



TOWARDS SMART ZERO CO₂ CITIES ACROSS EUROPE
VITORIA-GASTEIZ + TARTU + SONDERBORG

Deliverable 7.12: Monitoring Summary

WP7, Task 7.3

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Author(s):	David Grisaleña (VIS), Patxi Sáez de Viteri (MON), Felix Larrinaga (MU), Alain Perez (MU), Julia Vicente (CAR), Susana Gutiérrez (CAR), Jose Luis Hernández (CAR), Kristina Bozhkova (ZERO), Peter Rathje (ZERO), Torben Esbensen (ZERO), Simon Stendorf Sørensen (PLAN), Jaanus Tamm (TAR), Veronika Mooses (UTAR), Mirjam Veiler (UTAR), Siiri Silm (UTAR), Urmo Lehtsalu (ET)



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Abbreviations and Acronyms

Abbreviation/Acronym	Description
API	Application Programming Interface
APP	Application software
BEMS	Building Energy Management Systems
DHW	Domestic Hot Water
EU	European Union
EV	Electric Vehicle
GPS	Global Positioning System
HDD	Heating Degree Days
HEMS	Home Energy Management Systems
ICT	Information and Communication Technologies
KPI	Key Performance Indicators.
LCA	Life Cycle Assessment
LH	Lighthouse
PV	Photovoltaic
SmartEnCity	Towards Smart Zero CO2 Cities across Europe
WP	Work Package
CIOP	City Information Open Platform
SAB	Name of a housing association
SOBO	Name of a housing association
B42	Name of a housing association
CSV	Comma Separated Values
XML	Extensible Markup Language
JSON	JavaScript Object Notation
CT sensor	Current Transformers sensor
CTI	Common Telecommunications Infrastructure
BEI	Bus Eléctrico Inteligente (Smart Electric Bus)
CAN bus	Controller Area Network bus
SCADA	Supervisory Control And Data Acquisition
NOx	Nitrogen Oxides
HDD	Heating Degree Days
ID	Identification code
eBike	Electric Bicycle

Table 1: Abbreviations and Acronyms

0 Publishable Summary

This deliverable summarizes WP7 monitoring process and data collection aspects in LH cities of the SmartEnCity project. It outlines the data collection sources and equipment (operational devices, surveys, databases) and data quality aspects as defined in D7.9. The input covers aspects from seven protocols of Energy Assessment, ICT, LCA, Mobility, Social Acceptance, Citizen Engagement, Economic Performance. This document covers the methodological aspects related to data used for the final performance estimation in D7.13. The document is structured by the input of the three LH cities.

1 Introduction

1.1 Purpose and target group

SmartEnCity project aims to contribute to Smart Zero CO₂ cities in Europe with an extensive set of activities such as retrofitting of buildings and district integrated interventions, developing sustainable urban mobility, engaging citizens etc. The impact of these activities can be evaluated based on collected data from installed devices and sensors, surveying residents, using various databases and calculating different KPIs. Monitoring is, thus, an essential part of the SmartEnCity project. Previous deliverables in WP7 (e.g. D7.3, D7.4, D7.9) set a framework for data collection in seven different themes/protocols: Energy Assessment, ICT, LCA, Mobility, Social Acceptance, Citizen engagement, Economic Performance. In order to keep track of the data collection in every LH city, internal reporting was set up (see section 3).

It was foreseen that at least two years of full set of data should be considered after the implementation of the activities in each LH demo site. However, the plans were greatly challenged by various factors such as the COVID-19 pandemic, increase of costs in the building and IT sector, the exit of certain company from the project, which lead to necessary amendments and an extension of the project time and monitoring time-period.

In light of these challenges, the **purpose** of this deliverable is to document a summary of how the data gathering process took place in every LH city. This includes a description of what equipment and protocols were set up, what data was collected and how, and to give an overview of the data quality.

This deliverable is **targeted** to all external stakeholders (other European cities, companies, universities, think-thanks, etc.) interested in data collection aspects of the SmartEnCity project. As this deliverable summarizes the main points regarding monitoring and data gathering, it also targeted to all internal partners who were involved in the project to have relevant methodological aspects documented for future purposes.

1.2 Contributions of partners

The structure for this deliverable is divided between LH cities. The responsible person from every LH city forwarded this task to other partners and many partners gave their input for a certain city. The following Table 2 depicts the main contributions from participant partners in the development of this deliverable structured by each LH city.

Participant short name	Contributions
ZERO, ET, PLAN	Content to sections 4.3, 5.3, 6.3, 7
VIS, CAR	Content to sections 4.1, 5.1, 6.1
TAR, UTAR,	Content to sections 4.2, 5.2, 6.2



TREA, ET	
UTAR	Content to sections 1, 2, 3, 7

Table 2: Contribution of partners

1.3 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
D3.1, D4.1, D5.1 and D3.2, D4.2, D5.2	City diagnosis and baseline have been described in D3.1, D4.1 and D5.1 by each LH city (input for sections 11.1.8, 11.2.8 and 11.3.8), and baseline calculations that are presented in integrated planning reports before the interventions start for every LH city (D3.2, D4.2 and D5.2).
D7.1, D7.2	D7.1 KPIs Definition for Pre-intervention Data Collection and D7.2 KPIs Definition for information.
D7.3	D7.3 SmartEnCity Evaluation Protocols compiles the holistic methodology developed for the evaluation of the performance of the interventions carried out in the three LH cities participating in the SmartEnCity project. This methodology consists of seven protocols where each protocol covers the description of the objectives to be evaluated and the methods to be applied. These are represented by a set of KPIs which will be used as tool to quantify the results reached after the execution of the interventions and actions. Specific procedures are described for each city and further advanced in this deliverable regarding data quality.
D7.4	D7.4 City Impact Evaluation Procedure defines the procedure proposed for the estimation of the impacts and performance of the actions at a city level by means of high-level indicators that allow explaining the impact of the integrated actions. Data collection and quality procedures advanced here related to impact measurement described in D7.4.
D7.6, D7.7, D7.8	Monitoring programmes (D7.6, D7.7 and D7.8) aim at the definition of a comprehensive and complete monitoring program in three subthemes: 1) district intervention, 2) vehicle and urban mobility, and 3) integrated infrastructure, that define the necessary requirements for monitoring and metering the actions selected in these three fields.
D7.9	Data collection approach report identifies the procedure to collect the information for evaluating the impacts in each city based in the protocols and KPIs defined in deliverable D7.3

Table 3: Relation to other activities in the project

2 Objectives and expected Impact

2.1 Objective

WP7 aimed to create a methodological framework for the evaluation of the intervention. This covers the selection and customization of evaluation topics (i.e. protocols), setting up a set of key performance indicators (KPIs) at city level, followed by the installation of equipment and setting-up technical systems and finally, gathering the data that will be used as an input for KPIs and performance analysis. This deliverable aims to provide a summary of the monitoring process in every LH city, an overview of data acquisition from sensors, surveys and databases, and to provide an overview of the collected data quality. This covers the outcome of the work done in Task 7.3.

2.2 Expected Impact

The expected impact of this deliverable is the existence of a document that covers all the relevant aspects related to data collection and monitoring process, which can be used for future purposes in similar projects in cities. This deliverable can be used by interested parties who want to learn the data collection approach in the SmartEnCity project. This deliverable goes hand-in-hand with D7.13, which reports KPIs and analyses final performance, whereas the current deliverable describes the methodological aspects of data collection.

3 Overall methodology for data collection and data quality in the lighthouse cities: Internal data collection and evaluation reports

All deliverables in WP7 (led by partner CAR) have progressively led to the formation of comprehensive framework for monitoring and data gathering. D7.3 defined thematic protocols (Energy Assessment, ICT, LCA, Mobility, Social Acceptance, Citizen Engagement, Economic Performance, City Indicators). D7.6, D7.7, D7.8 defined monitoring in three subthemes: 1) district intervention, 2) vehicle and urban mobility, and 3) integrated infrastructure. D7.9 defines KPIs across protocols in every LH city.

In order to keep track with equipment installation and data gathering process, internal reporting was set-up in WP7 Task 7.3. This includes the compilation of data collection and evaluation reports that covered the 6-months and 7-months periods. In the data collection and evaluation reports, an overview of data gathering and equipment installation had to be reported in different thematic protocols (Table 4) in every LH city.

