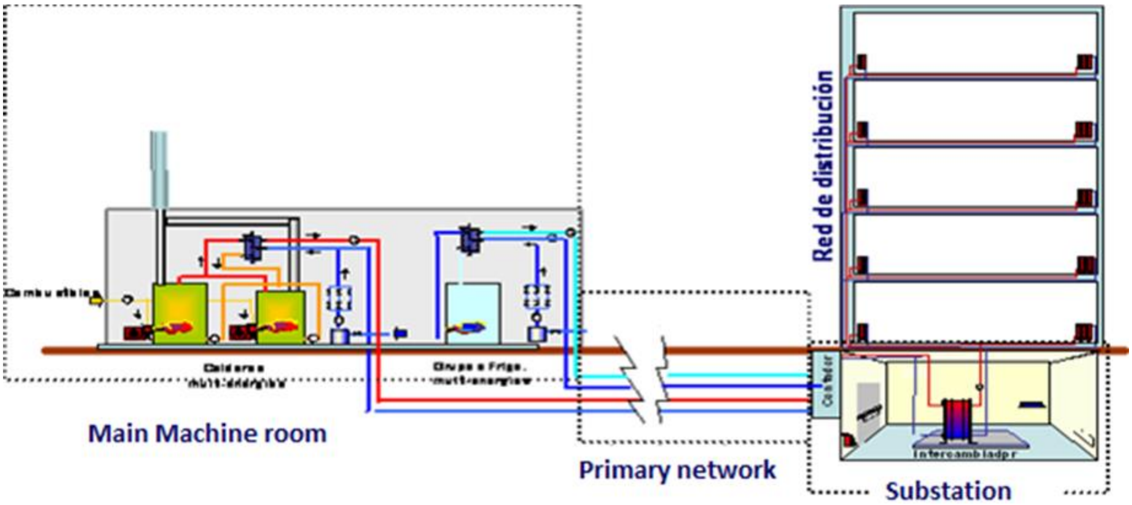

Image 6: District Heating system

The main characteristics of a DH system are the following:

- Greater energy efficiency. A DH plant has seasonal energy efficiency (understood as the relationship between the energy produced and consumed over a large period of time) that is superior to the individual system.
- Reduction of operating costs. Being the centralized production reduces the maintenance costs of the equipment, this coupled with the improvement of seasonal performance and the improvement in energy purchase reduces operating costs.
- Safer facilities. Gas pipelines in the building are removed which reduces the risk of leaks and explosions. Qualified maintenance personnel permanently monitor the facilities through remote management.
- Greater comfort Reduction of the risks of power cuts, thanks to the flexibility of the multi-energy package. By not having individual boilers, no smell, dust or smoke is generated in the homes or any noise caused by boilers.
- Pollutant reduction. An increase in energy efficiency leads to a reduction in pollutants derived from thermal production, which will contribute to a reduction in CO2 emissions.
- Ease of implantation of renewable energies. The centralization of heat production allows the implementation of renewable energies such as Biomass at an optimal cost. Biomass by having a neutral balance of the CO2 footprint prevents the emission of large amounts of CO2.

In this task a valuation study of the District Heating connection in Txomin-Enea was done, starting from the District Heating´s water connections, to the horizontal

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distribution of pipes around the houses to be supplied. In this way, several issues were analysed:

- Horizontal distribution pipes around the dwellings to be supplied, reaching substations.
- After the substations, vertical uprights are able to connect the considered transfer modules located in each dwelling.
- These transfer modules substitute the individual boilers and their dimensions are similar to those of a wall boiler, so it was determined that this was the ideal solution for this type of works. These transfer modules have two heat exchangers, one for domestic hot water and one for heating.
- Energy meters to be installed in the substations and the transfer modules. The difference between the energy given by the substation and that consumed by all the dwellings is the losses in the network. It is very important to minimize these energy losses as much as possible.
- Communication system: M-bus communication cable to connect these meters with the concentrator.

The following table shows the reference consumption of dwellings from which was possible to obtain data and serves as a benchmark. This table shows the situation of different doorways with a consumption ratio (different kind of fuel, but mainly natural gas), and the baseline for comparison with data after retrofitting (energy consumption savings, CO2 emission reduction). Not all information was possible to obtain from the doorways. There are five values in red colour, which are not taken into account for the analysis because they are not correct.

	DOORWAY		HEAT PRODUCTION	EQUIPMENT LOCATION	FUEL	HOUSE OCUPATION	ANNUAL OCUPATION	SURFACE (m2)	FUEL CONSUMPTION	ratio kWh PCS/m2
DOORWAY 11	1	A	BOILER	Balcony	Natural Gas	2	100%	85	3.507 kWh HHV	41,26
	1	C	BOILER	Balcony	Natural Gas	2	100%	78	10.421 kWh HHV	133,60
	2	B	BOILER	CLOSED BALCONY	Natural Gas	3	100%	82	14.501 kWh HHV	176,84
	2	D	BOILER	Balcony	Natural Gas	2	100%	80	7.593 kWh HHV	94,92
	3	A	BOILER	Balcony	Natural Gas	1	100%	85	3.735 kWh HHV	43,95
	3	B	BOILER	CLOSED BALCONY	Natural Gas		100%	82	11.099 kWh HHV	135,35
	3	D	BOILER	Balcony	Natural Gas	2	100%	80	3.459 kWh HHV	43,24
DOORWAY 13	1	A			Natural Gas			66,2	6.372 kWh HHV	96,25
	1	B			Natural Gas			67,11	955 kWh HHV	14,22
	1	E			Natural Gas			67,73	7.288 kWh HHV	107,60
	1	F			Natural Gas			55,65	7.459 kWh HHV	134,03
	2	C			Natural Gas			52,91	3.478 kWh HHV	65,73
	2	D			Natural Gas			62,23	3.117 kWh HHV	50,09
	3	B			Natural Gas			67,11	2.689 kWh HHV	40,06
	3	D			Natural Gas			62,33	1.128 kWh HHV	18,10
	4	D			Natural Gas			62,23	8.934 kWh HHV	143,57
	4	E			Natural Gas			67,73	6.134 kWh HHV	90,57
	5	B			Natural Gas			67,11	7.206 kWh HHV	107,37

