TOWARDS SMART ZERO CO_2 CITIES ACROSS EUROPE

VITORIA-GASTEIZ ✣ TARTU ✣ SØNDERBORG

Deliverable D3.10: (Vitoria-Gasteiz) Demo Intervention Summary Report

WP3, Task 3.3

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Author(s):	Aroa Albareda (CEA), Juan Carlos Escudero (CEA)

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Abbreviations and Acronyms

Abbreviation/Acronym	Description
SmartEnCity	Towards Smart Zero CO_2 Cities across Europe
DHW	Domestic Heat Water
DH	District Heating
BEI	*Bus Eléctrico Inteligente* (“Smart Electric Bus” in Spanish)
CP	Charging points
SUMP	Sustainable Urban Mobility Plan
TUVISA	Transportes Urbanos de Vitoria-Gasteiz Sociedad Anónima (Vitoria-Gasteiz Public Bus Company)
H2020	Horizon 2020
EV	Electric Vehicle
ETS	Euskal Trenbide Sarea (Basque Railway Network in Basque language)
CIOP	City Information Open Platform
SUMPSP	Sustainable Mobility and Public Space Plan
e-bike	Electric bicycle
IT	Information Technology
CIOP	City Information Open Platform
ICT	Information & Communication Technologies
AVS	Added Value Service
KPI	Key Performance Indicator

Table 1: Abbreviations and Acronyms

1 Publishable Summary

The City of Vitoria-Gasteiz was awarded European Green Capital in 2010 and its strategy for sustainability and environment protection is well recognised. As a lighthouse city, the involvement of the municipality in SmartEnCity Project is an example of its commitment towards energy efficiency, resources management, energy transition, and improvement of the living conditions of its inhabitants.

In the task T3.4 “(Vitoria-Gasteiz) **Building retrofitting**”, the different retrofitting works in individual buildings in Coronation neighbourhood have been carried out by Visesa (VIS) according to the process developed in “District Integrated Intervention” task and described in the D3.2 “District intervention planning report”. Specific building documentation validation and quality control have been carried out to ensure individual interventions are aligned with the defined ambition levels, and coordination actions, have been also developed and put in place. This task has concluded with the end of retrofitting works of 26 residential buildings (302 dwellings) and gathering of construction certificates to ensure measures have been implemented and correctly commissioned.

Regarding the construction of a new district heating system (T3.5) to supply heating and Domestic Hot Water (DHW) to participant dwellings in Coronation neighbourhood, the deployment of the **district heating network** (design + project + construction) has being carried out by Giroa-Veolia and it is included as a part of an energy services contract between this company and the different Communities of Owners added to the project, together with the energy management, operation & maintenance, full guarantee and financing of the interventions.

Towards the desired fully electric public transport network of Vitoria-Gasteiz, the BEI project arose from the inter-institutional agreement between the Vitoria-Gasteiz city council, the provincial government and the Basque Government. By this agreement, it was decided to finance the evolution of the circular bus-line with the highest number of passengers in the city (Line 2 or “peripheral”) into a modern and clean **electric bus** rapid transit **line** (T3.6) with 48 bus-stops (24 for each direction), 4 ultra-fast charging points (inverted pantographs), 7 articulated e-buses and 6 conventional-size e-buses. This represented a significant technical challenge given the length of the bus line (>10 km) and market´s charging/battery constraints. Thirteen smart electric buses (BEI) that will replace twelve diesel buses that currently give service to Line 2 are expected to be fully operational by spring 2022.

Furthermore, following the principles of the sustainable mobility, several SMARTENCITY partners (AVG, CEA, VIS and GIR) decided to promote, within the task 3.6, a progressive replacement of combustion vehicles with their electric counterparts. These **electric vehicles** (EV; cars, vans and bikes), have been incorporated within the abovementioned partners´ fleets and are used in a daily basis in the city of Vitoria-Gasteiz for their respective organizational needs for everyday operations, related to SmartEnCity in many cases. These partners have also installed the required **charging infrastructure** when this was lacking. The EV use and charging data are to be monitored through the project´s data platform (City Information Open Platform; CIOP). The direct benefits for the city will be realized in the zero emission of polluting gases and the reduction of noise.

In addition to the above and related to the **last mile logistic electric infrastructure** (T3.6), Fagor Ederlan´s objective within SmartEnCity was to purchase new EV for different types of

freight logistics and tourist routes in the lighthouse city of Vitoria-Gasteiz. Different models of EV would be acquired to change 26 diesel vehicles for electric ones to do the same logistic and transport service. Due to relevant events, which make it extremely difficult to advance the objectives envisaged in SmartEnCity, as of June 30th 2018, Fagor Ederlan adopted the decision to abandon its smart mobility business development strategy, as derived from the initiative of Edermobility Services and, consequently, its participation in the SmartEnCity project, considering the achievement of the strategic objectives as unfeasible. This is why implementations made in different business are no longer working in the city. This company was in fact dissolved and the corresponding budget was applied to new mobility measures approved in the last amendment.

During this project, the basic infrastructure to provide the city with the general backbone services and functionality of a city platform was designed, deployed, and commissioned (T3.7). This backbone or **CIOP** (City Information Open Platform) serves as the global framework over which any city area will host the necessary intelligent **IT infrastructure** (or service) to assist intelligent data management and decision support to the city officials and service operators.

In addition, SmartEnCity has provided the city of Vitoria-Gasteiz with an initial set of **Added Value Services** to manage and operate those pilot actions developed during the Project and set in place additional tools and services to enable their extension to other districts in the city and other city/area services.

2 Introduction

2.1 Purpose and target group

D3.3 Building retrofitting interventions

In terms of **building retrofitting**, this document contains general information about the process of renovation of the 26 buildings (302 dwellings) and the results of the interventions. The main target audience of these actions are the citizens owners of the dwellings. Additionally, the rest of citizens and businesses of the Coronation district are beneficiaries of the improvement of the area.

D3.4 District heating network

Regarding the **District heating network**, this deliverable also aims to summarise the deployment process of a new district heating network carried out in Vitoria-Gasteiz. In the following sections it will be briefly described the process by which the different Communities of 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.

D3.5 Electric bus line

The deployment of high capacity and **100% electric public transport** is paramount for sustainable mobility and to achieve carbon neutral cities in the near future. Apart from the introduction of the tram in 2008 and the progressive substitution of city council´s staff fleets, the public bus transport company, TUVISA, incorporated five hybrid buses for the first time in 2018, and five more in 2019, making a total of ten vehicles of these characteristics with an investment of 3.3 million euro. The next most significant milestone regarding electric mobility in Vitoria-Gasteiz, will be the incorporation of the smart electric bus (BEI) in the Line 2 (>10 km), the highest capacity line of the city bus network, with a BRT format (dedicated lane for most of the route) and with a total of thirteen electric buses. The deployment of the BEI represents a significant technical challenge and one of the main activities within SmartEnCity, with an outstanding benefit for all the citizens of the municipality.

D3.6 EV fleets and charging infrastructure

Despite the fact that the city of Vitoria-Gasteiz is not looking for an increase in the number of vehicles on the street but the opposite [following the city Sustainable Mobility and Public Space Plan (SUMPSP)], it does support the electrification of the demand for motorized transport, starting a progressive replacement of the current combustion vehicles. In this regard, a key aspect in this strategy has to do with mobility generated within the daily work in the administration (AVG/CEA) and also other public (VIS) or private (GIR) companies in their tasks related to the SmartEnCity project (retrofitting and district heating actions in the demos area) the promotion of **electro-mobility** in this area has a remarkable importance also due to its exemplary effect within the city. This measure along with the one of the municipality **e-bike sharing station** that will be also detailed here and the electric bus line deployment (already described) conforms the bulk of Vitoria-Gasteiz sustainable mobility actions within

SmartEnCity. Both the Electric Vehicles and the Charging Points are being monitored, and the data will be available through the CIOP.

D3.7 Last mile logistic electric infrastructure

Althought Fagor Ederlan abandoned its participation in the SmartEnCity project, with concerns to **last mile logistic electric infrastructure**, Vitoria-Gasteiz is committed to a change in urban mobility, both of goods and people. Fagor Ederlan aimed to improve and electrify existing combustion vehicles in last mile logistic businesses and implement new business models of electric mobility in the city of Vitoria-Gasteiz, such as the self-guided tourist routes. The pilot was implemented but ended a few months later, when Fagor Ederlan left the project.

D3.8 ICT Infrastructure and City Information Open Platform

Deliverable D3.8 contains a detailed description of the **ICT Infrastructure** deployed and commissioned as well as the **City Information Open Platform** deployed for the benefit of the city of Vitoria-Gasteiz and its citizens. It contains general information about the architecture, data space and functionality of the core platform services as well as the **Added Value Services** implemented for the particular applications covered by the project actions. If further details on the platform developed in Vitoria-Gasteiz are required, please check deliverable D3.8.

2.2 Contributions of partners

The following Table 2 depicts the main contributions from participant partners in the development of this deliverable.