Topic	M9 City diagnosis	M18 Baseline	M30	M36	M42	M48	M54	M60	M67	M74	M78
Energy Assessment	–	Baseline estimation	Data collected between M19–M74								Final performance
ICT	–	Baseline estimation	Data collected between M19–M74								Final performance
LCA	–	Baseline estimation	–								Final performance
Mobility	–	Baseline estimation	Data collected between M19–M74								Final performance
Social Acceptance	–	–	Data collected between M19–M74								Final performance
Citizen Engagement	–	–	Data collected between M19–M74								Final performance
Economic Performance	–	Baseline estimation	Data collected between M19–M74								Final performance
City Indicators	City diagnosis	–	Indicators related to energy assessment and mobility protocols need to be coordinated with data collection under these protocols. Other data collected between M19–M74								Final performance

Table 4: Protocols and time-frame for data collection internal reporting

The input from each LH city was retrieved to generate the data collection and evaluation report, that described the status of IT systems set-up, installed equipment and data collection protocol-wise. A request to responsible person from every LH city was made (ZERO, VIS, TAR) who collected the input from other partners working with certain protocols (e.g. in Tartu Citizen Engagement protocol – IBS, Social Acceptance protocol – UTAR, ICT – ET). All the collected information was finally reviewed and summarized by T7.3 leader UTAR. Finalized reports were sent back to LH cities and uploaded to project website EMDESK.

4 Monitoring programmes upgrade: update on final physical equipment and devices used for data acquisition, and commissioning plans accomplished

4.1 Vitoria-Gasteiz

4.1.1 Monitoring programme review

The heterogeneous nature of activities done in the SmartEnCity project implies that data sources and means of data collection and storage will differ. In some cases, data were provided by systems that included sensors or data acquisition systems that automatically collect data and upload it to a repository. In other cases, it resides in another system's repository and simply needs to be moved or copied. Data collected by other methods such as questionnaires, interviews, direct observations or detailed reports and their results were registered in forms (digitally or on paper).

Monitoring equipment for **Energy Assessment** for retrofitted dwellings are shown in Table 5.

Variable	Definition	Meter	Location
Building heating energy	This variable provides the information about the consumption of the building related to the heating part of the energy.	Heatmeter	Output of the building substation (heating circuit)
Dwelling heating energy	Similar to building, but at dwelling level.	Heatmeter	Output of the building substation (DHW circuit)
Building DHW energy	Similar to the case of heating in the building, but for the DHW distribution circuit.	Heatmeter	Inlet dwelling (heating circuit)
Dwelling DHW energy	Similar to building, at dwelling level.	Heatmeter	Inlet dwelling (DHW circuit)
Electricity	Electricity consumption related to the dwelling, as well as some existing appliances.	Wattmeter	General circuit, appliances plugs
Temperature	For comfort conditions, the temperature inside the dwelling will be measured.	Temperature probe	Main room
Outdoor temperature	If a weather station is installed, the data are gathered via sensors.	Temperature probe	Roof
Outdoor humidity	Similar to temperature, this variable would be in case of installation of weather station physically, otherwise, see table below.	Humidity probe	Roof

Table 5: Monitoring equipment for Energy Assessment for retrofitted dwellings

Other sources of relevant information are outlined in Table 6.

Variable	Definition	Source	Type
Energy demand	This is the simulation result about the energy performance of the dwellings/buildings.	Simulation engine	CSV (or similar) files
Costs/Investments	The economic KPIs required some information, which is collected from bills,	Bills	Files



	investment plans, etc.		
Climate forecast	For the aforementioned forecast services, the source of information is necessary to be collected.	API	XML/JSON
Weather conditions	In case of weather station API, the information of the weather conditions is an external source.	API	Rest

Table 6: Other sources of relevant information

In the case of dwelling monitoring, a number of ICT solutions were assessed to monitor energy and comfort parameters. There were certain constraints that conditioned the final selection of equipment. These constraints were:

- ✦ Different electrical infrastructure was already installed in the houses (smart meters, electrical panels, etc.). While some dwellings already had smart meters others still used old meters that reduce the possibilities for connectivity. The location of those smart meters was also a constraint. There was a high heterogeneity among installations in the dwellings.
- ✦ Legislation restricts the possibility to connect to smart meters to utilities in such a manner that third parties can only collect data through these institutions with previous consent from residents.
- ✦ The objective was to install no invasive meters. That is, install equipment that does not require civil works or manipulation of other equipment such as the main electrical panel.
- ✦ Try to install the same solution (energy-comfort) in all the dwellings/buildings.

Having these constraints in mind, the selection of the equipment was the one represented in Figure 1, where the equipment is the following:

- ✦ **Energy Monitor:** the energy monitor is a display that integrates the electrical energy measurements of several sensors (sensor clamps + mini transmitters). It is a multi-channel device and can monitor up to 10 power sources. The monitor also gathers and collects data registered by the temperature sensor. The monitor is a device which receives real-time energy usage data from the sensors and sends 5 minutes average data (thus power, temperature and humidity will be calculated as the average in the indicated period of time) to a server by connecting with it through a modem or a broadband router. The measuring frequency is established to be every 5 minutes but may be varied.
- ✦ **Optic pulse current sensor:** this sensor is the one used in most of the households as it is non-intrusive. It is installed in front of the smart meter and measures electricity consumption and production by reading the digital electricity meter's optical impulse output on a digital electricity meter. The probe measures values from the electricity meter and gives them to the Transmitter which is connected with the probe by a cable. The Transmitter is attached near the electricity meter, collects the measured values from the probe and wirelessly sends the data to the Homebase every 6 seconds.
- ✦ **Temperature Sensor** is a wireless sensor that measures the temperature of the location where it is placed (living room, bedroom, etc.). The sensor uses wireless technology to connect with the Energy Monitor and send temperature data about the location being measured. The Energy Monitor receives from the temperature sensor the temperature in Celsius degrees (°C) (every 6 seconds). The Energy Monitor calculates the average temperature in Celsius degrees (°C) for the last 5 minutes and sends that information to the remote server expressed as a single measurement.