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	6	A			Natural Gas			66,1	4.428 kWh HHV	66,99
	6	D			Natural Gas			62,23	2.859 kWh HHV	45,94
	6	E			Natural Gas			67,73	2.048 kWh HHV	30,24
	7	A			Natural Gas			63,07	1.086 kWh HHV	17,23
DOORWAY 14	4	A	BOILER	Balcony	Natural Gas		100%	73	1.738 kWh HHV	23,81
	4	C	BOILER	Kitchen	Natural Gas		100%	53	2.496 kWh HHV	47,09
	4	D	BOILER	Balcony	Natural Gas	3	100%	67,46	2.872 kWh HHV	42,57
	4	E	BOILER	Kitchen	Natural Gas		100%	79	6.823 kWh HHV	86,37
	4	F	BOILER	Kitchen	Natural Gas		100%	56	8.284 kWh HHV	147,93
DOORWAY 15	2	A						76	420 kWh HHV	5,52
	2	D			Natural Gas			76	2.853 kWh HHV	37,54
DOORWAY 16	2	B			Natural Gas			79,86	415 kWh HHV	5,20
	2	C			Natural Gas			85,96	3.527 kWh HHV	41,03
	3	A			Natural Gas			76,53	5.916 kWh HHV	77,31
	3	B			Natural Gas			79,86	6.336 kWh HHV	79,34
	3	D			Natural Gas			83,27	2.977 kWh HHV	35,75
DOORWAY 22	1	IZ			Propano			80	496 kg	6,20
	2	IZ			Propano			80	334 kg	4,17
	3	DR			Propano			80	718 kg	8,98
	3	IZ			Propano			80	185 kg	2,31
DOORWAY 23	1	DR			Propano			80	463 kg	5,78
	2	IZ			Propano			80	857 kg	10,72

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	3	DR	Propano	80	118 kg	1,47
DOORWAY 31	1	AF	Natural Gas	136	5.438 kWh HHV	39,98
	1	D	Natural Gas	65	2.320 kWh HHV	35,69
	2	A	Natural Gas	73	2.164 kWh HHV	29,64
	2	C	Natural Gas	65	3.056 kWh HHV	47,01
	2	E	Natural Gas	62,47	3.385 kWh HHV	54,19
	2	F	Natural Gas	62	6.816 kWh HHV	109,93
	3	A	Natural Gas	73	3.588 kWh HHV	49,15
	3	C	Natural Gas	65	3.559 kWh HHV	54,75
	3	D	Natural Gas	65	8.136 kWh HHV	125,17
	3	E	Natural Gas	62	216 kWh HHV	3,48
DOORWAY 32	1	A	Natural Gas	68	3.661 kWh HHV	53,84
	1	B	Natural Gas	63	6.449 kWh HHV	102,37
	1	D	Natural Gas	74	4.759 kWh HHV	64,31
	1	F	Natural Gas	65	6.756 kWh HHV	103,94
	2	C	Natural Gas	60	5.961 kWh HHV	99,36
	2	E	Natural Gas	61	6.324 kWh HHV	103,68
	3	A	Natural Gas	68	1.948 kWh HHV	28,65
	3	D	Natural Gas	74	3.676 kWh HHV	49,67
	3	E	Natural Gas	61	471 kWh HHV	7,71

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TOTAL 60 dwellings	**4.582 kWh HHV** **453 kg**

TOTAL 56 dwellings	**4.925 kWh HHV** **453 kg**

Table 3: energy consumption before the retrofitting

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In addition, a comparison of thermal consumption in similar buildings and calculations of energy losses in the network was made, determining consumption curves of both heating and DHW.

A study of the maintenance cost differences between an individual boiler and the connection of the District Heating was also done. The savings resulting from this comparison thanks to DH system, in fixed terms, was around 48%.

7.2 Construction works

7.2.1 Project design

After the meetings with the neighbours, and their consequent acceptance and permission, it was agreed to write the project design of each building and each particular dwelling. All the information regarding neighbours engagement is explained in details in section 6 Citizen Engagement.

This project design work was done by two architectures companies, dividing the ten building into two parts. Giroa decided to split the work in 2 blocks with two architectures companies due to the amount of work and to reduce the time need to elaborate the project designs. Precisely, they divided it on portals 11-16 (AGM Architects), other on 22-23, and 31-32 (BASA Architects).

The project design documents described the aspects and the general characteristics of the works: insulation solutions, roofs, windows, etc. in order to provide a first global image and establish a budget. It served as an understanding and guide so the tenants and Giroa had a global vision of the works in formal, technical and economic aspects.

The project design documents also were the base for asking construction companies project budget for the execution.

In order to choose the construction company for the execution works of the retrofitting project, Giroa compared the proposals provided by five companies in the sector. Not only technical criteria were taken into account, but also the capacity of each one to adapt to the project deadlines and the economic aspects.

With respect to the technical criteria, based on the experience of each of the companies (similar work executed), Giroa considered that the five companies compared were at the same level in terms of the quality of their constructions. All of them had demonstrated experience in similar retrofitting projects to those of Antzieta.

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Regarding the capacity to adapt to the deadlines required by the project, it should be noted that not all of them were able to guarantee the specified schedule, which was a determining factor. The company Andrasa, which was finally selected, met this condition.

Another factor that conditioned the choice of the construction company was the volume of work in a district level. The capacity to face this project with 10 buildings to be retrofitted was not possible for all companies, and Andrasa showed capacity to do all work in parallel. That is one the main reasons why Andrasa was chosen.

The bids for the contract were drawn up in two parts, maintaining the same division as in the project designs: on the one hand Antzieta 11, 13, 14, 15,16 and, on the other hand, Antzieta 22, 23, 31, 32. The case of Antzieta 12 was special, since they had already contracted a construction company for retrofiring their block before Replicate project proposal was presented to the neighbours. They wanted to maintain their contract and to work with the company Freyssinet. Giroa in order to facilitate the course of the works, decided to maintain this way, arranging and according their work to the conditions of the Replicate Project. Andrasa was hired for the rest of the doorways.

Image 7: retrofitting intervention plane

7.2.2 Retrofitting execution

The execution consisted on the retrofitting of 156 dwellings and 34 commercial premises, divided into 10 portals: the façade and roof isolation, window replacement, ground floor isolation and connection to the Heating District.