Participant short name	Contributions
CEA	Overall content of Deliverable D3.10 Overall content of Deliverable D3.5 and D3.6
AVG	Contents in Deliverable D3.3, D3.5 and D3.6
TEC	Contents in Deliverables D3.5 and D3.6 Overall review and comments to this document
VIS	Overall content of Deliverable D3.3 Contents in Deliverable D3.6 Overall review and comments to this document
GIR	Overall content of Deliverable D3.4 Contents in Deliverable D3.6
EDS, FED	Overall content of Deliverable D3.7
MON, MON(MU), EGIS, LKIT, CAR, TEC	Overall content of Deliverable D.3.8

Table 2: Contribution of partners

2.3 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
D3.3	This deliverable provides the overall description of the Building retrofitting interventions completed.
D3.4	This deliverable provides the overall description of the District heating network deployed and in use.
D3.5	This deliverable provides the overall description of the Electric bus line in operation.
D3.6	This deliverable provides the overall description of the EV fleets and charging infrastructure deployed and in use.
D3.7	This deliverable provides the overall description of the Last mile logistic electric infrastructure deployed and in operation.
D3.8	This deliverable connects all demo actions into ICT platform. Data will be easily used for evaluation and replication purposes.

Table 3: Relation to other activities in the project

3 Objectives and expected Impact

3.1 Objective

D3.3 Building retrofitting interventions

The overall target for the retrofitting action in Vitoria-Gasteiz's demo is to build the foundations for a Zero Carbon district through the optimal investment on energy reduction measures and complementing the heating supply with a biomass based efficient heating network. According to the simulations carried out, the combination of both interventions would allow buildings achieving the maximum rate of energy label according to the Spanish regulation. The objectives of the building retrofitting interventions are:

- To rehabilitate of the enclosure of 27 residential buildings (312 dwellings) with the implementation of insulation beyond the requirement of the Spanish Building Technical Code. It includes, where considered necessary, a double-glazed exterior window that ensures the insulation quality of the openings without the need for interior works.
- To connect the 312 houses to the District Heating network, supplying them centralized hot water for heating and DHW, by means of forest biomass of local origin.

D3.4 District heating network

The District heating network aims to achieve the following objectives:

- 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.

D3.5 Electric bus line

The objectives pursued in relation to the electric bus line are as follows:

- To fully electrify the highest capacity bus line in the city of Vitoria-Gasteiz.
- To implement a state-of-the-art e-buses charging infrastructure in the municipality.
- To increase the visibility and acceptance of EVs.
- To raise awareness about sustainable mobility and, specifically, fully electric public transport.

D3.6 EV fleets and charging infrastructure

With regard to the objectives of the EV fleets and charging infrastructure the following are noted:

- To progressively electrify municipality and public/private companies´ fleets in the city of Vitoria-Gasteiz.
- To progressively deploy EV charging infrastructure in the municipality.
- To increase the visibility and acceptance of EVs.
- To raise awareness about sustainable mobility and, specifically, fully electric transport including not only cars or vans but also e-bikes.

D3.7 Last mile logistic electric infrastructure

The objective of Fagor Ederlan in the project was to improve, optimize and electrify urban transport businesses already implanted in the city as well as to implement new business models of electric mobility, with the aim of reducing the carbon footprint of last mile transport as create new electric mobility initiatives (Last mile logistics and tourist routes).

D3.8 ICT Infrastructure and City Information Open Platform

The general systems and services implemented, give support to the Added Value Services deployed for the actions carried out during the project. Though the CIOP, SmartEnCity provides services to the city like citizen engagement and acceptance, measuring the comfort in the dwellings, energy consumption monitoring, electric bus function overlooking, energy demand and consumption forecasting, and others. All these services are related to actions executed during the project.

District heating network provides the infrastructure necessary to deploy sensors and systems producing data in the district. Those data are collected in the CIOP platform. Data is finally used by the different AVS. Monitoring is one of the main objectives for those AVS. Data is also used for KPI calculation. The readiness of the system to uptake data from this DH enables the calculation of short- and medium-term energy demand so that the ESCO providing the service can adequately manage the supply of biomass fuel to the boiler rooms.

3.2 Expected Impacts

D3.3 Building retrofitting interventions

Buildings joining the project were categorized in three different “typologies”, from the energy point of view.

				From the BEST tables	
BUILDING TYPE	Number of Buildings	Number of dwellings	Total heated square meters	Expected energy savings (kWh/m²Y)	Eligible Special Unit Costs
11	16	226	16.156	147,18	2.377.874€
10	5	35	3.637	141,94	516.270€
17	6	51	3.316	127,08	421.386€
TOTAL	27	312	23.109		3.315.530€

Energy savings and CO2 reduction:

kWh/year saved:	3.315.000 kWh/year (average 135 kWh/m²y)	**CO_2 reduction/year:**	1.089 Ton

Table 4: Estimated impact of the building retrofitting

D3.4 District heating network

The expected impacts of the district heating network are:

• Environmental impacts:

- Estimated saving of CO2 (building retrofitting + district heating): 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.

D3.5 Electric bus line

The expected impacts of the electric bus line are:

Estimated saving of CO2: 1.304 tn/yr.

The medium-term goal of the operator is to supply the system with 100% RES electricity, which would significantly improve the figures.

12 conventional diesel buses (around 1753 gr CO2 per km) replaced by electric ones (around 200 kWh/100 km and 1 kWh= 0 gr CO2 renewable energy) and around 62.000 km/yr per vehicle1[2].

D3.6 EV fleets and charging infrastructure

The expected impacts of the EV fleets and charging infrastructure are:

Overall estimated saving of CO2: 30.55 tn/yr. according to the following Table 4:

Impact	Km/Year	Fuel saving (Kwh/yr)	Annual CO_2 reduction (tn/yr))
6 EVs + 2 CPs	35.110	122.625	28,4
Bike station (6 bikes)	1.200	8.820	2.15

Table 5: Estimated impact of EV fleets and charging infrastructure

D3.7 Last mile logistic electric infrastructure

The expected impacts of the Last mile logistic electric infrastructure are:

Estimated saving of CO2: 36-ton CO_2/year.

Currently vehicles dedicated to last mile logistics run an average of 18.000 km/year/vehicle but the estimated average annual distance with software would be 10.900 km/year/vehicle (40% less).

D3.8 ICT Infrastructure and City Information Open Platform

The deployment of the CIOP in Vitoria-Gasteiz is expected to have a manifold impact in several areas. Although not limited to the ones mentioned below, it is considered to be the catalyst to improved advanced services built on top of the smart platform. One of the most interesting aspects of this deployment is the additional support offered to the city for the design, development and deployment of its smart city strategy, which is currently under consideration in the municipality. The CIOP should be considered as a powerful tool upon which build this strategy. In line with this, the platform offers the possibility to deploy the municipality open-data policies to help build additional data-intensive services for the benefit of all citizens. Additional economic development may be expected for IT companies offering these added value services where solutions appear as a response to city and citizen demands. Subscription services based on real time data usually emerge when value is offered to the customer. For the city, the smart platform or CIOP means the opportunity to have a central intelligence and data storage system to help build new services, generate additional cross sectorial decision support systems, real time data availability for better city management and the opportunity to bring the citizen updated information and communication channels, to improve their quality of life.

[2] These impacts are calculated taking into account the full deployment of the fleet.

4 Demonstration actions completed:

4.1 Action 1: Building retrofitting interventions (D3.3, linked to Task 3.4)

Technical approach and Business model:

Vitoria-Gasteiz's building renovation intervention consisted mainly of envelope retrofitting which involves intervening in the façade and the roof, improving the envelope's insulation and airtightness, and installing new low-energy windows. In Vitoria-Gasteiz, the Coronación neighbourhood was chosen for this intervention as it was identified as the city's most vulnerable neighbourhood in terms of social issues, stability, habitability, accessibility, and energy efficiency. This district thus reflects the major challenges in terms of retrofitting and implementation of Smart City concepts: very high density, low-medium income, and a relevant social dimension.

In the Energy Rehabilitation of buildings, there are two main actions:

a) Rehabilitation of the enclosure with the implementation of insulation beyond the requirement of the Spanish Building Technical Code. It includes, where considered necessary, a double-glazed exterior window that ensures the insulation quality of the openings without the need for interior works.

b) Connection of the houses to the DH, for the supply of centralized hot water for heating and DHW, by means of forest biomass of local origin. It is the other main feature of the implementation.

The initially estimated costs for the retrofitting interventions were on average 21,000 € + VAT per dwelling, including the connection to the new district heating (DH) network. This amount has varied, logically, in each community. Total investment for the 26 buildings retrofitted has been 6.8 million €.

The final price for the house owners, after discounting the Horizon 2020, Basque Government and Vitoria-Gasteiz Municipality grants, was on average 9,600 €. Thus, a 54% subsidy on the cost excluding VAT is accessed, for which the owners do not have to make an upfront payment. The rest, 46% + VAT, will be contributed by the homeowners as a private part in the project. It should be noted that this percentage of grants does not depend on income but is received only for being owners and is of a non-repayable nature.

VISESA, understanding the complexity of the processing and management of all the aids, and in order to facilitate this work for the citizens participating in the project, decided to jointly manage each and every one of them offering in practice: a comprehensive service of the entire rehabilitation process, as a single window and delegated paperwork management. The figure of the "Delegate Promoter" is another innovative aspect of the project.

So, we proposed the following business model: Visesa (VIS), as Basque public social housing, receives grants from H2020, Municipality and Basque Government, and signs agreements with each building community of owners.

Once the Communities of homeowners (buildings) decide to join the project, is the public company VISESA (VIS) who works as delegate promoter of the retrofitting actions, on behalf of them. Through agreements signed between both parties VIS manages, contracts,

supervises, and finances the correct design and execution of the rehabilitation works of the buildings, delivering the final product “turnkey” to its owners and charging them the cost difference less subsidies.