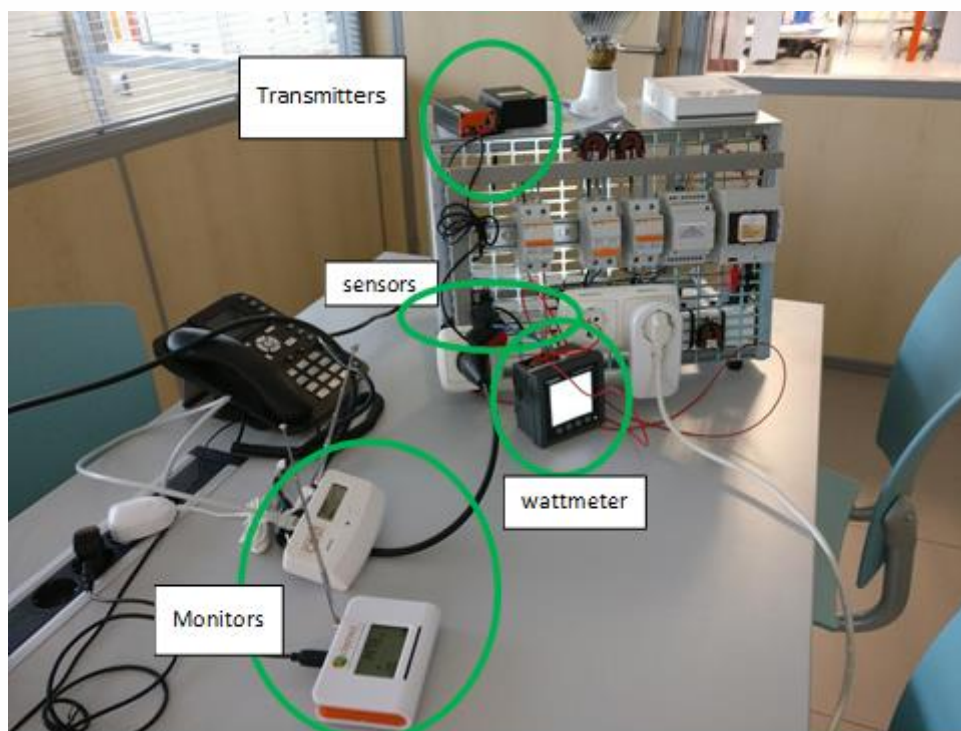


Figure 1: Lab set up for dwelling monitoring equipment in Vitoria Gasteiz



Figure 2: Current sensor in Vitoria Gasteiz

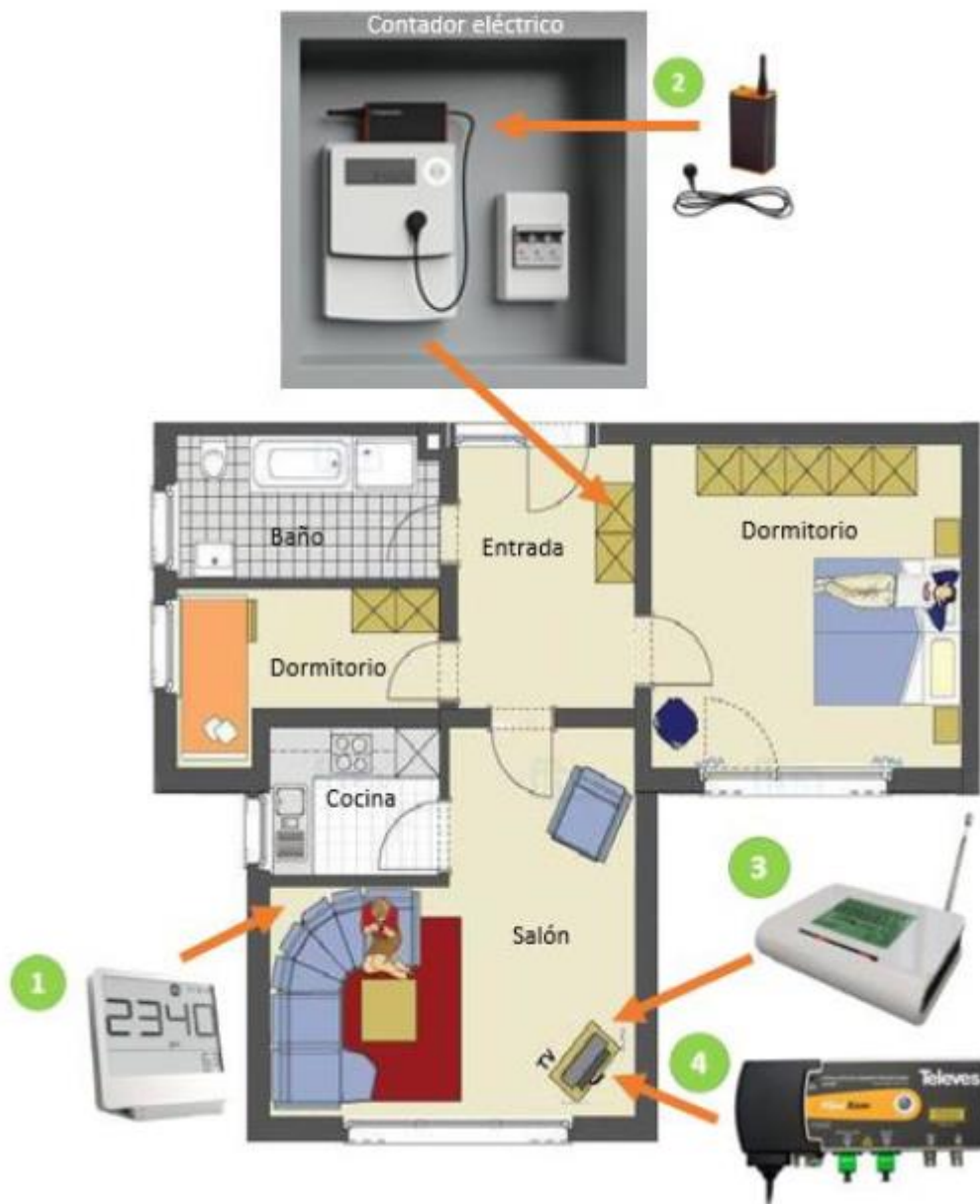


Figure 3: Dwelling monitoring infrastructure diagram

The **Home Energy Management Systems** (HEMS) solution presented in the previous paragraphs by itself is focused on the private area of the house and requires connectivity to reach the monitoring platform. Additionally, the infrastructure can be used to offer applications and ICT solutions to the residents. The **Building Energy Management System** (BEMS) infrastructure for Vitoria included the usage of the CTI (Common Telecommunications Infrastructure) already available at building level to communicate the houses in a central point. That is, the BEMS communication system used the CTI infrastructure that covers from the television distribution system to the television sockets installed in every user's home as seen in Figure 3. This avoided providing independent internet access for each of the dwellings and, consequently, reduced the cost of the interventions. It also provided a centralised point in the building to receive, send and share information, from private homes and public community places, like elevators, community light or heating.

District Heating Network monitoring equipment are explained in Table 7.

Variable	Definition	Meter	Location
Generated DHW energy	Total energy generated by the district heating for DHW feeding to the district.	Heatmeter	DHW main boiler output circuit
Generated heating energy	Similar as above, but for heating purposes.	Heatmeter	DHW main boiler output circuit
Generated DHW energy by support boiler	Total energy generated by the support boiler to cover the DHW demand peaks.	Heatmeter	DHW main boiler output circuit
Generated heating energy by support boiler	Similar as above, but for heating purposes.	Heatmeter	DHW main boiler output circuit
Consumed fuel	Total boilers fuel consumption, in terms of biomass (or gas if applicable), which is helpful to determine the performance of the boiler.	Volume Meter/Counter	Boiler input
Electricity	Boiler and distribution elements electricity consumption for heating energy generation	Wattmeter	Boiler room main cabinet

Table 7: District Heating Network monitoring equipment

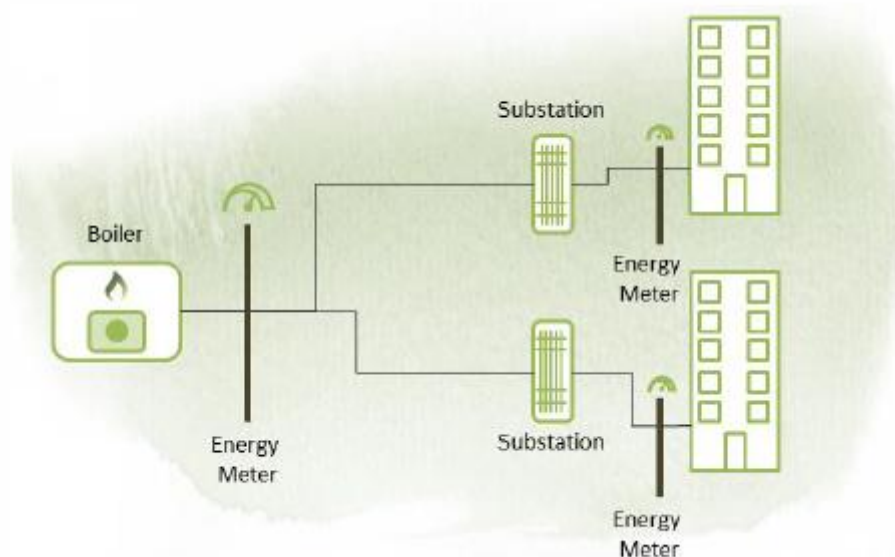
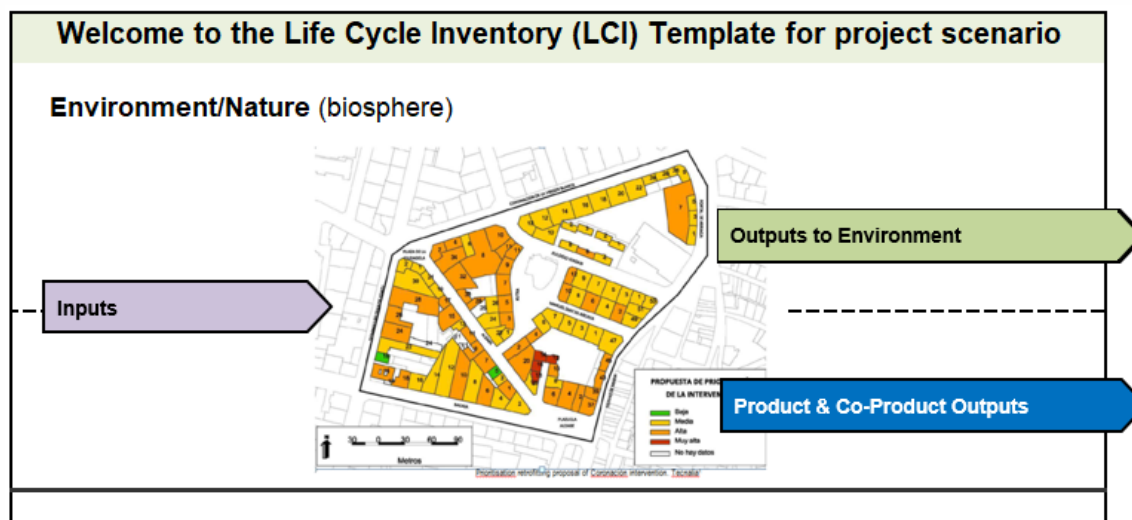


Figure 4: District heating monitoring diagram

Data collecting process for **Life Cycle Analysis** was carried out through an iterative process among partners requesting several information. The object of assessment in this case is the retrofitting and biomass district heating system implemented in the Vitoria-Gasteiz demo site to reveal the environmental impacts from different life cycle stages to compare them with the baseline, that is, the normal behaviour of the district functioning before SmartEnCity project. Data gathering was done through an Excel questionnaire, and additional data were gathered from official documents like the technical sheets of the materials.



OBJECT OF ASSESSMENT	Retrofitting and biomass district heating system implemented in the Vitoria-Gasteiz demo site to reveal the environmental impacts from different life cycle stages
PROCESS SCOPE:	From Cradle to Grave
FUNCTIONAL UNIT (F.U)	1 m ² of conditioned area, considered for a time period of 1 year
REFERENCE STUDY PERIOD	50 years
CUT-OFF AND ALLOCATION RULES	Life Cycle Inventory data for a minimum of 99 % of total inflows to the core module have been included. Input shall be declared at a minimum of 98% and a cut-off rule of 1% regarding energy, mass and environmental relevance has been applied.