It is important to mention that the retrofitting intervention and the DH system development needed to be properly coordinated and aligned. It was necessary that the DH installation would be in operation before the retrofitting intervention could start because the DH is the supplier of heating and DHW of these dwellings.

Before the works started, the contracts with both the neighbours and the construction companies were signed, and the scaffolding permits obtained. Fomento San Sebastian and the Municipality of Donostia-San Sebastián granted the permits in the shortest possible time.

The execution process started with the assembly of the scaffolding. Once the scaffolding was mounted, the surface prepared, that is, the previous facade was removed and the insulation chosen by the neighbours placed. Finally, the coating offers the aesthetic finish of the facade. On the roof the tile was removed, the thermal insulator was placed, a waterproof sheet was placed and then the new tile was replaced.

Image 8: Scaffolding mounted

As previously mentioned, the rehabilitation works were divided into two main parts: On the one hand, the portals 11-16 and on the other the portals 22-23 and 31-32. In this way, greater efficiency has been achieved in the works for the architecture studies reducing the time needed to prepare the projects.

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The following paragraphs explain in more detail de work done in each aspect of the execution. This table shows the decision of each portal regarding façade solution:

Building	SATE	VENTILATED FAÇADE
Antzieta 11		X
Antzieta 12		X
Antzieta 13		X
Antzieta 14	X	
Antzieta 15	X	
Antzieta 16	X	
Antzieta 22	X	
Antzieta 23	X	
Antzieta 31		X
Antzieta 32		X

Table 4: Neighbours decision in the façade

Neighbours had the option of choosing two types of facade insulation, between SATE finish and a ventilated façade. SATE option was included in the project funding, and it was the base of project proposal, and Ventilated façade supposed an extra cost for the neighbours that wanted a better solution. Both solutions fulfil the required savings.

As an addition, for those who requested it, the existing metallic railing on the balconies was removed and the fronts and roofs of the balconies cleaned up. Neighbours also had the option to choose colours in the finishing. The storm drainpipes were replaced.

In order to give more added value to the intervention, it was decided that the neighbours who wanted it, could add to the reforms, other arrangements that could be having in their dwellings in order to undertake additional reforms to the communities, as an advantage of participating in the Project. Those extra works were an additional cost for them, but neighbours could take advantage of having all agents of the project working in their homes to repair or improve other issues.

<u>SATE façade</u>

As described in the preceding table, for the portals 14,15,16,22,23 a SATE facade system with external thermal insulation was installed on the facades of the balconies, and aluminium composite panel on the windows of exterior carpentry was installed.

SATE proposal was to perform the Isolxtrem material from Baixens with a 10cm porexter Plus (Neopor) insulation plate that has better performance than the usual extruded polystyrene plate.

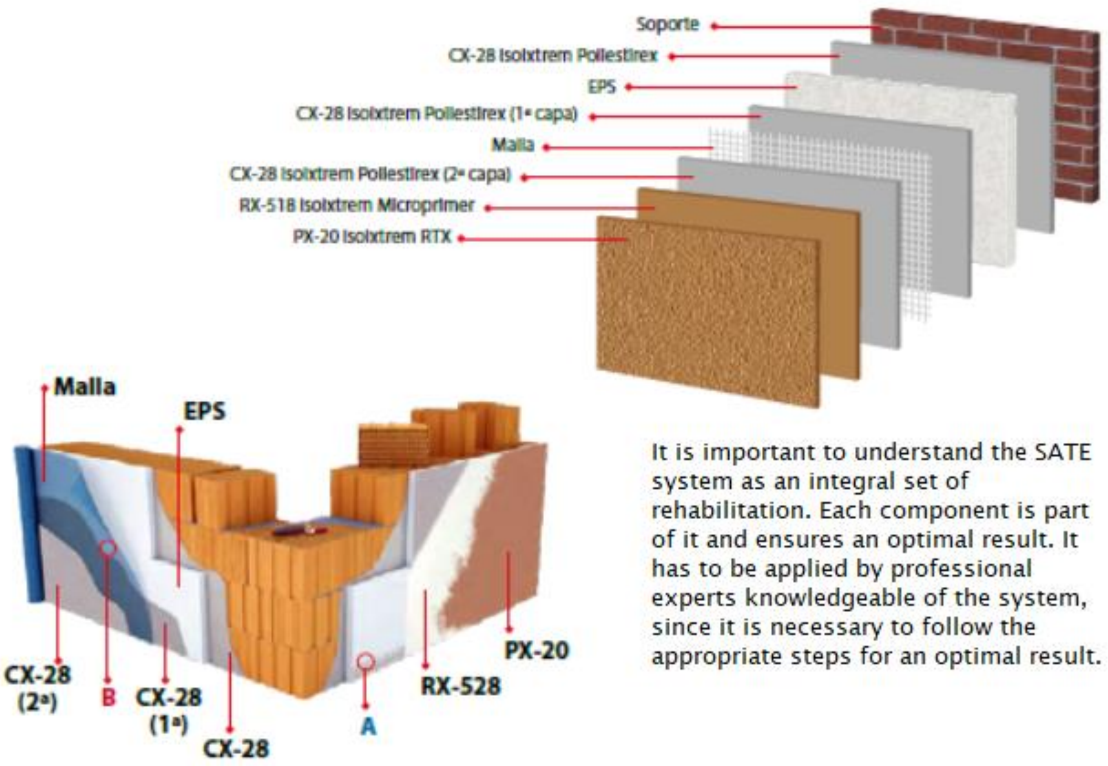

Image 9: SATE system

Before the placement of the coating mentioned above, prior actions were required that Giroa included in the proposal.

- General restoration of the facades
- Surface cleaning
- Disassembly of various elements of balconies (not including awnings)
- Lifting and relocation of balcony railings
- Water discharge

- Elimination of the gas installation and gas boilers

- Channelling of telecommunications wiring
- Replacement of the downspouts

The image 12 corresponds to part of the facade of Antzieta 16, at the height of the second floor. Fully placed thermal insulation is observed, including the pins that secure it to the support. It remains to place the reinforcement mesh, scrape and apply the acrylic mortar. It is also appreciated that auctions such as the surrounding of the windows are still unrealized.