VIS also manages the different subsidies administrative tasks (application, justification, etc.) as ”one-stop shop agency“, discharging the neighbours of these cumbersome red tape tasks.

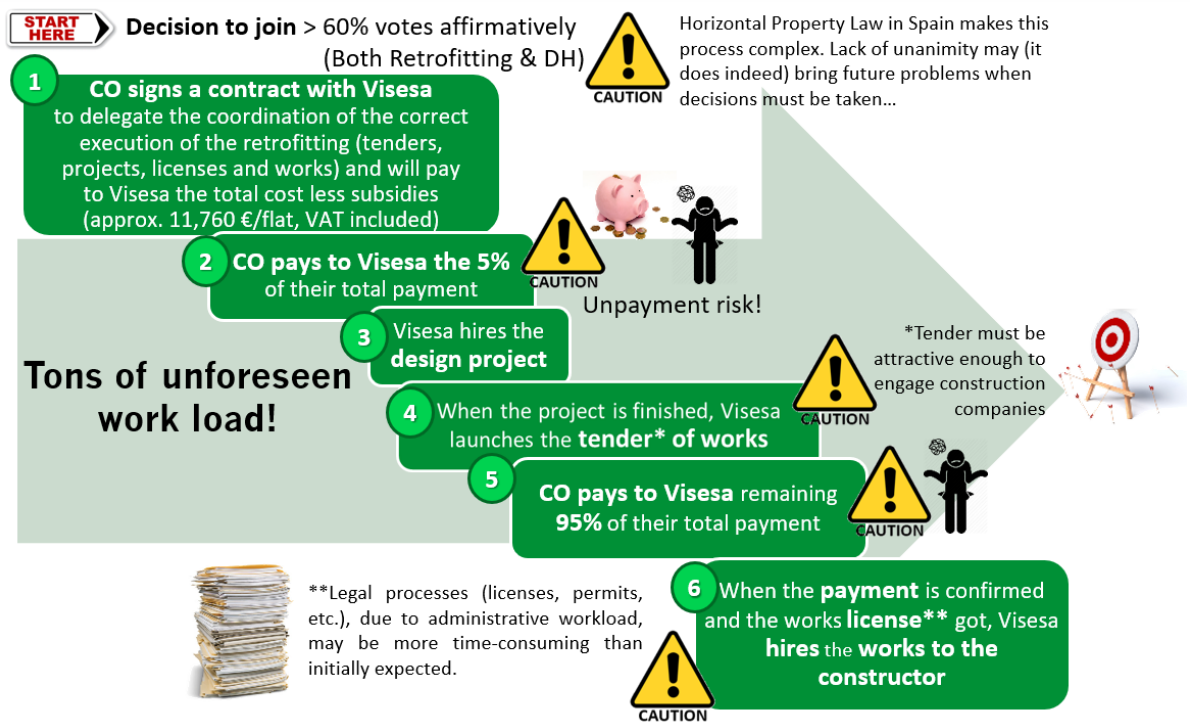

Figure 1: Communities joining process (source VIS)

Scope of the action:

Coronación district is located in the north-west edge of the old town of Vitoria-Gasteiz. The district was built to accommodate mainly immigrants that were coming to the city during 50s and 60s to work in the industry. Coronación can be considered as the first neighbourhood of the first aforementioned city ring built before 1980. The orography around the central almond-shaped old town provoked a natural development adapted to the territory and the main streets already existing at that time, with the concept of urban expansion (“ensanche”) concerning facades and block courtyards. Most part of buildings were constructed during 60s and 70s (85% of dwellings were built before 1970), presenting minor urban changes after that period.

The important conclusions of the Social – Urban analysis confirm the impression from the first diagnosis tasks about the fact that Coronación is one of the districts with a higher need of actuation in the city of Vitoria Gasteiz.

Focusing on the energy efficiency, thermal comfort and accessibility perspective, a wide range of buildings present potential retrofitting improvements, especially in the envelope due to their non-insulated facades.

Regarding the process of homeowner's recruitment, due to the constraints, the project anticipates a strategy of citizen involvement based on the direct transmission of information to citizens at different levels: city, neighbourhood, community, and owner. Through different means: participatory workshops, informative assemblies, mailboxes, meetings with communities, neighbourhood office, door-to-door campaign, radio, and press spots, among others, and coordinated by inter-institutional governance.

The following are "sine qua non" conditions for communities to benefit from the project:

- Be within the scope of action (demo area).
- Insulate the entire housing enclosure (facades, courtyards, roofs) Windows will depend on their general condition.
- Connect to the heating network.

As in the first period, the efforts were focused on general project communication and engagement of different intervention area stakeholders (neighbours and commercial associations, sociocultural centres, religious collectives, etc.), the second period was "the commercialization" period: direct contact with neighbours (more than 2,000 visits and phone calls), more than 300 meetings with the 147 communities of homeowners (average 10-12 dwellings per building) in order to explain the project and budget, the voting process by neighbours of each building to reach an agreement to join the project (more than 60% affirmative votes needed), signing of the contract with Visesa for the execution, etc.

After closing the period of adhesions to the project at the end of 2018, during the first part of 2019 the contracts, between Visesa and the communities of owners, for the retrofitting, were signed: 27 buildings (312 dwellings), 23,110m^2. One of them (Portal de Arriaga 3) resigned after the design project was done. So, finally 26 buildings (302 dwellings), 22,460m^2 confirmed their decision to carry out rehabilitation.

Figure 2: Demo area and buildings joining the project (source VIS)

Works developed:

In the beginning of the project (June 2016) and, in order to have a first knowledge of the intervention cost in an average building, one of the most representative buildings was chosen (demo area) and a design project and budget was developed.

In order to obtain adhesions from homeowners, it was necessary to inform them about the retrofitting proposal of their building, as well as the correspondent budget. A detailed study of the 108 existing buildings was done by VIS.

Retrofitting informative documentation for the homeowners was also prepared, with explanation of the process, prices, subsidies, and technical solutions.

With the information of the demo area diagnosis and after several meetings with neighbours and communities of owners, an initial action zone was selected by VIS in December 2016, to implement a first intervention process.

A collaboration process of co-creation was developed with the “early adopters” contributing with their opinion in the generation of several informative materials (deliverables, brochures, etc.) and contractual documents to be signed with VIS for retrofitting and with GIR for heating supply. Additionally, early adopters facilitated actual energy bills in to define competitive heating supply tariffs.

In November 2017 retrofitting design projects of the “early adopters” buildings were completed.

Rest of buildings´ design projects were developed during the period May 2018 – August 2019.

Early adopters’ works began in June 2018 and finished in January 2019. In December 2018 monitoring sensors were installed in each dwelling and have been taking data since then (electricity consumption, temperature, and humidity).

Figure 3: “Before and after” retrofitting works in Eulogio Serdán 8 (source VIS)

In December 2018, next nine buildings retrofitting works tender was launched to contract the construction companies that were in charge of the refurbishment. The tender was divided in different batches in order to make it more attractive to the construction companies with several buildings per batch which meant a higher budget for the finally awarded companies.

The fifteen remaining buildings, joining the project, have been retrofitted during the last reporting period, being finished before July 2021.

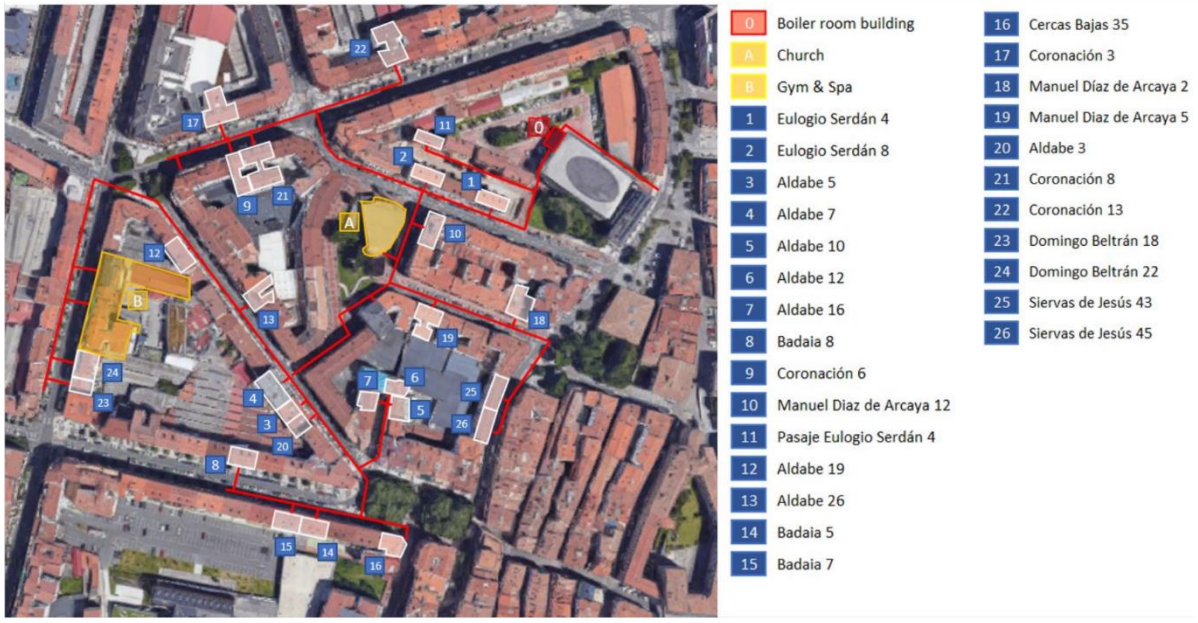

Figure 4: Buildings retrofitted and connected to the District Heating (source VIS)

Figure 5: Badaia 8. Thermal scan. Before & After

Based on lessons learnt in this project, VISESA has developed the procedure to be followed (flow chart) in the rest of buildings and useful for other projects (replication), since the beginning of the citizen engagement to the final completion.