Functional Unit = 1 m² of conditioned area, considered for a time period of 1 year

Building retrofitting interventions: Envelope's insulation

* Envelop façade insulation

Envelop insulation total surface (façade) = 16.603,07 m²

Please, explain how the new thermal insulation systems installed are, data such as commercial name, thickness, surface, supplier etc are more than welcome.
If you have a data sheet, with technical details, please, indicate it

ETICS: External Thermal Insulation System
14 cm. Several commercial systems like:
EPS HD RHONATHERM 30 kg/m³
StoTHERM Classic 3PS 32

Density = 30 kg/m³
Thickness = 14 mm

Figure 5: Data gathering for LCA

With regard to **mobility**, Smart Electric Bus (BEI), eVehicles used by partners in the demo area and eBikes are main actions in Vitoria-Gasteiz. In terms of monitoring, two levels of data are identified for Smart Electric Bus: monitoring equipment, which refers to hardware equipment, and other sources that provide information.

Variable	Definition	Meter	Location
Speed, acceleration, braking, engine revolutions, electricity consumption, state of charge of the battery	These variables are the basic ones that provide a proper assessment of driving performance. They are usually available through the vehicles CAN bus	Assistance system for efficient driving	Inside the bus
Charging time, kW recharged in each charging process	These are the basic variables required to monitor the charging process	SCADA system	
CO, NOx emissions	CO and NOx emissions sensors will provide a fair assessment of the actual pollution in the area.	CO, NOx sensors	Integrated in the assistance system for efficient driving
Number of passengers	This variable measures the occupancy rates. The installed system will allow more than 95% reliability	Passenger counter system	Inside the bus
Abrupt turn while driving	Unexpected and abrupt turning of the vehicle	Accelerometer	Integrated in the assistance system for efficient driving

Table 8: Mobility monitoring

For the electric buses there will be two main monitoring systems:

- ✦ Assistance system for efficient driving: to monitor the buses driving performance
- ✦ SCADA system: to monitor the charging process of the buses

The assistance system for efficient driving is connected to the CAN bus and is able to store, process and send all the relevant variables which are related to the driving process every 10 seconds. These data are downloaded at the central control system, in real time, to allow their analysis and the definition of real time guidelines that can lead to a more efficient driving process in terms of electricity consumption.

The assistance system for efficient driving is able to generate real time alarms, and on-line monitoring of the vehicles is possible from the central control system. Drivers are informed about potential driving-related incidents, and adequate recommendations are provided. The ultimate goal is to achieve environmental benefits, reduce maintenance service and increase the comfort of passengers thanks to an improved driving experience.

The central control system has specific software to analyse the registered data. Different indicators are calculated to assess the efficiency of the driving process (electricity consumption of different buses lines, drivers, vehicles, etc.) Moreover, this central control system is integrated with the Tracking and Monitoring System and thus it is possible to relate relevant parameters (e.g. routes, demands, types of services, etc.) to the actual costs.

The SCADA system is able to control the whole charging infrastructure. Different screens show the different charging stations with the related monitored information and generated alarms.

Other sources of information for mobility monitoring are indicated in Table 9.



Variable	Definition	Meter	Location
Outdoor temperature	This variable is useful to assess the performance of electric batteries under different outdoor temperatures.	Weather station	Fixed locations in the city

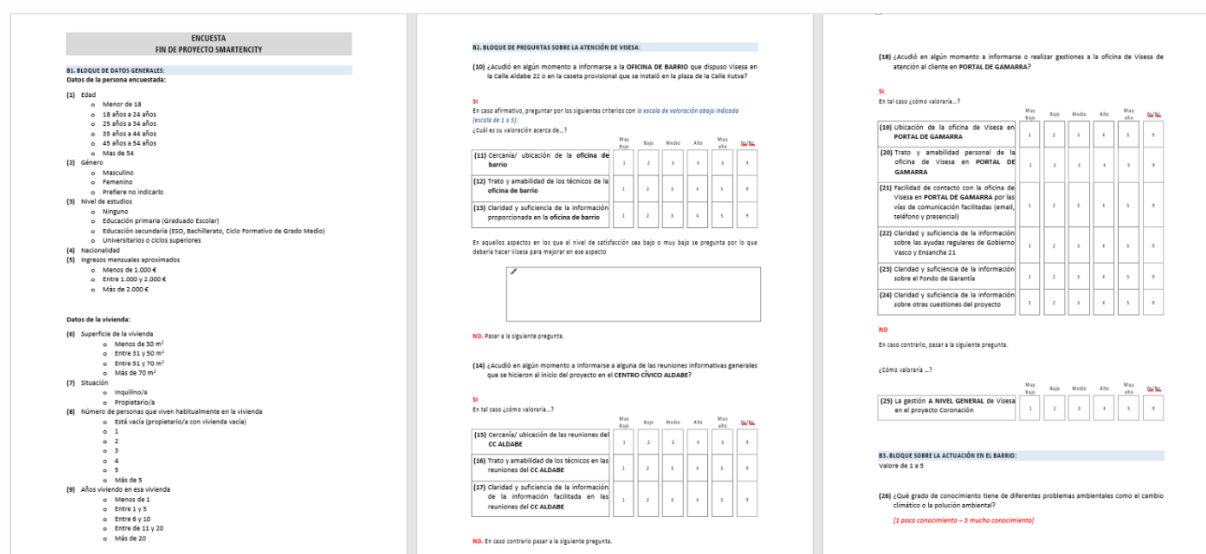
Table 9: Mobility monitoring data sources

eBike hub at the Municipality offices for employees is under routine operation since 2020. Monitored data include number of users and travelled kilometres by each of the bicycles. The kilometres are obtained manually from the bike's own display. In the case of eVehicles to be used by partners in demo area replacing those with combustion engines, only mileage data is available in those cases where smart chargers aren't available.

Social acceptance data were retrieved through a phone survey among the beneficiaries of the project. The questionnaire was prepared by an iterative process with involved partners during last reporting period. The questionnaire includes a series of 40 questions related with social acceptance, citizen engagement and general satisfaction.

Citizen Engagement protocol was treated jointly with social acceptance aspects, among others, in a comprehensive dedicated survey. This means data were as well retrieved through a phone survey among the beneficiaries. Regarding this, personal data protection needed to be a must of the actuation and to do so, Visesa checked all the privacy agreements previously signed with the participants to be sure that all the required protection was covered by them. In addition to that, Visesa prepared and signed a new agreement with the consultancy firm that carried out the survey so they were able to manage correctly all personal and contact data that they needed to accomplish their task. By means of this, the privacy of the participants was completely ensured in the whole chain of this task: Beneficiaries – Visesa, Consultancy Firm – Beneficiaries and Visesa – Consultancy firm.

Apart from that, surveys always remained anonymous and only aggregated and treated data were used to extract conclusions.



ENCUESTA FIN DE PROYECTO SMARTCITY

BLOQUE DE DATOS GENERALES:
Datos de la persona encuestada:

(1) Edad

- Menor de 18
- 18 años a 24 años
- 25 años a 34 años
- 35 años a 44 años
- 45 años a 54 años
- 55 años y más

(2) Género:

- Masculino
- Femenino
- Preferencia no indicar

(3) Nivel de estudios

- Ninguno
- Educación primaria (Graduado Escolar)
- Educación secundaria (ESO, Bachillerato, Ciclo Formativo de Grado Medio)
- Universitarios o Ciclos superiores

(4) Nacionalidad

(5) Ingreso mensual aproximado

- Menos de 1.000 €
- Entre 1.000 y 2.000 €
- Más de 2.000 €

Datos de la vivienda:

(6) Superficie de la vivienda

- Menos de 30 m²
- Entre 31 y 50 m²
- Entre 51 y 70 m²
- Más de 70 m²

(7) Situación

- Propietario/a
- Inquilino/a

(8) Número de personas que viven habitualmente en la vivienda

- Está vacía (propietario/a con vivienda vacía)
- 1
- 2
- 3
- 4
- 5

(9) Año viviendo en esa vivienda

- Menos de 1
- Entre 1 y 5
- Entre 6 y 10
- Entre 11 y 20
- Más de 20

BLOQUE DE PREGUNTAS SOBRE LA ATENCIÓN DE VISEA:

(10) ¿Alcudió en algún momento a informarse a la OFICINA DE BARRIO que dispuso Visea en la Calle Aldabe 20 o en la caseta provisional que se instaló en la plaza de la Calle Aldabe?

SI

En caso afirmativo, preguntar por los siguientes criterios con la escala de valoración abajo indicada (entre 1 a 5):
(¿Cuál es su valoración acerca de...?)