Image 10: thermal insulation SATE system

The image 13 corresponds to part of the facade of Antzieta 22, at the height of the second floor.
The thermal insulation fully placed, cracked and with the applied acrylic mortar is observed. It is also appreciated that the old floor of the terrace is removed and replaced by the new one.

Image 11: thermal insulation Antzieta 22

The following photo corresponds to the Antzieta 16 block. It is observed that both the facades and the roof are finished.

Image 12: Antzieta 16 Façade and roof finished

The image 15 corresponds to one of the windows of Antzieta 23. It is noted that the thermal insulation of the perimeter of the window is completely placed. Acrylic mortar has been cracked and applied both on the sides and on the top. The lower part, the one corresponding to the sill, has been finished off with a folded sheet of brown composite panel.

Image 13: windows Antzieta 23

The image 16 corresponds to one of the rain downpipes of Antzieta 23.These have been replaced by new brown lacquered metal tubes to match the façade.

Image 14: Antzieta 23 downpipes

VENTILATED FAÇADE

As described in the preceding table, for the portals 11,12,13,31,32 a ventilated facade system of ceramic pieces with thermal insulation was installed. Mouldings, lintels and composite sills were placed. The existing metal railing on the balconies were removed. The fronts and ceilings of the balconies were sanitized. Rainwater conduction downspouts were replaced.

Image 15: Antzieta 11 Ventilated façade

The Image 17 corresponds to one of the balconies of Antzieta 11. In the photo on the left the insulation is placed (Fixed with spikes), as well as the profiles that support the ceramics that make up the finish of the ventilated facade. In the photo on the right, the same area already finished, with the ceramic of the ventilated facade already placed.

The image 18 corresponds to a facade of Antzieta 31. It is observed that the insulation is placed (fixed with spikes), as well as the profiles that support the ceramic that composes the finish of the ventilated facade. In this particular case, the ceramic cannot be placed until the scaffolding is removed.

Image 16: Antzieta 31 Ventilated façade detail

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The image 19 corresponds to the main facade of Antzieta12. It is observed that the

railings of the balconies are placed, as well as the lattices that have been used to hide the amounts of DH.

Image 17: Antzieta 12 façade and balconies

ROOF

Ceramic tile coverage was eliminated and a new finishing of mixed ceramic tile on double wooden slab, sheet waterproofing and thermal insulation was displayed.

Bearing in mind that the new coating of the roof had greater edge than the existing one, in the development of the planned works, a new flashing in the joints of the new tile roof with singular points such as chimneys and roof holes was installed.

The auctions of the existing chimneys were dismantled and disposed of a new ventum type of aluminium fins.

A drainpipe for rainwater to run into also was displayed.

The existing covering of corrugated plates corresponding to the courtyards was dismantled and replaced by new ones.


Image 18: Roofs Antzieta 11-13 and Antzieta 14

RETROFITTING COMPLETED:

In January 2019, the retrofitting works of the buildings Antzieta 15-16 were finished and their integration in the monitoring system was completed. From the substation, a line MBUS was thrown collecting the consumption data of the dwellings, and this data was collected by the online platform.

Image 19: Antzieta 15 and 16 finished

After finishing Antzieta 15 and 16, the execution and connection to the DH of the rest of the buildings was completed. This project gets "A" Energy Certification for all buildings. The following pictures show the buildings finished.

Image 20: Antzieta 11-16

Image 21: Antzieta13-14

Image 22: Antzieta 22-23

Image 23: Antzieta 31-32

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7.2.3 DH Connection and transfer modules

The works related to the facilities included the installation of a buried pipeline through the housing block connecting with the district heating, the assembly of the substation, the distribution pipes to undertake the dwellings and the installation of the exchange modules in the houses themselves.

From the District Heating network, a horizontal distribution of pipes was placed around the dwellings to be supplied. The horizontal pipe traces considered for each of the housing blocks are illustrated below:

Image 24: DH network Antzieta Nº11 to Nº16

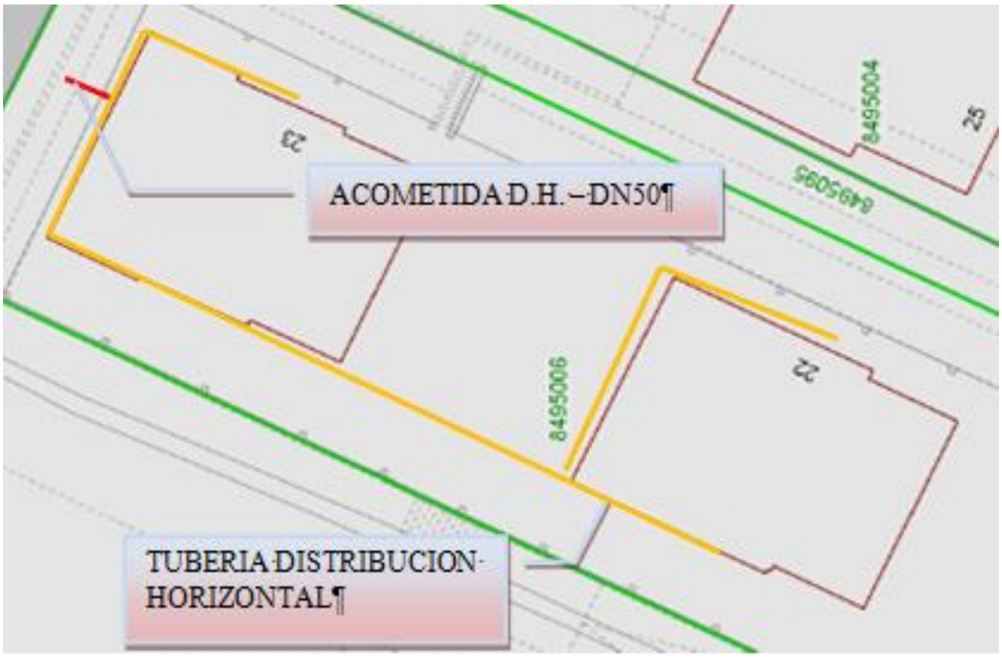

Image 25: DH network Antzieta N°22 and N°23

Image 26: DH network Antzieta N°31 and N°32

A transfer module replaced the individual boilers of the houses. This transfer module is equipped with two heat exchangers to provide heating and DHW for the individual home. It is also equipped with thermal energy meters and DHW consumption.