In parallel with the retrofitting works, the comfort conditions and energy consumption monitoring infrastructure was deployed in the dwellings. These data are gathered in the CIOP and showed to the participant citizens through a new developed smartphone app. The new application monitors energy consumption and comfort conditions in the dwelling gathering information from sensors installed in it. The main objective is to empower residents in the knowledge of comfort conditions and energy consumption.

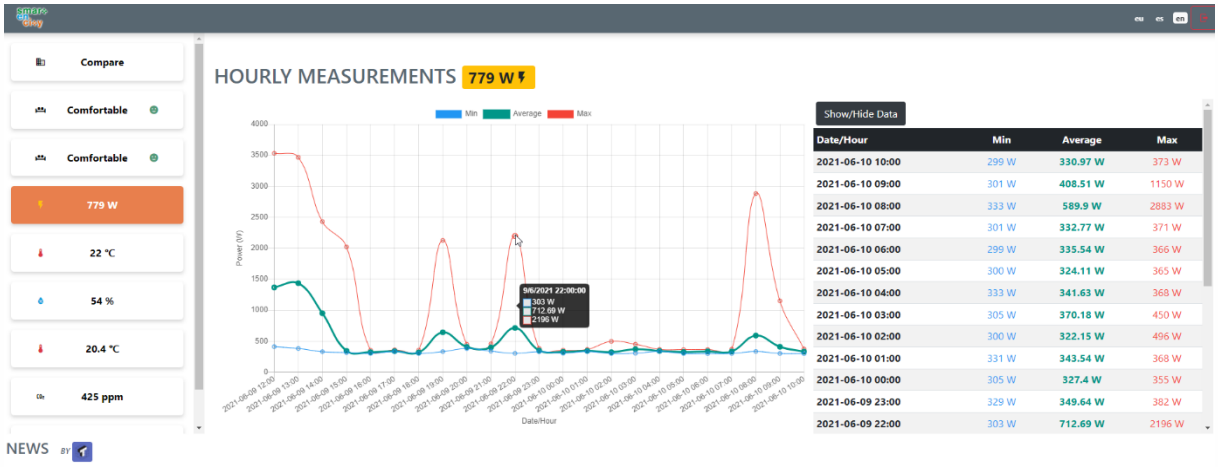

Figure 6: Home Monitoring APP (Energy consumption)

4.2 Action 2: District heating network (D3.4, linked to Task 3.5)

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 neighbourhood of Coronación with the planned accession of 750 homes.

Several discussions about the constitution of this Company, led to the decision that the Company would be formed exclusively with EVE and GIROA, with a 50% shareholding.

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

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 connected to the network 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 m^2, 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 m^2 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.

Face-to-face marketing took 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 that could eventually join the project and in order to get more accessions, the necessary steps were taken to broadcast advertising on different local radio stations.

To this commercial management was also added the printing and distribution of 1,650 advertising cards in the mailboxes of the dwellings of communities located in the neighbourhood 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 Centre. 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.

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 heating 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.

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.

Finally, in July 2019, 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. In September, the tender was declared void.

Throughout the months of October and November, new options were studied in order to reduce the investment and adapt the District Heating Network project to the number of adhered homes.

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

Finally, after the new specifications were published, 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.

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.

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 mainly by two biomass boilers Herz Firematic 501 of 500 kW each. This fact allows and guarantees at least 80% of the energy needed with renewable energy source.

Figure 7: 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.

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 8 and 9: Gas boiler and water tanks (source GIR)

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 screw conveyors, 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.

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.

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.

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 10: District heating network

Once the thermal energy is produced in the boiler room, it is distributed to the different buildings through the heating network.

The works began with the excavation of the trenches in June 2020.

The works of the district heating network have mainly 6 phases. First of all, the trench has to be excavated. After this, the pipe is introduced in the trench and welded. 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.

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.

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, to maintain an appropriate aesthetics and to convince the residents of Coronación, each building has its own substation. Giroa decided to install one substation per doorway.

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 building.

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 flats. Each dwelling 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.

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, as well as remote energy reading system for homes.

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.

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.

4.3 Action 3: Electric bus line (D3.5, linked to Task 3.6)

The deployment of high capacity and 100% electric public transport is paramount for sustainable mobility and to achieve carbon neutral cities in the near future. In the specific case of Vitoria-Gasteiz, the introduction of the tram in 2008 was an important milestone in the electrification of the city's public transport, together with the progressive substitution of city council's staff fleets and the incorporation of 10 hybrid buses by the public bus transport company TUVISA.

On May 10th, 2018, the Cooperation Agreement between the Basque Government and Vitoria-Gasteiz City Council to complement the implementation of the BEI in the city of Gasteiz was signed. The purpose of this agreement was to promote the implementation of

several complementary actions to foster the introduction of electrification in urban public transport in Vitoria-Gasteiz.

In this regard, the Vitoria-Gasteiz City Council, the provincial government and the Basque Government agreed to finance the evolution of the circular bus-line with the highest number of passengers in the city (Line 2) into a modern and clean electric bus rapid transit line with 48 bus-stops (24 for each direction), 4 ultra-fast inverted pantographs, 7 articulated e-buses and 6 conventional-size e-buses (18 meters long with a capacity of 139 people and 12 meters long for 90 people, respectively). The smart electric bus (acronym BEI in Spanish) will cover a route of just over 10 kms with a service frequency of 8 minutes and circulating through exclusive lanes for a large part of the route. Moreover, BEI will enjoy priority traffic lights at junctions and will serve key points in the city such as the main Hospital, the Basque Government Headquarters, Bus Station, University Campus or the Mendizorrotza sport and leisure facilities.

The total investment of the project amounts up to 42,850,000€ with a SmartEnCity contribution of 395.000 € for the purchase of e-buses/charging infrastructure.

Figure 2 shows the new Line 2 design including the location of the charging infrastructure. More into detail, light and dark blue lines represent the two senses of Line 2 (Lines 2A and 2B to be more precise) to be fully electrified (dots for the planned bus-stops; the yellow circles highlighting those with pantographs for opportunity charge on-street; Boulevard and Mendizorrotza stations, at the top/north and the bottom/south of the map, respectively). Night charge will be performed in the new TUVISA facilities (red circle).

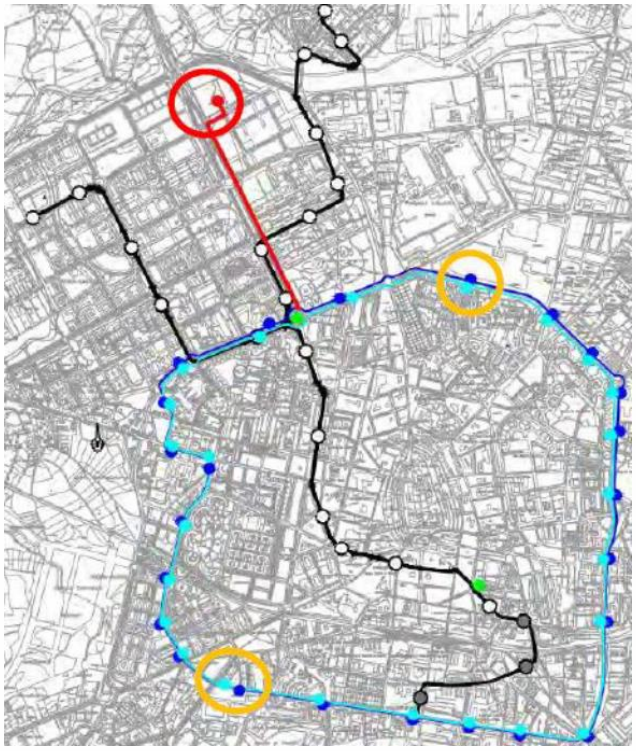

Figure 11: BEI project

The tender for the purchase of the buses and the associated infrastructure was awarded in May 2019. The first e-bus unit, along with the pantographs was deployed by July 2020; the

model presented was the Irizar ie-tram 12m long version powered by a motor of up to 180 kW with lithium-ion batteries. 13 e-buses that will replace 12 diesel buses that currently give service to Line 2 are expected to enter in operation by the end of 2021, together with the completion of the construction works.

The new facilities to host the BEI were tendered in February 2021 and are planned to be built by the end of 2021.

Figure 12: Infographic of the future public bus Functional Charging Unit. Source: AVG

During the 20th and 21st of June 2019, one e-bus unit, similar to the one expected to be implemented, was presented in a public event and displayed in the streets of Vitoria-Gasteiz as to allow citizens to know better how the new buses will look like and also to experience the service in situ.

Figure 13: Smart Electric Bus (BEI) circulating through the city of Vitoria-Gasteiz as part of the public presentation on June 2019. Source: AVG

The final prototype of the vehicle was presented on July 14th, 2020, at an official ceremony with the city´s mayor and representatives from the provincial and regional governments. The citizens were able to visit the convoy, which was showcased in different points of Vitoria-Gasteiz from the 14th to the 20th of July (2020), to get to know its characteristics from a personal experience.