	Muy Bajo	Bajo	Medio	Alto	Muy Alto	%
(11) Cercanía/ ubicación de la oficina de barrio	1	2	3	4	5	
(12) Trato y amabilidad de los técnicos de la oficina de barrio	1	2	3	4	5	
(13) Claridad y suficiencia de la información proporcionada en la oficina de barrio	1	2	3	4	5	

En aquellos aspectos en los que el nivel de satisfacción sea bajo o muy bajo se pregunta por lo que debería hacer Visea para mejorar en ese aspecto.

NO. Pasar a la siguiente pregunta.

(14) ¿Alcudió en algún momento a informarse a alguna de las reuniones informativas generales que se hicieron al inicio del proyecto en el CENTRO CÍVICO ALDABE?

SI

En tal caso ¿cómo valoraría...?

	Muy Bajo	Bajo	Medio	Alto	Muy Alto	%
(15) Cercanía/ ubicación de las reuniones del CC ALDABE	1	2	3	4	5	
(16) Trato y amabilidad de los técnicos en las reuniones del CC ALDABE	1	2	3	4	5	
(17) Claridad y suficiencia de la información de la información facilitada en las reuniones del CC ALDABE	1	2	3	4	5	

NO. En caso contrario pasar a la siguiente pregunta.

(18) ¿Alcudió en algún momento a informarse o realizar gestiones a la oficina de Visea de atención al cliente en PORTAL DE GAMARRA?

SI

En tal caso ¿cómo valoraría...?

	Muy Bajo	Bajo	Medio	Alto	Muy Alto	%
(19) Ubicación de la oficina de Visea en PORTAL DE GAMARRA	1	2	3	4	5	
(20) Trato y amabilidad personal de la oficina de Visea en PORTAL DE GAMARRA	1	2	3	4	5	
(21) Facilidad de contacto con la oficina de Visea en PORTAL DE GAMARRA por las vías de comunicación facilitadas (email, teléfono y presencial)	1	2	3	4	5	
(22) Claridad y suficiencia de la información sobre las ayudas regulares de Gobierno Vasco y Euzkadi 21	1	2	3	4	5	
(23) Claridad y suficiencia de la información sobre el Fondo de Garantía	1	2	3	4	5	
(24) Claridad y suficiencia de la información sobre otras cuestiones del proyecto	1	2	3	4	5	

NO

En caso contrario, pasar a la siguiente pregunta.

¿cómo valoraría...?

	Muy Bajo	Bajo	Medio	Alto	Muy Alto	%
(25) La gestión a NIVEL GENERAL de Visea en el proyecto Coromación	1	2	3	4	5	

BLOQUE SOBRE LA ACTUACIÓN EN EL BARRIO:
valor de 1 a 5

(26) ¿Cuál grado de conocimiento tiene de diferentes problemas ambientales como el cambio climático o la contaminación?

(2) poco conocimiento - 5 mucho conocimiento

Figure 6: Example of survey

CONTRATO DE TRATAMIENTO DE DATOS PERSONALES

POR ENCARGADO DEL TRATAMIENTO

En Vitoria, a 28 de febrero de 2022.

REUNIDOS

De una parte, D. Carlos [REDACTED] mayor de edad, con DNI nº [REDACTED] interviene en nombre y representación de VIVIENDA Y SUELO DE EUSKADI, S.A., con domicilio en Vitoria (Álava), Portal de Gamarra 1A-2ª Planta, y NIF nº A20306775, quien manifiesta su capacidad y poder suficiente para la celebración del presente contrato y para actuar en nombre y representación de la referida sociedad, en adelante el **Responsable del tratamiento**.

Y, de otra parte, Dª. Maite [REDACTED] mayor de edad, con DNI nº [REDACTED] actuando en nombre y representación de ATARI CONSULTORA SOSTENIBLE, S.L., con NIF nº B01582709 y domicilio en Vitoria (Álava), calle San Prudencio, nº 27-5º Oficina 8, quien manifiesta su capacidad y poder suficiente para la celebración del presente contrato y para actuar en nombre y representación de la referida sociedad, en adelante el **Encargado del tratamiento**.



Ambas partes, en la representación que actúan y reconociéndose mutuamente la capacidad necesaria para el otorgamiento del presente **CONTRATO** puestos previamente de acuerdo

EXPONEN

1.- Que VIVIENDA Y SUELO DE EUSKADI, S.A. es responsable de diferentes tratamientos de datos personales que están sometidos al Reglamento (UE) 2016/679 del Parlamento Europeo y del Consejo de 27 de abril de 2016 relativo a la protección de las personas físicas en lo que respecta al tratamiento de datos personales y a la libre circulación de estos datos y por el que se deroga la Directiva 95/46/CE y a la Ley Orgánica 3/2018, de 5 de diciembre, de Protección de Datos Personales y garantía de los derechos digitales.

2.- Que ATARI CONSULTORA SOSTENIBLE, S.L. es una mercantil que desarrolla su actividad profesional, entre otras, en divulgar e implementar medidas para el ahorro energético y la sostenibilidad medioambiental, asesoramiento y desarrollo sostenible, prestación de servicios relacionados con el desarrollo, gestión y promoción de actuaciones para el fomento de ahorro y eficiencia energética.

Figure 7: GDPR agreement signed with consultancy in charge of the survey

AUTORIZACION PARA EL TRATAMIENTO DE DATOS DE CARÁCTER PERSONAL

Mediante la firma del presente documento, D./Dña. _____ con Documento de identidad Nº _____, mayor de edad, y residente en _____, en adelante, el "Interesado", concede su consentimiento, libre, específica, informada e inequívocamente para el tratamiento de datos de carácter personal, en los términos que se señalan a continuación:

Responsable: el Responsable del tratamiento (en adelante, El "Responsable") de los datos personales que se recaban es VIVIENDA Y SUELO DE EUSKADI, S.A. (en adelante, "VISESA") con y NIF A20306775 y domicilio en Portal de Gamarra, nº 1ª-2ª Planta, C.P. 01013 Vitoria (Álava).

VISESA ha designado una Delegada de Protección de Datos, con quien puede contactar en la dirección indicada o, por correo electrónico, en la dirección dpo@visea.eus.

Finalidad: los datos que se pudieran recabar serán obtenidos con la finalidad de realizar labores de **investigación y desarrollo** en el marco del proyecto SmartEnCity (Barrio de Coronación) financiado por la Comisión Europea dentro del Programa H2020 (en adelante el "Proyecto"), con el objeto de ajustar y optimizar las condiciones de **confort en la vivienda**, y reducir las emisiones de CO₂ y la factura energética en lo posible

Legitimación del tratamiento: la base jurídica que legitima el tratamiento de los datos personales del interesado es el **consentimiento** que ha prestado a través de este documento, pudiéndolo retirar en cualquier momento sin que exista ninguna consecuencia negativa en caso de hacerlo.

El interesado **autoriza a VISESA** la delegación de las operaciones de recogida, tratamiento y análisis de los datos obtenidos para las operaciones descritas anteriormente a los socios del Proyecto ("Encargados" del tratamiento) amparándose en las cláusulas de confidencialidad existentes en el marco de dicho Proyecto.

Categoría de datos: Los datos personales recabados son datos identificativos, electrónicos y de consumo:

- Nombre y apellidos
- Dirección
- Consumo energético
- Confort (temperatura, humedad relativa, niveles de CO₂).

Plazo de conservación: los datos personales relacionados en el párrafo anterior serán conservados por un plazo de **1 año tras la finalización del Proyecto** o del periodo de **prestación de servicios** sobre en los datos acordados con el Interesado.

Sin perjuicio del plazo anteriormente citado, el Responsable podrán mantener los datos debidamente bloqueados por el período máximo que exija la **normativa aplicable**.

Destinatarios: ese informa al Interesado de que el Responsable **no cederá sus datos** personales a terceros ajenos a las actividades del Proyecto, ni se realizarán transferencias internacionales de datos a terceros fuera de la Unión Europea.

Derechos: el Interesado tiene derecho a solicitar al Responsable el acceso a los datos personales, su rectificación o supresión, o la limitación de su tratamiento, o a oponerse al mismo, así como el derecho a la portabilidad de los datos, dirigiéndose a tal efecto una solicitud a la dirección postal o electrónica anteriormente indicada, adjuntando copia del DNI o pasaporte y el derecho que desea ejercitar.

En n todo caso, el Interesado tiene derecho a presentar una reclamación ante la Agencia Española de Protección de Datos.

Medidas de seguridad: el Responsable adoptan las **medidas técnicas y organizativas** necesarias para evitar la pérdida, mal uso, alteración, acceso no autorizado y robo de los datos personales facilitados, habida cuenta del estado de la tecnología, los costes de aplicación, la naturaleza, el alcance, el contexto y el fin del tratamiento, así como los riesgos de probabilidad y gravedad variables para sus derechos y libertades.