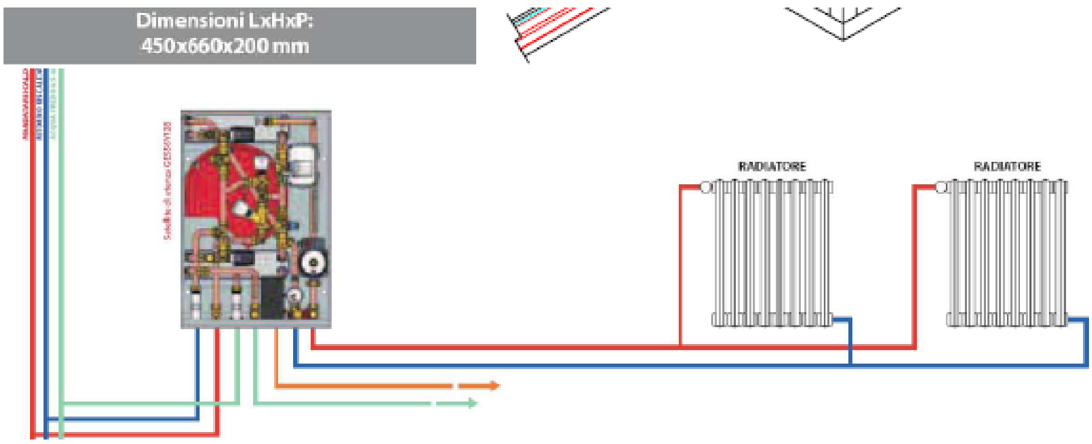

Image 27: transfer modules and heating installation

Four horizontal pipes were reached at the height of the location of the individual boilers in the houses, and vertical uprights were installed to connect the transfer modules.

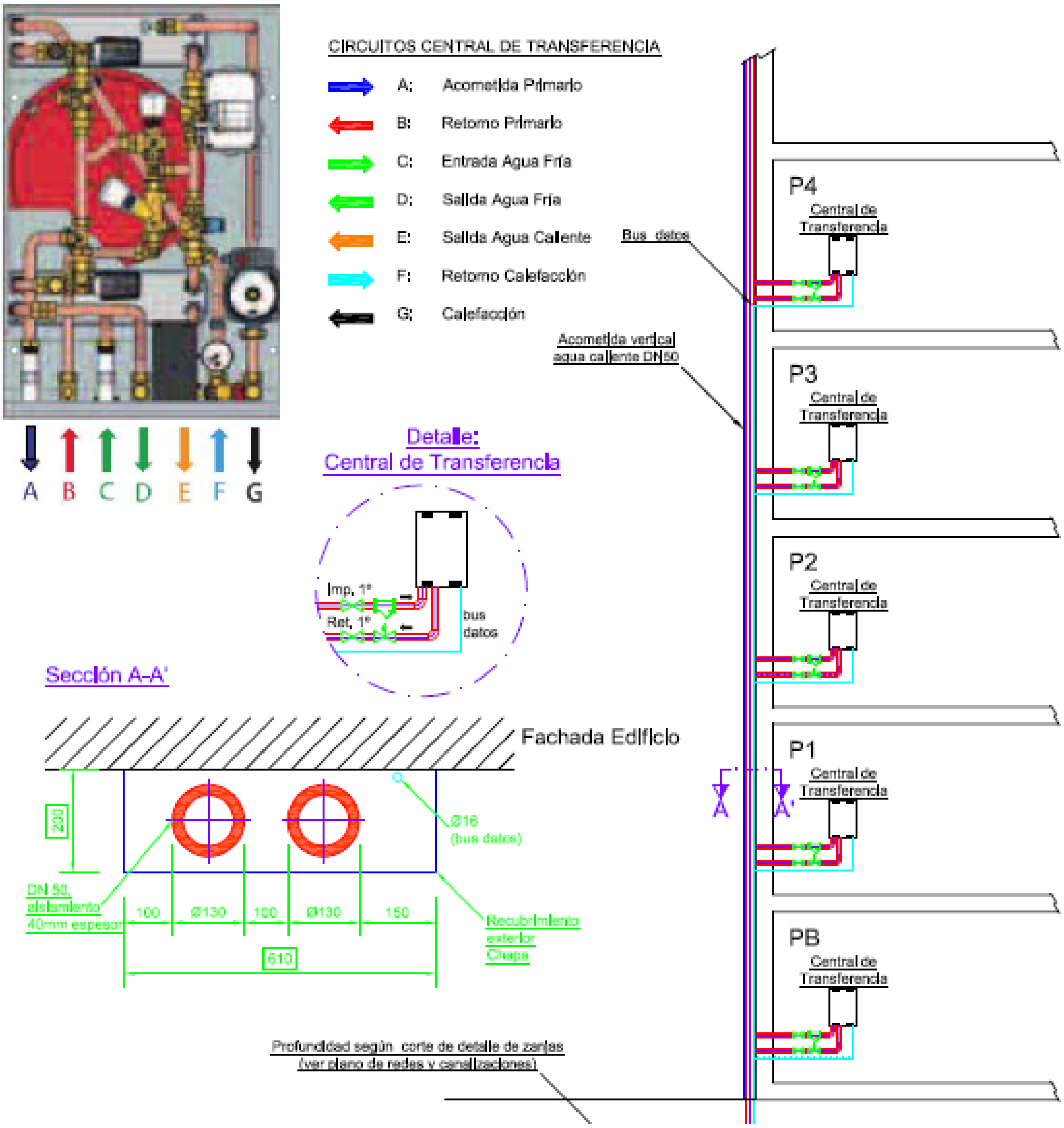

Image 28: transfer modules and upright installation

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These modules are the substitute for individual boilers and their dimensions are similar to those of a wall-mounted boiler, therefore it was the ideal solution for this type of works.