The city council set up a specific website to inform in detail on the development of the works (in Spanish and Basque only); this website has been replaced (July 2020) by the official one that contains all the information on this new sustainable transport mode and also provides information on specific problems that may arise during the deployment period, such as affectations to traffic (congestions during the public works) and parking provision (due to dedicated lanes in the majority of the route, in areas with a deficit in parking availability for residents a significant part of them will be replaced at nearby locations). This has been tried to overcome by means of increasing communication and answering to citizens´ doubts, complaints and suggestions one by one through the mobility forum and other participatory channels in the city council.

Since July 2020, incoming convoys are being monitored and the next ones to be incorporated, will be monitored in terms of both performance and energy consumption through monitoring devices embarked in each e-bus until the end of the project. Moreover, charging will be also monitored by devices installed at the charging units (immediately upon each deployment as with the e-buses); fast-charging performance at pantographs will be thus tested since August 2020 until the end of the project. These data will be integrated within the SmartEnCity ICT platform (CIOP) as to monitor charging performance until the end of the project.

4.4 Action 4: EV fleets and charging infrastructure (D3.6, linked to Task 3.6)

Five EVs have been incorporated: AVG incorporated two EVs, VIS another two (plus another hybrid car) and GIR the remaining one. Apart from this CEA installed and launched a e-bike sharing system (including 6 e-bikes with their docking and charging infrastructure and a mobile and web-based App for sharing) in the garage of the Vitoria-Gasteiz city council's main technical offices building for the city workers (both AVG and CEA) regular use.

As part of its sustainable mobility strategy, the City Council of Vitoria-Gasteiz (AVG) has contracted the supply by renting of two electric vehicles (EVs; model Nissan ENV200) adapted to the needs of the Participation Department and Civic Centers, and specifically for the concierge service. These vehicles will be used mainly for internal messaging/mailing purposes (envelopes and parcels) between the various municipal offices. The two electric vehicles replace other combustion vehicles that have been used so far.

The term of the contract is 48 months (EVs were deployed the 3rd of February 2020) subjected to an annual extension.

Figure 14: Electric van in the garage of Vitoria-Gasteiz technical offices

Visesa (VIS), within its sustainable mobility strategy, will substitute gradually its fleet of combustion vehicles by electric ones. Three vehicles have been already substituted so far (2 full electric and 1 hybrid), specifically those one used in Visesa's technicians' frequent visits to Coronación Demo District for retrofitting works supervision and the necessary meetings with tenants. Visibility of electric vehicles in the demo area is a useful tool in the aim of fostering the awareness in the district about sustainable mobility. VIS fleet is in a renting mode, so the acquisition of the new electric vehicles has been carried out gradually during the second part of 2020. Rental fee is around € 450 / month on average (cost differs depending on the car model).

Subsequently, it has been also necessary to install 2 Charging Points in the head office of Visesa (VIS). This allows controlling and measuring consumption and charging patterns data. Two chargers (7.2 kW/each), with two connection points each one, were installed in VIS facilities in October 2019. Being a community access garage, these CPs are configured with an access card to ensure their correct use.

Figure 15: Charging points at Visesa's parking places

Giroa (GIR), continuing in the line of investing on renewable energies, will have an electric vehicle to travel from its offices located in the Miñano technology park, which is 10km from the Coronación neighbourhood. The vehicle will be used by people involved in the project and to be able to carry out daily contact tasks with all the professional groups involved, as well as the follow-up of the buildings retrofitting works and continue carrying out marketing and support tasks for the neighbours of the neighbourhood.

This vehicle has 2 recharging points: The Giroa-Veolia offices located in the Miñano technology park, which have 5 recharging points, and the parking lot of the new Cathedral of Vitoria-Gasteiz (700m from the biomass power plant), which has 2 recharging points. Both points use the IBIL charging system.

Figure 16: Recharge of the EV in the Cathedral parking lot

As a specific development of the AVG's SUMPSP, a Cyclist Mobility Master Plan (CMMP) was also drafted. This CMMP was designed to promote the bicycle as an active and sustainable mode of transport and alternative to the use of the automobile. This is especially relevant when considering city council staff as they could help raising citizenry awareness and promoting the use of e-bikes as a way of commuting.

Today, an important part of the displacement of municipal staff within their working hours is done in unsustainable ways, mainly combustion vehicles. The electric bicycle seems the ideal way to develop many of these displacements since most of them are limited to the urban environment and without the need to transport cargo.

Within this context, CEA decided to foster sustainable and active mobility among the CEA and AVG workers by installing and operating a sharing system of e-bikes for both institutions´ workers at the basement of the city council´s technical offices building (where both organizations shared their main working space). The system has been already installed and after a testing phase is now operating since May 18th, 2020. By mid-2021, even considering the negative impact of the COVID19 scenario with many employees working at home, more than 6500 km have already been covered and 59 workers have registered to use the system.

The total investment (35.618,77) included these concepts (euro; VAT included):

- Supply of the bicycles and their accessories: 11.372,79

- Supply and installation of the docking and loading station: 15.572,70

- Management system (installation, software licenses): 3.146,00

- Maintenance of the management system and e-bikes: 5.527,28

Figure 17: Charging dock and e-bikes in VG City Council Technical Offices

As of January 2021, all the systems/EVs where deployed and in use.

4.5 Action 5: Last mile logistic electric infrastructure (D3.7, linked to Task 3.6)

Touristic routes around the city:

Fagor Ederlan implemented a new concept of sustainable and interactive tour driving an electric vehicle. Running since 30th November 2017, the tourist had the opportunity to meet unique and funny stories of the city driving zero-emission, easy-to-drive cars with room for up to 4 people. Driving an electric vehicle allowed the visitants to access places where normally the traditional vehicle could not reach.

The tourist could choose between four types of tours: City tour, Gastro & Culture Tour, All in one and The Green tour. For the advertising and sale of the service a website was designed and an official presentation was made for all the hotel owners of the city.

Figure 18: The two electric vehicles used in Vitoria-Gasteiz for the touristic tours

After several months in operation, Artea Guías Turísticos, S.L. the company with which had been signed a marketing contract to provide de service, had to finish the contract due to internal problems. Due to this circumstance the route service was cancelled.

Last mile logistics:

Instead of working on the implementation of new business models, in the case of last mile logistics services, work was carried on the signing of collaboration agreements with active logistics operators in the city of Vitoria-Gasteiz. The objective of this collaboration was to electrify, optimize and, if possible, diversify and innovate their current operations.

3 types of business were worked:

- COURIER: Withdrawal of the project from Koiki Home, S.L., with whom was signed an agreement of intentions for the development of a parcel delivery business model based on the contract of people in need of social reinsertion. The reason is the obtaining of funds by this company that enabled it to develop the project alone.

- DELIVERY OF URBAN GOOD: There was the intention to sign collaboration agreements with merchandise companies to substitute the vehicles used by electric vehicles and optimize the operation through the implementation of the software. Collaborations were not possible.

- FINAL DELIVERY TO THE CONSUMER OF SUPERMARKET PRODUCTS: A collaboration agreement was signed with an important brand of supermarkets and a logistics operator with the aim of improving the current operation and the design and testing of new last mile urban delivery business models. This project aimed to replace the vehicles used for the delivery (combustion vans) by electric vehicles and optimize the delivery process at home by implementing management software, allocation and optimization of routes.

During the project two lines of work were differentiated:

- Analysis of the current operative in Vitoria-Gasteiz for its electrification and optimization.

- Real testing of a new multi-business delivery model.

Edermobility Services, Linked Third Party of Fagor Ederlan, was in charge of the development of the smart mobility services for Vitoria-Gasteiz. This line of business based on electric vehicles strongly leant on the Group's light truck electric manufacturer, which experienced financial difficulties and discontinued its activity. This produced a cascade reaction in electric mobility which rendered financial loss. The decision was made to re-structure the business activities-including closing down Edermobility Services- and abandon all together this activity. Therefore, Fagor Ederlan requested its withdrawal from the project.

4.6 Action 6: ICT infrastructure deployed and commissioned. City Information Open Platform (D3.8, linked to Task 3.7)

The CIOP Portal and AVS implementation has been as follows:

CIOP Landing application and access page:

This Web Application is the landing page for the CIOP portal. From this application the rest of Added Values Services can be accessed. Its main function is to provide general information about the project and connect to the utilities the portal offers. The objectives of this web application are:

- Present general information about the project expressed in KPIs.
- Provide general information about the AVS applications available.
- Provide access to those AVS applications.
- Present the information in three languages (English, Spanish, and Basque)

The tool can be accessed using the following link https://vitoria-gasteiz.smartencity.eu

The landing page presents general information about the project in the form of KPIs and offers links to search for information, contact page managers, get support and change language.