En todo caso, las medidas de seguridad aplicadas por el Responsable garantizan e incluyen, como mínimo:

- La seudonimización (evitar la identificación de la persona) y el cifrado de los datos;
- la capacidad de garantizar la confidencialidad, integridad, disponibilidad y resiliencia permanentes de los sistemas y servicios de tratamiento;
- la capacidad de restaurar la disponibilidad y el acceso a los datos personales de forma rápida en caso de incidente físico o técnico;
- un proceso de verificación, evaluación y valoración regulares de la eficacia de las medidas técnicas y organizativas para garantizar la seguridad del tratamiento.

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FECHA Y FIRMA

Figure 8: GPRD agreement signed between SmartEnCity partners and beneficiaries.



For evaluating **Economic Performance**, data collecting process was carried out during last reporting period by partners in and will continue until the end of the project. The collecting method is an iterative process among partners requesting several information regarding economic data. Data gathering was done through an Excel questionnaire, and additional data were gathered from specific interviews with partners and data from the energy calculations shared from the Energy assessment protocol.

KPI #	KPI	Units	How to	Who	Frequency	Dashboard
EC1	RC - Resident costs	€	Excel sheet	ACC	Single value	Single value
EC2	GR - Grant rate	€	Excel sheet	ACC	Single value	Single value
EC3	TAC - Total annual costs	€	Excel sheet	ACC	Single value	Single value
EC4	BF - Total annual benefits for residents	€	Excel sheet	ACC	Single value	Single value
EC5	CRR - Cost saving rate	€	Excel sheet	ACC	Single value	Single value
EC6	NPV - Net present value for resident	%	Excel sheet	ACC	Single value	Single value
EC7	ROI - Return of Investment for resident	€	Excel sheet	ACC	Single value	Single value
EC8	PB - Payback for resident	year	Excel sheet	ACC	Single value	Single value
EC9	Mobility TAC - Total annual costs	€	Excel sheet	ACC	Single value	Single value
EC10	Mobility DCa - Annual Costs Difference	€	Excel sheet	ACC	Single value	Single value
EC11	Mobility BUS - Benefits by uptake saving	dimensionless	Excel sheet	ACC	Single value	Single value
EC12	Mobility B - Benefits	€	Excel sheet	ACC	Single value	Single value
EC13	Mobility NPV - Net present value overall	€	Excel sheet	ACC	Single value	Single value

Figure 9: Data gathering for Economic Performance

Many of the **City Indicators** are coincident with KPIs already included on the assessment protocols. For these cases the data are already available or being processed. For the rest of cases, the data will be collected along project's last reporting period (M75 – M78).

4.1.2 Monitoring equipment commissioning

The key objective during commissioning phase is to ensure all components of the critical infrastructure, as well as the system as a whole, operates as intended and in accordance with the requirements established in the design phase. Here, the medium/long-term tests have to be completed according to the test plan established during the design stage.

Additionally, several days of continuous data gathering are run with the aim of checking data (i.e. correctly received within the envisaged features (range, frequency, etc.)) and also the communication is stable and available along time.

Besides, fine-tuning is implemented in this phase. This process takes into account the performance of all the system working together, therefore, some modifications/adjustments of the parameters could be necessary in contrast to the initial setup. Thus, the optimal performance is determined.

Last but not least, lessons learnt are extracted and documented in order to support maintenance and further installations. Moreover, the data sheets, installation schemas, etc. are also documented in this stage with the objective of keeping record of the installation in order to facilitate the maintenance.

Energy assessment data collection was severely influenced by COVID-19 emergency situation as Spain remained during a long period of time as one of the countries from the EU with more severe restrictions.

Comfort data sensors deployment in the dwellings had to be stopped due to the impossibility of interacting with tenants during the emergency situation and until beginning of 2021. From that date, installation process was resumed but progressed slowly due to social distancing

requirements and lack of specialized staff to carry out the installation task due to labour force adjustment plans in some of the participating partners forced by the economic difficulties derived from the pandemic.

Sensor installation was carried out in several phases. In September 2021, the third and final round of installations was launched. With this final effort we aimed to install the sensors in the remaining 40 dwellings that, due to several circumstances, couldn't be completed in the previous two rounds. After this actuation, all retrofitted buildings have most of the dwellings monitored.

Invoice gathering with energy consumption data. This task was finalised in September 2021. The District Heating service start make this task unnecessary because energy consumption is now gathered directly from dwellings through a new optic fibre network deployed in parallel with district heating infrastructure. Consumption data are saved in a database for analysis and KPI calculation.

VIS, in coordination with MON and CAR, compiled invoices from electricity and gas consumption. One example of this data is depicted on Figure 10. Moreover, aggregated data from Nortegas (piped gas supplier) were obtained for January 2016 to May 2021 which were disaggregated by year. Figure 11 shows the aggregated consumption for the first 4 years. On a second step, based on monthly HDD (Heating Degree Days), the year consumption was monthly determined (considering also the heating season) in order to establish the process to inject data into the CIOP.

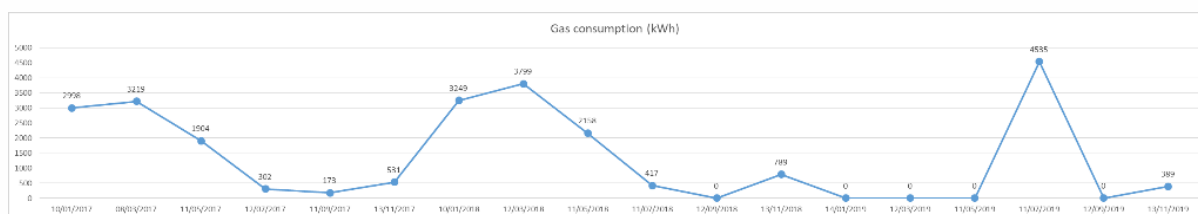


Figure 10: Gas consumption of one dwelling. Source: MON

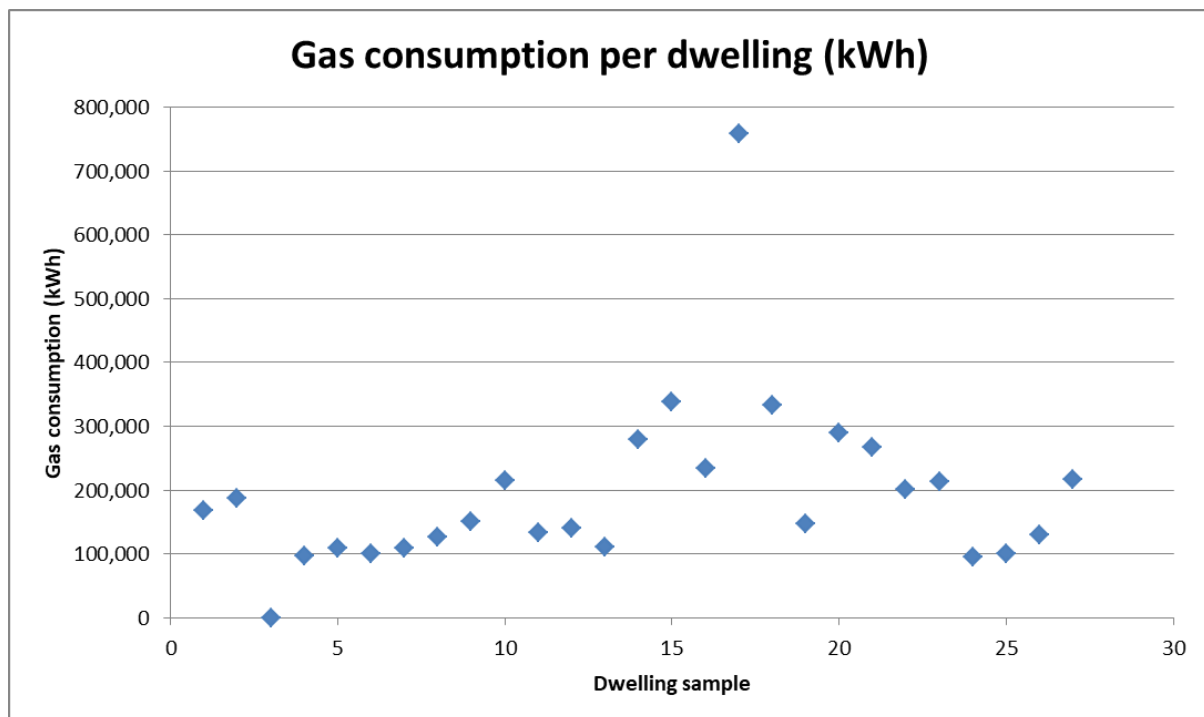


Figure 11: Thermal consumption from the distribution network. Source: MON

The team in charge of implementing and deploying the services for the **CIOP** met the commitments on time. The services are set in place and running. The CIOP was given an access landing page common to all services. This landing page also shows a number of high level KPIs. This page (<http://vitoria-gasteiz.smartencity.eu>) is the common entrance gate for the services implemented and their supporting apps. It also manages the type of audience to which each of the services is oriented (public, residents, service providers) and also allows filtering the area of interest (energy consumption, comfort, citizen support, mobility). Each of the services has a login service enabled so that, unless public access, authentication is needed to enter the service and data.