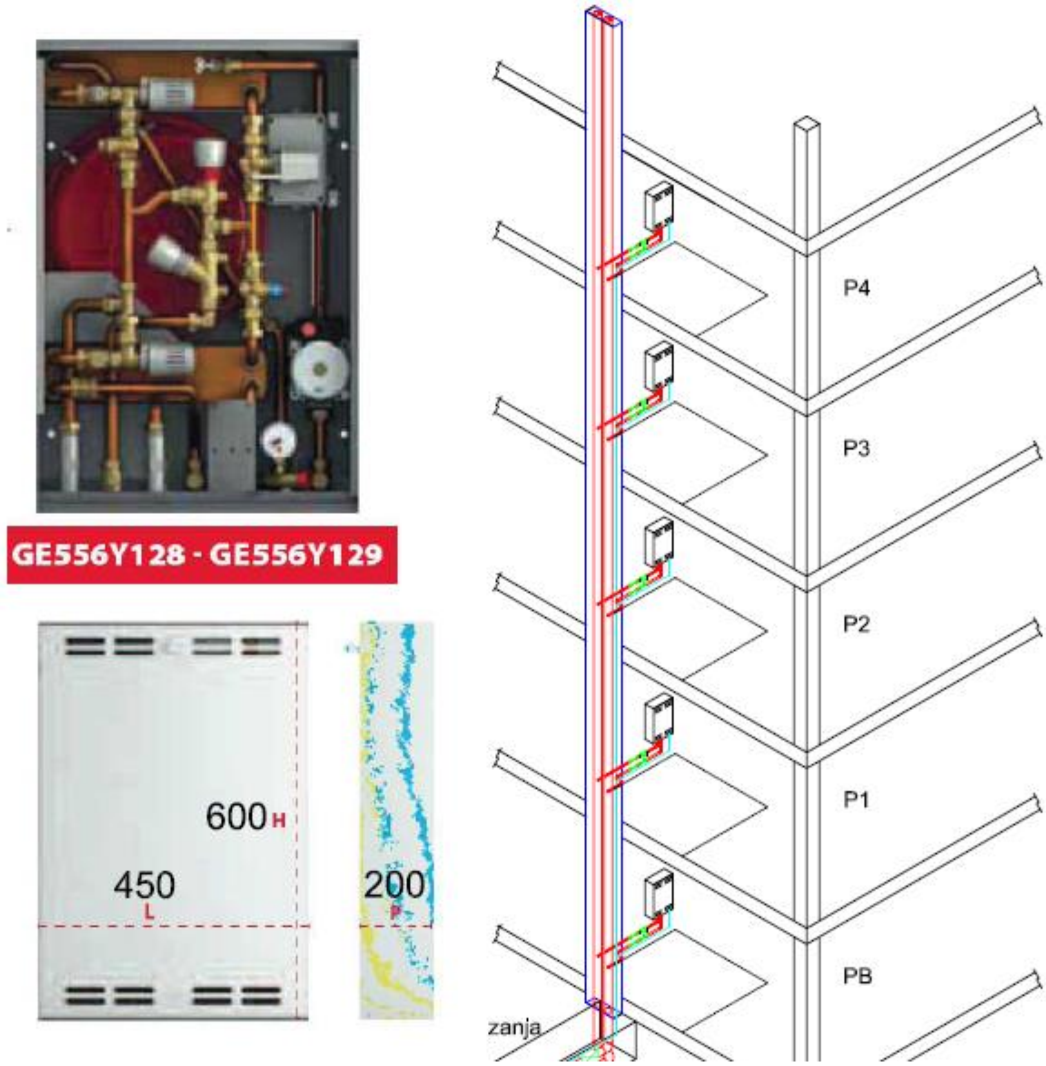

Image 29: transfer modules and upright installation

Likewise, in order to have an energy management of each of the supply uprights, thermal energy meters were installed in each of the vertical uprights.

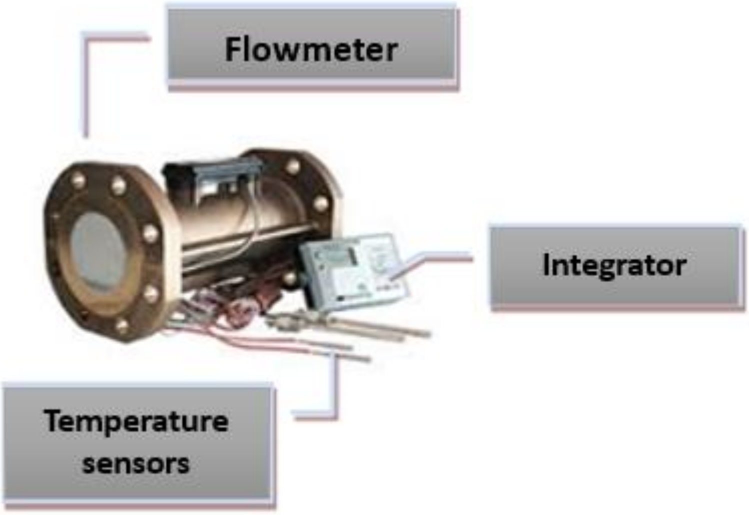

Image 30: thermal energy meter

These meters and the individual meters from the transfer modules were connected by an M-bus communication cable. The M-bus cable was sent to a meter concentrator located in each of the DH substation to connect it to the network of DH communications.

Buried pipe

The existing flooring was lifted and a trench was made in the premises, so that once the sub-central was connected to the district heating, it could be covered, leaving the space on the usable canalization.

The image 33 corresponds to the set of pipes that are buried in the housing complex of Antzieta 11-16, located in the basement under portal 15. The pre-insulated pipe already assembled is observed, in the absence of placing the insulation in the welded areas, lowering the pipe to the trench and covering it.

Image 31: buried pipes in the building

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<u>Substations</u>

The substations are connected to the primary network of the DH that carry the hot water from the production plant at 85°C to the basements of the buildings. The substations consist of two parts, a first prefabricated part that includes a first pumping group and exchangers, and a second part manufactured on site, with a second pumping group.

The image 34 corresponds to the prefabricated part of the substation, located in the basement under portal 15. The ends of the pre-insulated pipe that connect the sub-central to the district heating are observed.

Image 32: prefabricated pats of substation Antzieta 15

The image 35 corresponds to the part manufactured in situ of the substation, located in the basement under portal 15. It can be seen the collector that collects the water and also the outputs that supply the different circuits.

Image 33: substation construction Antzieta 15

The image 36 corresponds to the prefabricated part of the substation, located in the basement under portals 22 and 23. It is noted that the installation as a whole is finished. Pipe insulation included.