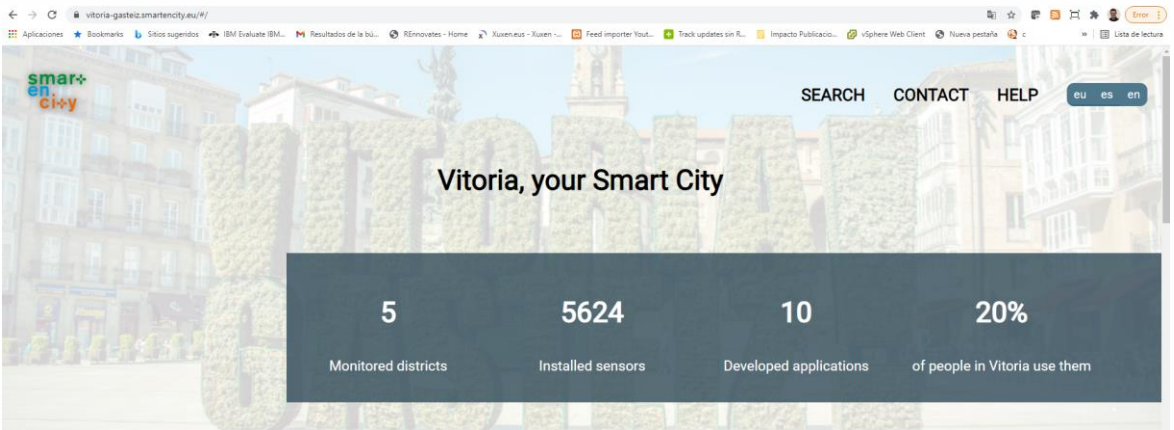

Figure 19: Portal Landing Page (development version)

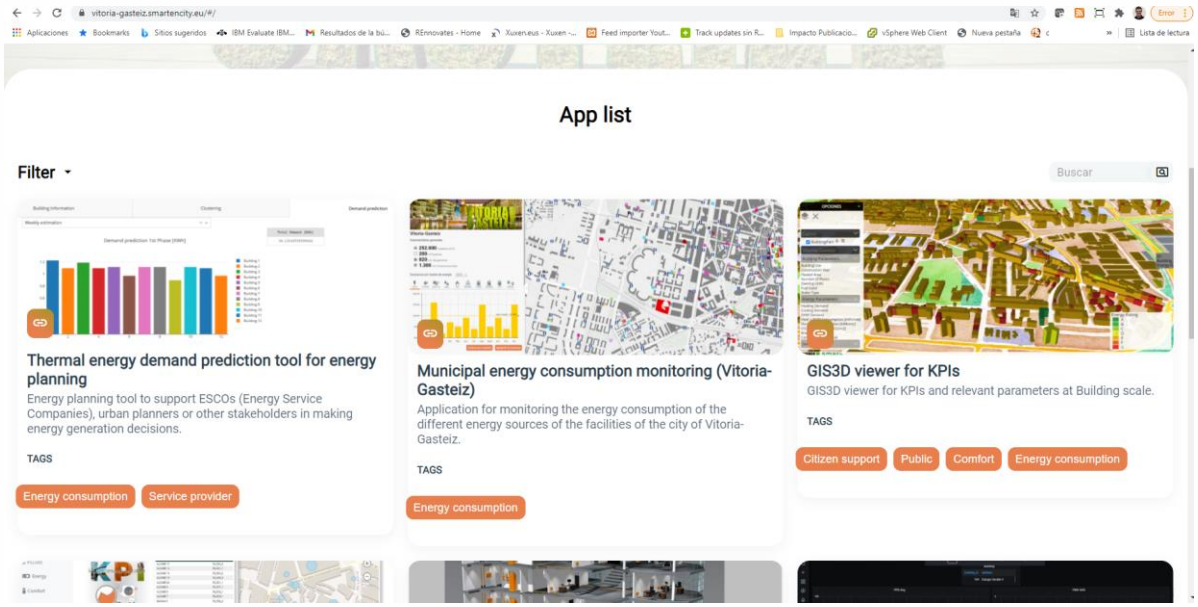

Figure 20: AVS list

CIOP Added Value Services AVSs:

This AVS tool enables residents in monitoring consumption and comfort conditions in the dwelling. The application monitors energy consumption and comfort conditions in the home from sensors installed in the home. The main objective is to empower residents in the knowledge of comfort conditions and energy consumption. To this end the application/solution objectives are:

- Collects electricity consumption and comfort data of the dwellings.
- Displays the data and recommendations to the residents (visualization tool).
- Allows comparisons (before and after the interventions).
- Calculates relevant indicators for the validation of interventions (KPIs).

Figure 21: Home Monitoring APP (Comfortable)

Installation and Management Support Tools:

This AVS tool supports installers and platform managers on providing service over sensor installations and monitor its behaviour. On one hand enables data commissioning for installations showing the status of each installation and its sensors and assuring that data is being acquired. On the other hand, it provides an alarm system for malfunctioning devices. Thus, when a device or sensor stops sending information detects this situation and informs platform managers about it. The tools also make possible to obtain and download data. The objectives for the tool are:

- Offer a form to support automatic registering of dwellings/gateways in the database during installations.
- Enable data commissioning. Correctness of data, frequency, completeness of data …
- Offer a system for installation sensor status monitoring.
- Offer an alarm system for malfunctioning devices/sensors.
- Offer a tool that facilitates the collection of missing information.
- Offer a tool that facilitates data consumption (download).

Data analysis of comfort conditions for ESCO support App:

This block considers tools for monitoring comfort conditions in buildings to support energy service companies. Building comfort information is presented on dashboards that allow energy service companies to monitor comfort, know the impact of energy saving and retrofit measures or identify anomalous situations. Building comfort calculations are based on the ASHRAE 55 standard, which determines the comfort level based on housing conditions (temperature and humidity) as well as contextual parameters (occupancy, outside weather conditions, isolation level…). In addition, clustering techniques are used to discern variations in building comfort as a function of variables and contextual conditions (this part will be presented in WP7 in relation to KPIs). This AVS tool permits building dashboards from the data collected in the different data repositories. The aim is to offer ESCO providers with dashboards relevant to comfort and energy measurements. The objectives for the tool are:

- Offer a web tool where an ESCO can build their own dashboards.
- Provide a dashboard that presents comfort information to support condition validation. The ESCO will use this tool to monitor building and dwelling conditions.

Local news channel (TV):

This AVS is a Web portal offering a local news channel based on RSS from websites about Vitoria that can be consumed through building infrastructure (TV). The aim is to offer residents a news channel with relevant information through TV in a similar way as offered in airports, public buildings or street panels. The objectives for the tool are:

- Collect data from websites with news about Vitoria-Gasteiz.
- Present data in a web portal and consume it on TV through building infrastructure.

- Enable a local news channel.

Municipal Buildings Energy Usage Monitoring:

The municipal energy consumption application provides information on the different municipal consumption of the city, including municipal buildings or facilities, water used in parks and gardens, public lighting and mobility of vehicles used by the city council.

It is specially oriented to analyse the different consumptions in the city. It also offers a carbon footprint indicator to observe the environmental impact. The City Council is currently carrying out a process of uploading historical consumption in order to perform information analytics. The application feeds a database that records the readings and invoices of the different meters in the city. In this way, in addition to energy consumption, the economic costs of each energy source are obtained.

The information is supported by the georeferencing of the consumption points distributed throughout the city. This georeferencing helps to locate the different meters, municipal buildings…

The application is aimed especially at municipal technicians to analyse consumption, check the areas or points of greatest consumption and see the variations or evolution that occurs in the reforms towards more sustainable energy sources.

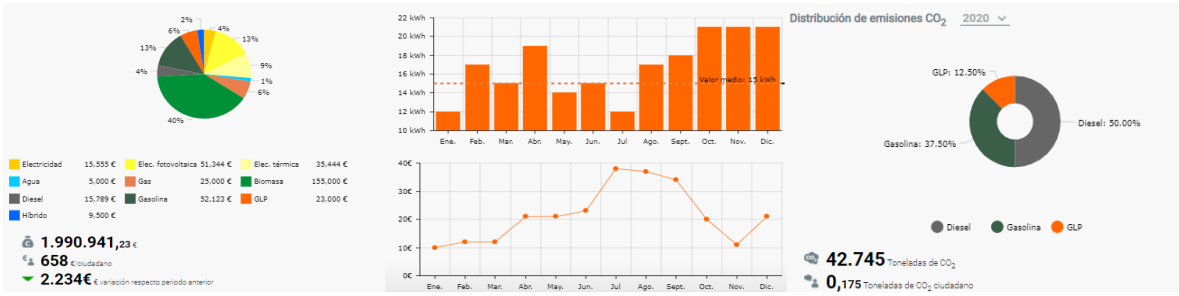

Figure 22: Graphics available in the presentation

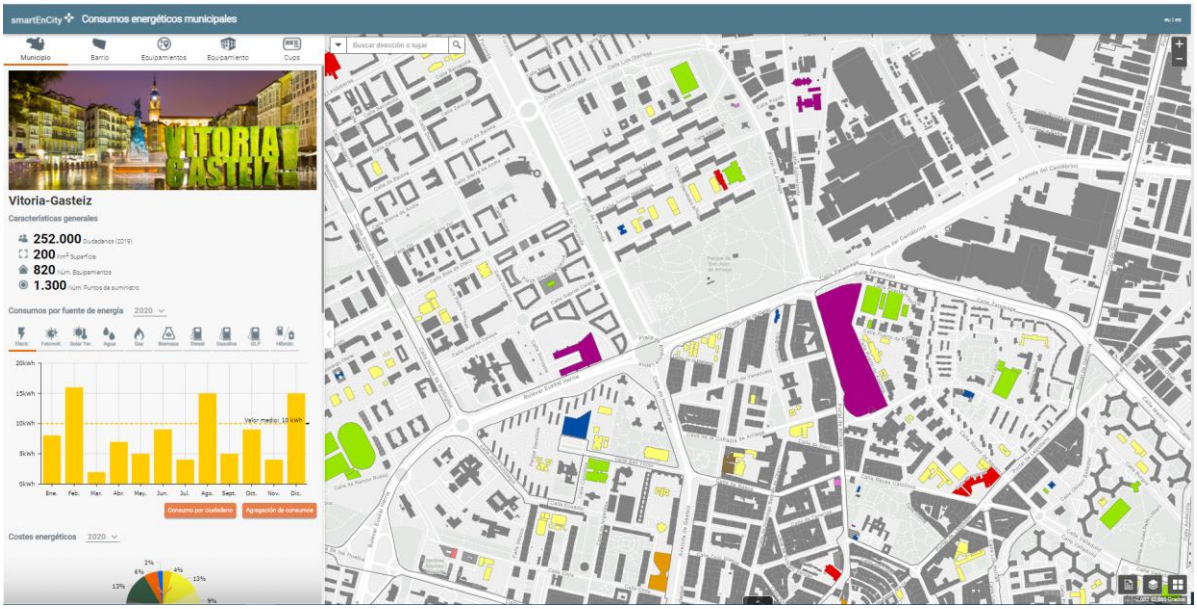

Figure 23: Municipal energy consumption application

Intelligent Electric Bus - BEI – Monitoring:

The Intelligent Electric Bus -BEI- application provides KPIs and the positioning of the future electric buses in Vitoria-Gasteiz.