At a dwelling level, tenants may access their respective home data and comfort analysis in a confidential way with a user/password access. A communication campaign was carried out to provide the tenants with the access credentials and show them how to access their data and the features the comfort app gives them. This service is already implemented and acquiring data.

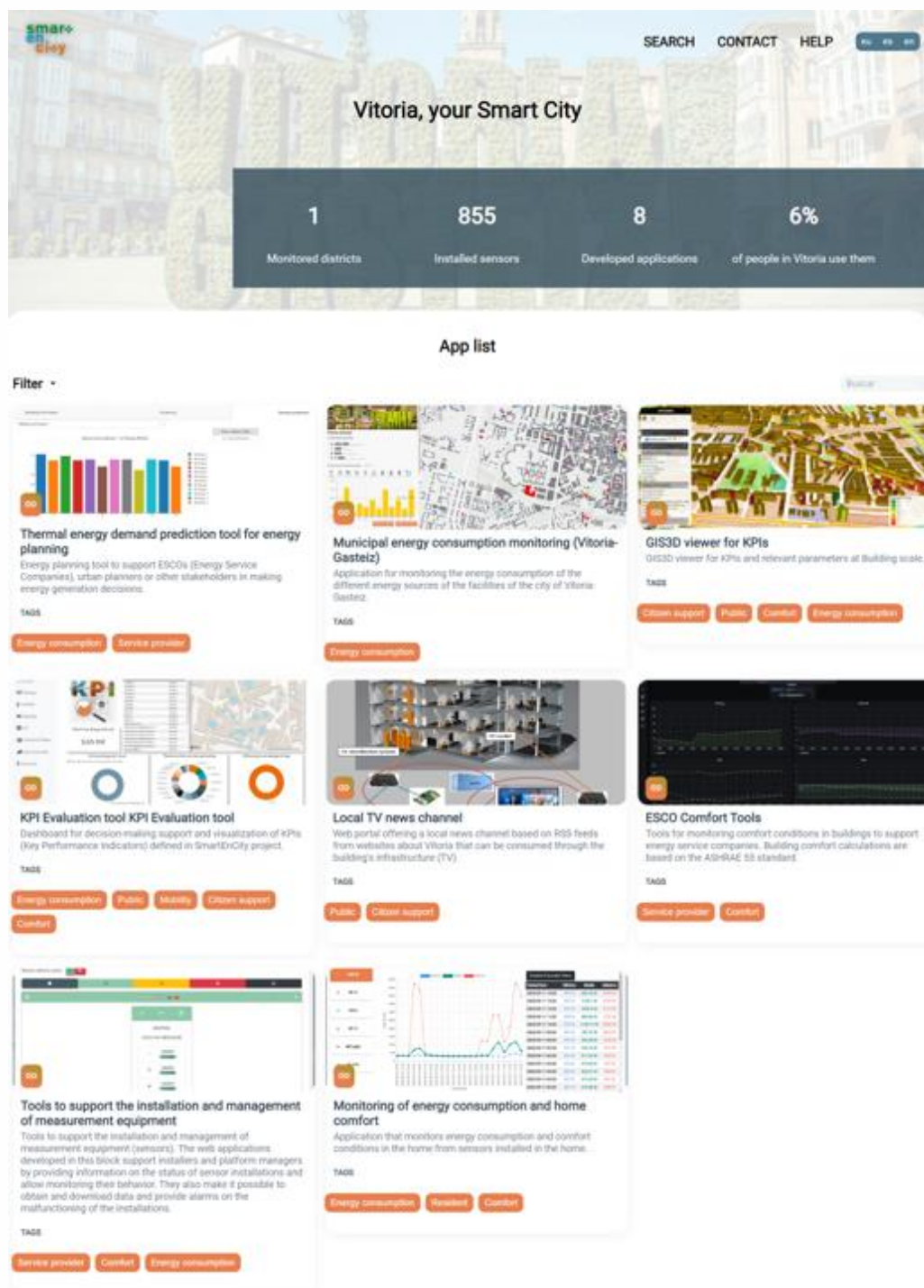


Figure 12: Vitoria-Gasteiz CIOP landing page

4.2 Tartu

4.2.1 Monitoring programme review

In terms of monitoring, two main sources of data gathering are used: monitoring equipment and other sources (API-s, questionnaires, surveys etc.) that provide information.

The Smart City platform (CIOP), created by the project partner TELIA and based on the Cumulocity software, is used to monitor Tartu's activities in the project. Cumulocity was the one to outperform other similar platforms (WP6) and was implemented as the first part of the City Information Platform (CIOP).

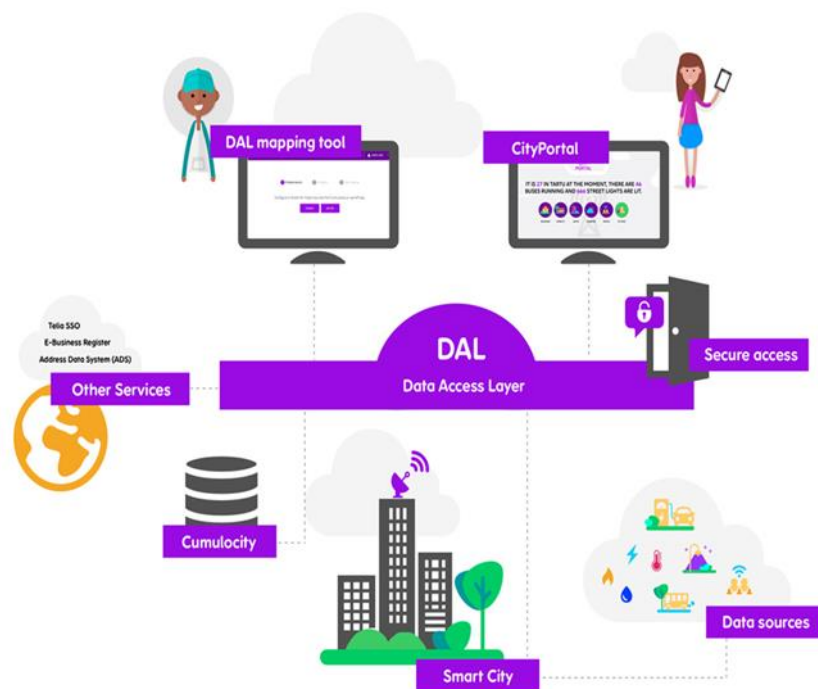


Figure 13: Tartu CIOP modules

On top of Cumulocity and other data inputs, one of the most important parts of the CIOP is Data Access Layer (DAL). This is a secure gatekeeper module between data producers and consumers. All authentications are controlled by DAL, also sharing, delegation information and consent management is handled in this module. These are the components to secure the data and ensure the GDPR compliance.

City Portal includes two strictly separate parts - Open Data portal and My Data portal. Under the Open part of the portal, everyone can see, free of charge, the data that has been published by the city or third parties.

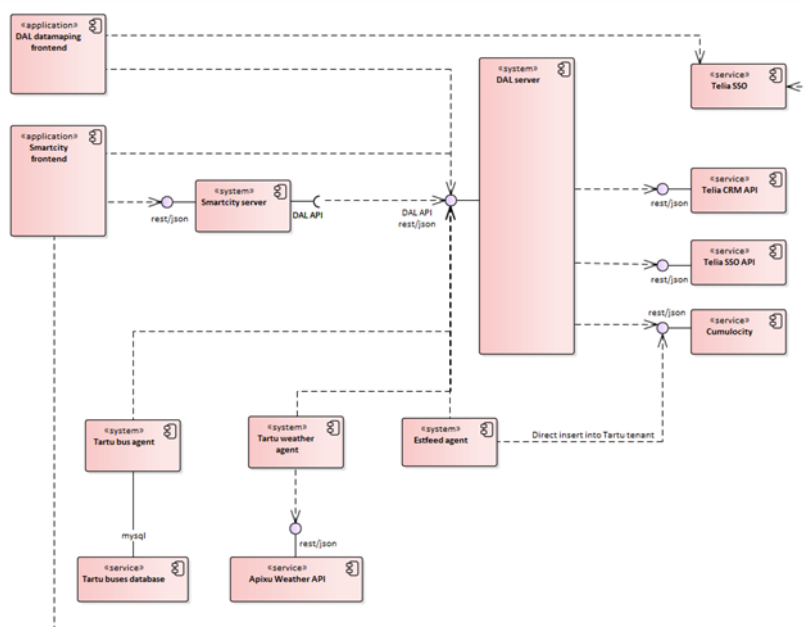


Figure 14: CIOP technical architecture

To calculate the KPIs, some variables needed to be measured with specific monitoring equipment, and this has been taken into consideration in the monitoring program. These variables characterize the performance of retrofitted buildings, EV-chargers, EV battery re-use, bike-sharing, biogas buses, public lighting and district heating and cooling systems.