Image 34: substation construction Antzieta 22-23

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The image 37 corresponds to the part manufactured in situ of the substation, located in the basement under the portal 22 and 23. It shows the collector that collects the water and also the outputs that supply the different circuits. It is finished, with the insulation in place and working.

Image 35: substation Antzieta 22-23

In all substations and pipes, cleaning and disinfection work was carried out on the pipes so that the treated water could arrive in perfect conditions.

The connection of the heating network from the DH power plant to the retrofitted buildings was one of the main tasks of the execution. This task was complicated and required to define specific solutions and pipes networks in each building. In the new buildings constructed in Txomi-Enea, there are specific locations planned to place the substations. However, in the existing buildings it was necessary to find a location to install the substations, and this task was a real challenge. A study in detail in each case was required to analyse the viability of the different possibilities in order to find a suitable location.

It was decided to install three substations for each building block (Antzieta 11-16 building blocks, Antzieta 22-23 building blocks and Antzieta 31-32 building blocks).

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In the case of Antzieta 11-16 building blocks and Antzieta 22-23 building blocks, the best solution was to locate the substations in the parking facilities underground. Pipe distribution around the parking facilities required a special work to find the most appropriate way to reach each building block.

In the case of block 31-32, the installation of the substation was not possible in the parking facilities, and after analysing several options, it was decided to install a prefabricated module outside the perimeter of the buildings. The prefabricated module was quite tight and the installation of the components of the substation required a special redesign.

Transfer modules

The photos correspond to the transfer station of Antzieta 12 and 22. Due to the singularities of each project, the first one remains inside the house and the second, in the same place where the boiler was located. The mains objective was to maintain the same location of the gas boilers for the transfer modules, but in some cases, the locations were changed due to complex installations or demanded by neighbours.

Image 36: transfer modules Antzieta 12 and 22

In many cases it was a simple installation, since the boilers were in the balconies, where the access was immediate. In the process of installing the transfer modules, the gas boilers had to be moved around the house in order to maintain the service during that

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process. Once the modules of one portal were installed, the dwellings were hydraulically adapted and the secondary circuit was filled with water from the

network, and so the supply from the DH started. In this way, the disturbances for the neighbours were reduced and the heating and DHW supply was maintained almost without interruption. A few hours were needed to change the heating and DHW supply from gas boilers to the DH system in each doorway.

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8. LESSONS LEARNT

The retrofitting intervention in Txomin Enea has been a complex project with several stakeholders involved and different interests, which has required a very important level of management and coordination. Besides the stakeholders participation in the retrofitting project, there have been other agents related to the urbanisation work of the district, such as the construction company of the new urbanisation and building work, the City Council as promoter of that work, subcontracted companies, the new neighbours of the district, etc. All these agents have lived together during the execution of the retrofitting project, which has meant a greater complexity to the work itself.

The identification and anticipation of problems that could occur in the project has been taken into account from the beginning. Although in all cases it is not possible to anticipate problems, project management aimed at anticipating problems, and it has made possible to shorten specific delays caused in the work. In fact, the project team has been prepared to quickly and efficiently manage any type of setback that arose in the project, to minimize its impact on the progress of the work.

Therefore, the work of management and coordination in the project is one of the most important parts and whose impact on the final result of the project is high. In this sense, it is necessary to provide adequate management and coordination mechanisms to ensure the correct development of the project in terms of the execution deadlines and budget, maintaining the same scope and impact.

The socioeconomic situation of the neighbours in these dwellings was complicated, and the public funds obtained to develop this project have been a key factor. Thanks to the Replicate project and the public funds, the neighbours took a positive stance towards intervention proposal presented by Giroa and FSS, and this facilitated the process of engagement. Due to low-income ratios in the neighbour, the project funds reduced the economical effort of the residents and make more feasible the intervention.

The participation of Fomento San Sebastián as a driver of the intervention and as a public agent of economic development of the city has provided greater security and confidence for the neighbours during the whole project in general and the specially in the citizen engagement process in the beginning of the project. In addition FSS has taken care about the correct management of deadlines and potential delays, the monitoring of all dwellings, the coordination with other department involved from the Municipality, etc.

The participation of the public sector in this type of projects is very helpful to facilitate the engagement of the neighbours, who would otherwise have doubts regarding the interests that the private sector may have as promoters of the project.

The effort made regarding the involvement and engagement of tenants in the project from the initial stages has been one of the key success factors. The neighbours association of Txomin-Enea was informed and involved in the project from the very beginning. In the preparation stage of the Replicate project, the neighbour association was informed about the aim of developing a district retrofitting in their dwellings, and they showed its agreement through a letter of interest. This point generated confidence and facilitated the initial steps of the engagement process. In addition, a direct and transparent contact with the neighbours was established, presenting and explaining the project with all the details and information. After some months of work, meetings and clarifications with neighbours, presidents, administrators and neighbour association, a 100% participation agreement was obtained, which shows the importance of a good citizen engagement strategy.

One point to highlight is the importance of daily and direct contact with the neighbours of the community. During the execution of the intervention, residents can feel uncomfortable and it is important to understand their concerns and maintain a fluid and adequate communication, in order to clarify doubts and avoid misunderstanding.

Environmental awareness of citizens is more and more important, and this factor has also been notorious in this project. In fact, the commitment to an energy efficient and sustainable district with a DH system fuelled by a biomass, in addition to being innovative in the Basque Country and Spain, provided a very important environmental character, which has been perceived very positively by the neighbours.

A great effort has been made to minimise possible deviations in the project budget, and it is important to highlight this aspect. In fact, the budget agreed with the neighbours has been maintained, and no additional costs have been included.

It is important to mention that the retrofitting intervention and the connection to the DH system entailed other several benefits for the neighbours: they are part of the Urumea Riverside District transformation, a new sustainable neighbour in the city with an innovative DH network; the dwellings increase their value; old renovated buildings integrated with new buildings; high efficiency buildings, etc.

All these factors mentioned above help to make the project management and its execution more favourable, so it is important to take them into account from the beginning.

This Project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N° 691735

9. INNOVATIONS AND IMPACTS

9.1 Benefits for the neighbours

The retrofitting intervention entailed several and important benefits for the neighbours. Firstly, the buildings have been renovated and insulated in the façade, roofs, basements and windows, which have improved the comfort in the houses in terms of inside temperature and noise reduction, and have reduced the energy consumption, the energy bill and the CO2 emissions.