The web application offers information related to the data taken by the electric chargers and the vehicles themselves through the Can Bus. This new means of transport and its associated infrastructure (chargers, stops…) has advanced technology for monitoring, recording incidents, planning, ticketing, etc.

The application obtains data of the electric bus from the iPanel Platform that manages and centralises all the information on this new urban transport.

The application is currently not accessible in a production environment due to the fact that the BEI is currently in testing and there is not enough information available to validate the application and make it available to end users.

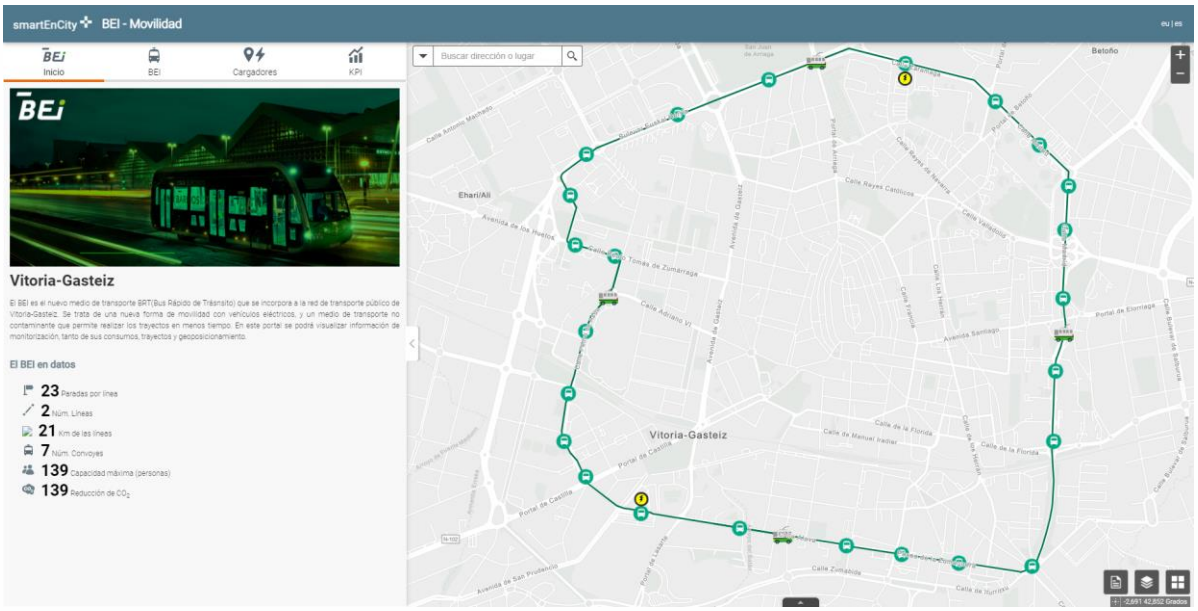

Figure 24: BEI user interface (Home page)

KPI Evaluation tool:

The KPI evaluation tool service is an application dedicated to the calculation, storage, and visualization of KPIs (not for all the pillars, where external calculators are used, e.g., comfort). The main aim of this tool is to provide a dashboard for decision-making and self-assessment of the interventions carried out in the city of Vitoria-Gasteiz, more particularly, in the Coronación district. In this sense, the tool calculates the KPIs of the SmartEnCity project. The service includes the main pillars of the project depicted as follows:

- Energy: this pillar includes the energy use per building, primary energy, and CO_2 emissions due to energy usage. Both thermal and electrical energy are considered within this pillar through diverse energy carriers.
- Comfort: although comfort is obtained at dwelling level within the application “Data analysis of comfort conditions for ESCO support App”, this pillar analyses the comfort levels in an aggregated way, per building, thus, avoiding issues with the GDPR for a public evaluation.
- Mobility: the use of clean and green vehicles, as well as the associated chargers, contributes to the reduction of the greenhouse emissions, therefore, the impact of the project actions related to these elements is included within this pillar.
- ICT: the Vitoria-Gasteiz CIOP itself is also globally assessed in terms of performance and other metrics such as scalability and extensibility.
- Social & Citizen: within this pillar, the social acceptance and citizen engagement are evaluated to obtain the satisfaction, involvement, and degree of commitment of the citizens as core of the Smart City.
- Environmental: Life Cycle Analysis (LCA) is another important aspect to remark, which is included as environmental pillar for the evaluation of sustainability aspects focused on the reduction of environmental impacts due to the district intervention.

- Economic: finally, economic aspects to evaluate the cost effectiveness of the district renovation and mobility interventions and the citizen engagement actions are also included, such as investments, cost savings associated to energy savings, return of investments and other indicators to provide some figures in terms of economy.

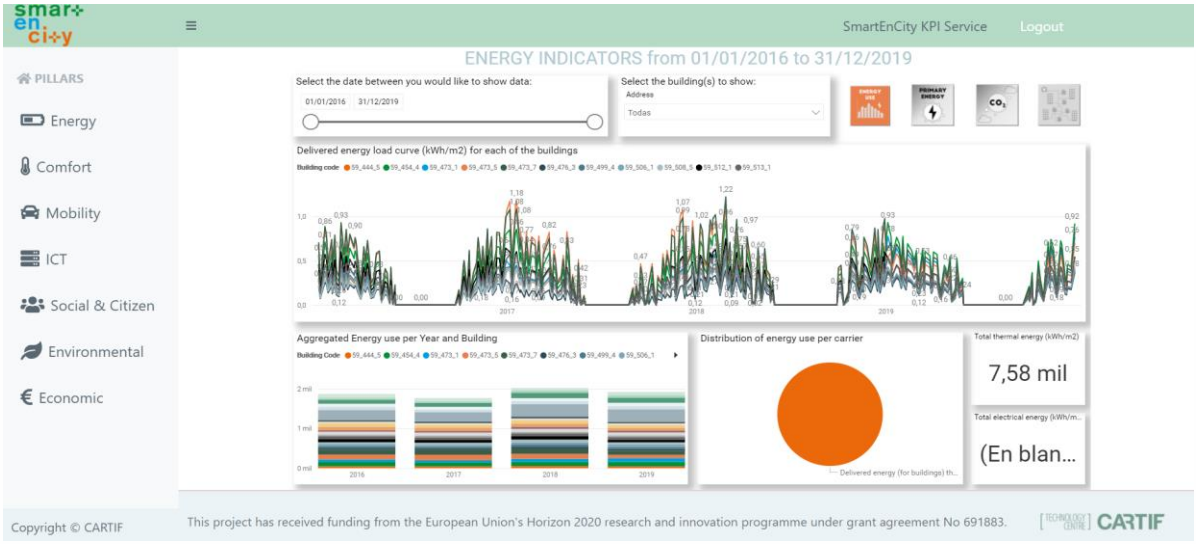

Figure 25: Energy dashboard of the KPI evaluation tool

Thermal energy demand prediction tool for energy planning:

The thermal energy demand prediction tool is a service whose aim is to provide an energy demand forecasting at multiple time spans in order to plan the energy generation and distribution according to this expected demand. The tool makes use of machine learning techniques to learn about the energy consumption patterns from historical data in order to predict the behaviour of the buildings.