Secondly, all 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 has one complete year of measures in two buildings, and six months in the rest of the buildings. The first analysis of the monitoring in the two buildings rehabilitated and connected to the DH shows a considerable reduction in their demand of around 22% compared to the 2018 figure, and the consumption of non-renewable primary energy is also significantly reduced around 67%.

It is also worth to mention the benefits due the DH system. 80% of the CO2 is reduced 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.

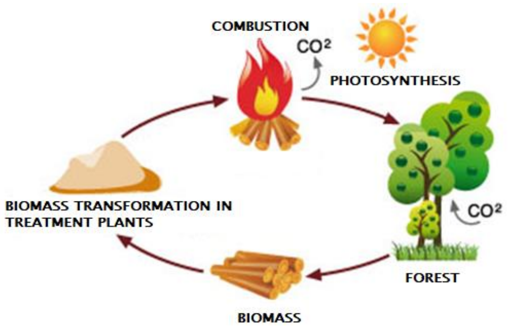

Image 37: biomass cycle

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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 5: biomass benefits

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. To all this, gas cookers have been changed to electric, which apart from improving efficiency, manages to reduce possible risks or dangers, avoiding gas.

The retrofitting in Txomin Enea 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.

Thanks to the Replicate project, all the neighbours benefit, not only in terms of energy savings, but also in terms of the image of the neighbourhood with the aesthetic similarities of the newly built neighbourhood of Txomin. The new neighbour Txomin Berria is homogeneous between new homes and the retrofitted buildings, so that the citizens of Donostia-San Sebastian identify all buildings with the same image.

One important aspect that the neighbours have highlighted in a very positive way has been the communication work of Giroa and FSS by having direct contact with them.

9.2 Innovation solution

This intervention is the first retrofitting in a district level that has been done in San Sebastian, and it can be seen an innovative project for the city and the citizens. It is an important step for Fomento San Sebastian and the City Council of San Sebastian, as the retrofitting at district level could be replicated in other parts of the city. The intervention at district level has entailed several benefits for the neighbours, cost reduction due a bigger project, coordination with stakeholders in charge of Giroa and FSS, integral renovation taking into account all buildings, participation in the neighbour transformation, etc.

In addition, those retrofitted buildings are integrated into the new urbanisation of Txomin Enea, which District Heating is the first action of this kind for the city and the region, with an innovative public-private management model which guarantees quality of service and energy prices stability for final users. Cities like Helsinki, Warsaw or Copenhagen have rates of over 90% of citizens connected to DH networks. In Spain, this implementation does not reach 0.5%. In Donostia-San Sebastian, with the Txomin DH network that supplies 1,500 dwellings, it has been achieved an implementation of 1.35% of the total 88,389 dwellings in the city.

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.

9.3 Social impacts

The added value that the Project has given to the Txomin Enea district from the social point of view is unprecedented, integrating the 156 houses within the new Txomin Berria neighbourhood.

It is important to underline the following social impacts thanks to the project:

- The neighbourhood dwellings increased the value thanks to the retrofitting intervention. This is not only generating a surplus in economic terms of the housing value, but also the heat network connexions and the improvements with regard to accessibility is generating an increase in the quality of life and comfort of its inhabitants.

- The retrofitting of the commercial premises will help to reactivate the local commerce in the new neighbourhood. These changes impulses the opening of businesses attracting new investors and improving the image of the premises.

9.4 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 $CO2$ emissions of 80%. 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.

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10. CONCLUSIONS

The main objective of the REPLICATE project is to build a sustainable city business model to promote the transition to a smart city. In this way, it will be possible to accelerate the deployment of innovative, organizational technologies and economic solutions to increase resources and energy efficiency, improve the sustainability of urban transport and drastically reduce the greenhouse effect in urban areas. In this way, the retrofitting project has contributed to renovate and add value to old dwellings in a new urban development of the whole district. In addition thanks to the Replicate project, many inconveniences presented by the dwellings have been solved and it has become a modern and sustainable neighbourhood.

This intervention has been successfully completed, and the results obtained after the retrofitting can already be observed. On the one hand, the interior comfort of homes has been improved while reducing energy consumption and the CO2emissions. On the other hand, the renovation of the dwellings has meant that they have been revalued and are properly integrated within the new urbanisation of 1500 houses of Txomin Enea.

It has to be said that the Citizen engagement is one of the key factors in the success of this retrofitting intervention in Txomin-Enea. The neighbour association was involved in the project from the very beginning and that facilitated the engagement and total agreement of all residents.

On a technical level, the project had to deal with unforeseen problems that have been solved in each case in the most appropriate way possible. Among them, it is worth mentioning the need to find an adequate location of the DH connection substations in the surroundings of the buildings. For this, in each block of buildings various locations have been analysed that could guarantee the necessary requirements for connection to the primary network of the DH and the distribution of the secondary network to each home.

The retrofitting project and the new urban development works coexisted during its execution, which has meant interference in both works and has required additional efforts in terms of coordination. The good predisposition of all parties has facilitated finding satisfactory solutions in each case.

This intervention is the first retrofitting in a district level that has been done in San Sebastian, and it can be seen an innovative project for the city and the citizens. It is an important step, as the retrofitting at district level could be replicated in other parts of the city.

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

This project improved significantly the environmental quality of the old buildings and so the neighbourhood, with an important reduction of CO2 emissions with less energy consumption. In fact, this energy consumption in the buildings is renewable energy. Another improvement is the reduction of noise as a consequence of boilers suppression.

The intervention at district level has also entailed several benefits for the neighbours, cost reduction due a bigger project, coordination with stakeholders in charge of Giroa and FSS, integral renovation taking into account all buildings, participation in the neighbour transformation, etc.

The great effort done in all stages of the project allowed to achieve the initial objectives, maintain costs and budget, achieve 100% citizen engagement, which is a challenge, maintain fluid communication and confidence with neighbours, guarantee supply throughout the work, etc.

The monitoring of the intervention already showed energy consumption reductions, and it will allow to quantify and measure the impacts, as well as to analyse deeply the savings in all dwellings during the following years. It constitutes very relevant information to study the replicability of the solutions in other areas of the city and to share the experience and lessons learned with other cities in the consortium and in Europe.