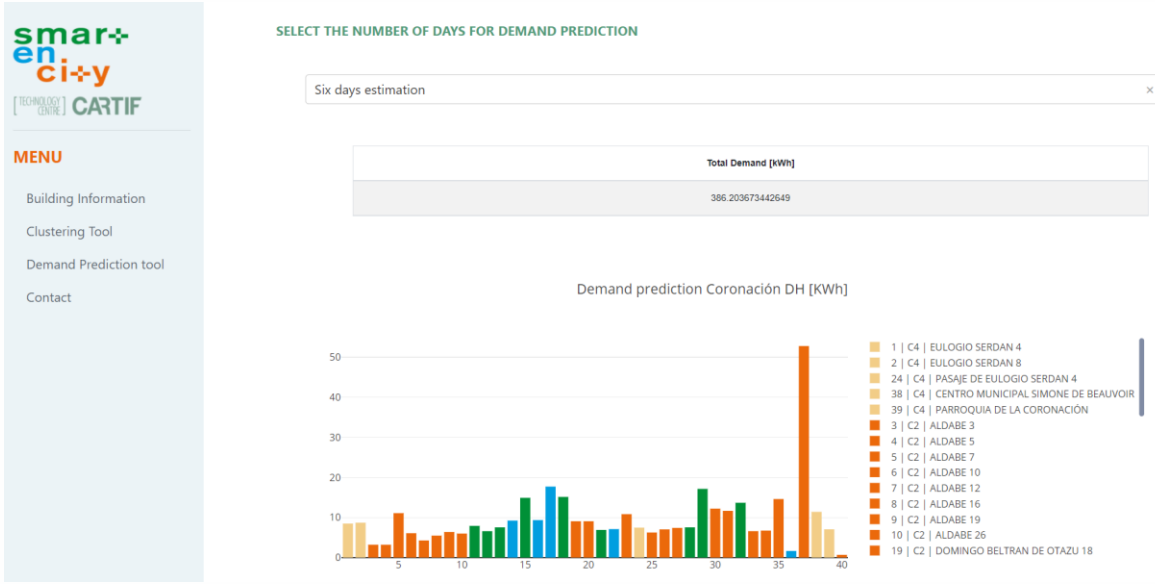

Figure 26: Energy demand forecast screen for the energy planning tool

GIS3D Viewer for KPI visualization:

Three types of indicators have been added to the model, building, energy, and solar indicators, these last two were calculated and added to the 3D model database, all these indicators are loaded into the 3D Model and can be displayed with building information. The Viewer also allows us to launch graphical queries on these indicators applying different styles to the buildings. Finally, the Viewer has a connection to the tool "KPIs Evaluation Tool".

Figure 27: GIS3D viewer preview

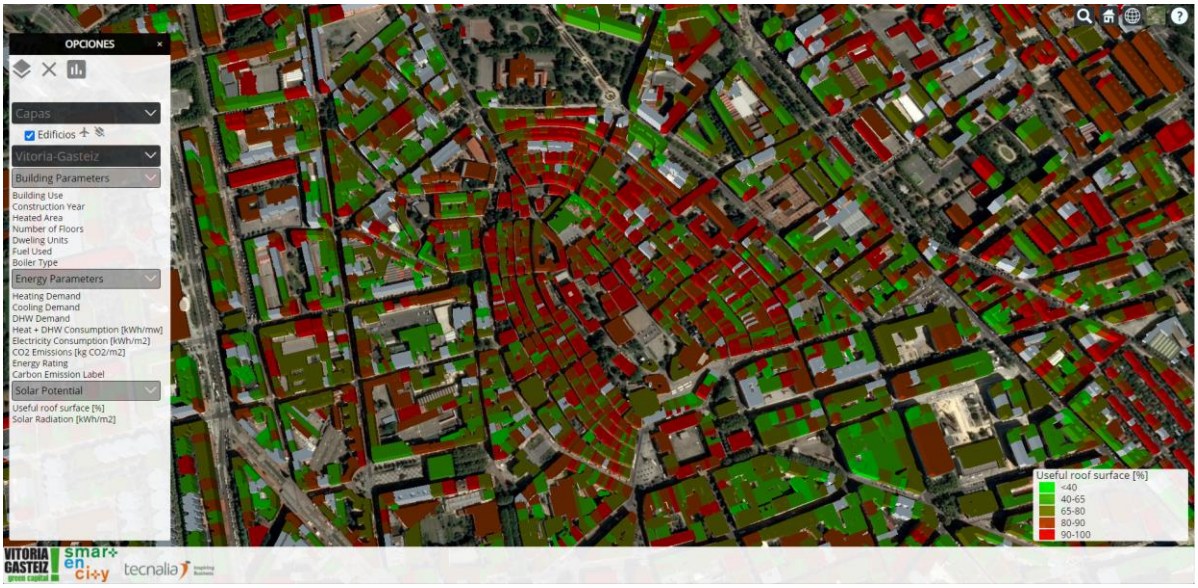

Figure 28: GIS3D query example of solar potential, useful roof surface %

5 Deviations to the plan

D3.3 Building retrofitting interventions

The implementation of the Building Retrofitting Task (T3.4) has been successful. The objectives set have been satisfactorily met, both in scope, quality, and deadlines.

The only deviation has been the resign of owners of the building "Portal de Arriaga 3". Therefore, 26 buildings (302 homes) have finally been rehabilitated, compared to the 27 (312 homes) planned. This has meant a reduction of the rehabilitated area from the 23.110 m^2 planned, to the 22,460 m^2 of heated area retrofitted.

D3.4 District heating network

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 really 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.

As indicated above, regarding the number of dwellings joined to the project, there was also a deviation from the original plan.

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.

D3.5 Electric bus line

There have been mismatches in deadlines related to BEI. The civil works have been delayed compared to the initial schedule. However, the testing of the vehicles is proceeding according to the initial plan.

The new facilities to host the BEI (and also, at a later stage, the rest of the public bus fleet) were initially planned to be built by July 2021 after a several months delay to the need, as requested by the Basque Government, to study their environmental impact in advance. Finally, the construction of the Functional Charging Unit, which includes the infrastructure needed to ensure the operation of the Smart Electric Bus, new garage and mechanical workshops for both BEI and regular bus fleet will be completed by February 2022.

The electric bus will be on the road before the end of the year, even if the night-time charging system is not yet definitively in service. It is expected that tests on the real route may also be carried out in September.

Further steps to the full operation of the electric bus line are progressing according to the plan, and the expectation is to have the complete fleet in operation by Spring 2022.

D3.6 EV fleets and charging infrastructure

Regarding the EV fleets and charging infrastructure deployed, there have been no significant deviations to the plan.

D3.7 Last mile logistic electric infrastructure

In terms of the last mile logistic electric infrastructure, due to Fagor Ederlan abandoned the project before its completion, only 3 of the 26 electric vehicles proposed have been able to be deployed.

D3.8 ICT Infrastructure and City Information Open Platform

The configuration and deployment of the CIOP has been in general terms in line with the initial scheduled planned. Minor adjustments had to be made to follow the natura development of the other actions that affected the CIOP deployment, in particular the data acquisition from sensors and systems.

6 Lessons Learned

Six years almost have passed since the official start of the project and demo actions (WP3) are completed, and the balance of the development of the project is really positive.

D3.3 Building retrofitting interventions

A multitude of readings and reflections can be made about the strengths and weaknesses of the project, and its approach to achieving the objectives. What seems obvious is that there was a series of factors that have functioned as enormous barriers when it comes to engaging citizens. Some of the most relevant are outlined below.

- Top-Down Project: the first barrier comes from the very conception of the project, promoted by institutions for citizens. The initial project has had to adapt to the reality of the neighbourhood and the particularities of each community. Greater citizen involvement in the conceptual phase would have been a great help.

- Horizontal Property Act (LPH): unlike what happens in other countries, in Spain, the LPH defines the majorities necessary to undertake according to what works in owner communities. For an energy rehabilitation, this necessary majority is set at 3/5 of the total property, and if we consider the high percentages of participation that the premises have in Coronación (demo area), the difficulty of bringing the entire community of homeowners into agreement is even greater.

- Neighbourhood heterogeneity: complexity increases as the conditions, advantages, and costs for the rehabilitation of the buildings differ due to the heterogeneity in the size of communities and the constructive differences between buildings in the area. In this case, working with very different communities has been a very positive experience, although a much easier and better results would have been obtained in an environment with buildings and communities of similar structure. In fact, the replicability of the first restorations would mean a much greater optimization of efforts and costs. This heterogeneity has, in fact, been a specific difficulty of the Vitoria-Gasteiz project, unlike the cases in other demo projects, where the buildings are practically equal to each other and allow much greater investment efficiency due to the aforementioned replicability.

- Initial lack of energy awareness: to undertake a project of this size, it is essential to generate a critical mass that really understands the advantages and is fully aware of energy rehabilitation.

Project management, single window: other of great achievement of the project, although it is not the most attractive, is the management of the entire process of the communities by Visesa (VIS) through a single window. The complexity of the processing and management of rehabilitation aid is such that the need for a public service that facilitates and guides citizens through this work has become evident.

D3.4 District heating network

The change in the proposed heating system implies the uncertainty of a new billing, a new company and new tariffs, “something” that was not yet a working reality in this case. In general, citizens are, or have been, not very receptive to change. This is evident even more

so when the idea of central heating is linked, erroneously but inevitably, to those installed in the 70s and 80s of the 20th century, where each user did not have control of the thermal comfort of their home.

Perhaps, in future interventions of this type, it would be advisable to give aid by tranches based on different energy improvement measures. Especially in cases like this, in which the size of the heating network is a future that depends on the number of end users, entrusting the project to such a high level of access to make the heating network viable is an added complexity and a contradiction in itself. In cases where there is already a previous installation of central heating systems, assuming the reality of a District-Heating will undoubtedly be more affordable and less problematic.

D3.5 Electric bus line

It is quite likely that in most cases civil works will be delayed for a variety of unpredictable reasons, so this should be taken into account when establishing a timetable.

D3.8 ICT Infrastructure and City Information Open Platform

From the ICT Infrastructure deployed and the CIOP, a high degree of complexity can be inferred from both the backbone services common and common framework, and the specific functionality deployed to support the actions executed in SmartEnCity project. This complexity could be a burden when the time comes to service, upgrade or migrate the CIOP components to a new location or IT service company.