For **bike share system**, variables of “Annual number of users” and “Annual distance driven” characterize the performance of bike-share system. GPS data logger is installed inside the bicycles.

For **biogas buses**, variable of “The accuracy of timekeeping for public buses” characterizes the performance of public transport. GPS data logger is installed inside the bus.

For **EV battery re-use**, variables of “Renewable energy coming from PV that is stored in the batteries”, “Energy used for recharging purposes” characterize the performance of EV-battery re-use system. Data loggers (electricity meters) are installed in electricity cabinets.

For **EV-chargers** variables of “Annual number of users” and “Amount of kW recharged” characterize the performance of EV-chargers. Data logger is installed inside the equipment.

Variables describing the **performance of the CIOP** such as “Used storage space for gathered data”, “The number of communication messages” and “Connected data sources (sensors etc.)” are calculated based on data, which is gathered from the system.

Data related to **District heating and cooling** is connected with CIOP. Fortum Tartu (new business name “Gren”) has its remote metering system for central heating that sends daily heat consumption to their information system. Fortum pushes then heating data directly to CIOP. New cooling station stores all the data to separate Fortum system that is not accessible for 3rd parties due to security reasons. Monthly based data is reported by Fortum to city manually and then added into CIOP. Variables such as “PV-plant production”, “Energy used for production of heating and cooling” characterize the performance of district heating and cooling system. Data loggers (electricity meters) are installed in electrical cabinets.

During the SmartEnCity project, 321 **smart lights** with controllers and more than 60 different sensors (movement, environment, video, noise) were installed in Tartu by Cityntel. Before the project started, Cityntel had installed another 1000 smart lights. After integration, all 1300 lights and sensors are reporting data to CIOP. Besides Cityntel smart lights, there is another smart lighting company, Gridens Technologies that has installed ~1200 smart lights – as the API integration had been unified before the SmartEnCity project. Now all ~2500 Tartu smart lights are connected into CIOP. Data loggers are installed inside the sensors.

The **smart home solution** for Tartu pilot area apartment buildings ‘smartovkas’ was produced and installed by the company EnLife Ltd. Both wired and wireless solutions are installed depending on house association preference. Every house got a central server device which works independently but is connected to the internet to share data with CIOP. The role of the central device is:

- ✦ to gather and store data from sensors and meters
- ✦ to communicate with controllers and repeaters
- ✦ to deliver commands to heat and ventilation system
- ✦ to serve a web and app interface for home users
- ✦ to exchange data with CIOP

In addition to the central server, the signal amplifiers, controllers, radio access points, impulse counters, thermostats, temperature and smoke sensors, tablet computers (control panels) were installed. Energy use (electricity, heating, gas, water) and electricity production of PV-panels characterize the performance of building retrofitting activities.

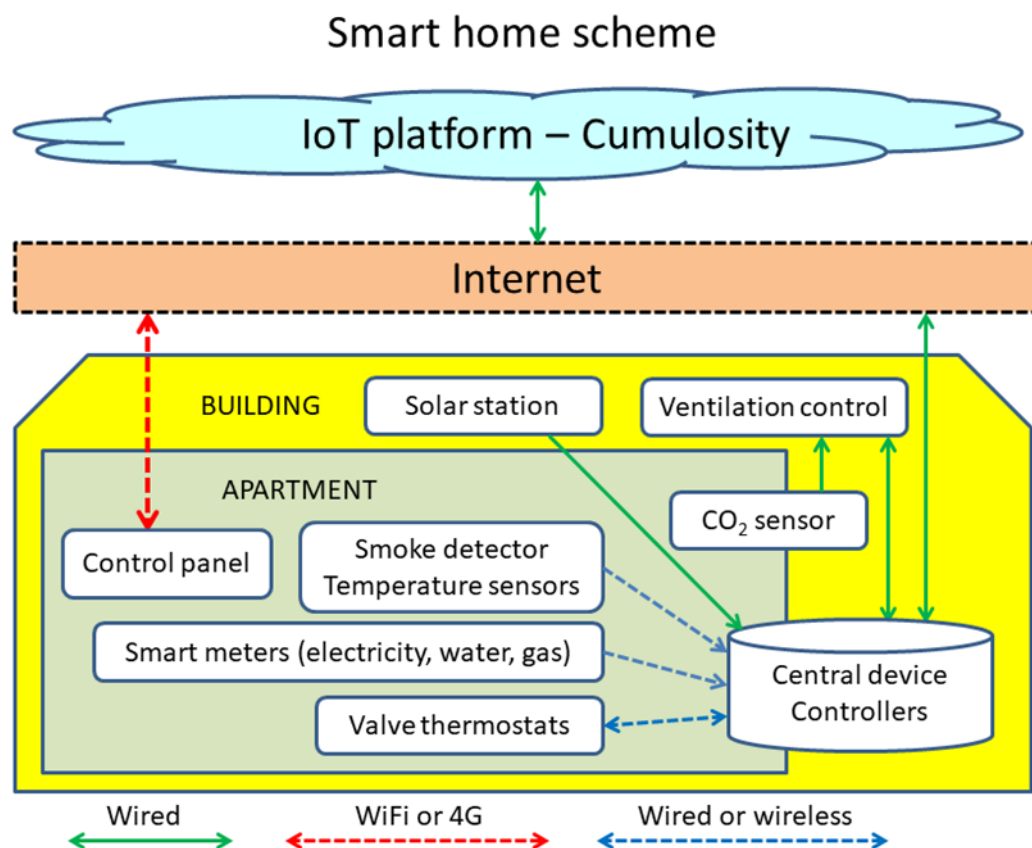


Figure 15: Smart home solution scheme

The smart home solution covers the following functionalities:

- ✦ Heat control – apartment owner can see and regulate the room temperature from the control panel and/or directly on radiator thermostats
- ✦ Ventilation control – apartment ventilation is controlled automatically based on apartment CO₂ level, the owner can maximize or minimize the ventilation for a shorter period and see current CO₂ concentration
- ✦ Remote metering – apartment's electricity, gas, and water meters are equipped with digital consumption readers; the consumption is displayed on the control panel and automatically delivered to the service provider
- ✦ Solar production – every 'smartovka' has installed solar panels for its' own small power station. The building will consume most of its' produced electricity, in case of extent production, the rest of the electricity is sold to the grid. The production information of the station is displayed on the home control panel.
- ✦ Smoke detection – every apartment gets a connected smoke detector and alarms will be delivered also to the mobile app and to other inhabitants
- ✦ Other data – current date, time and outside temperature are also displayed on the control panel
- ✦ Data interchange – energy consumption data is replicated to CIOP for pilot area monitoring

4.2.2 Monitoring equipment commissioning

For calculating the KPIs specific monitoring equipment is used. According to monitoring programme in general different energy and flowmeters are used for data gathering of variables. For mobility interventions GPS equipment is also used. The figure below illustrates the general monitoring schema in Tartu and how the monitoring system is connected to the CIOP.

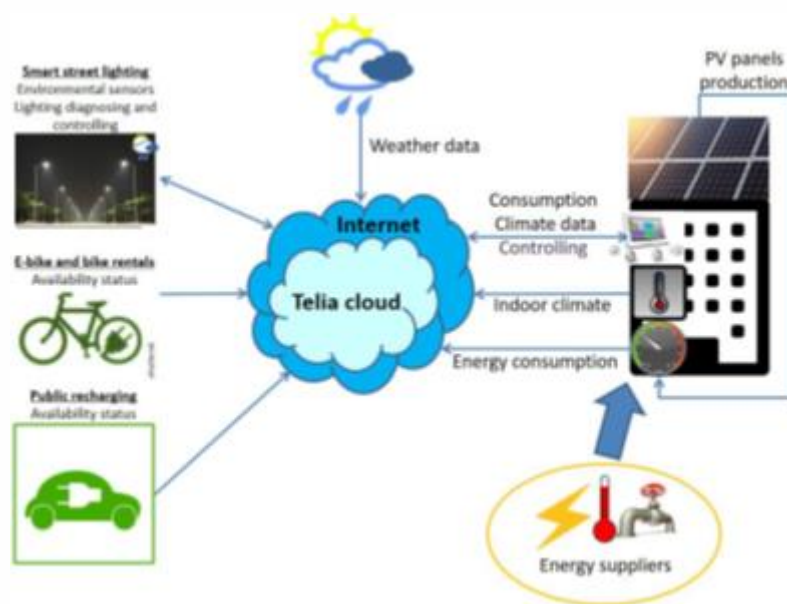


Figure 16: Monitoring system in Tartu

Building retrofitting interventions require various monitoring equipment in order to perform control actions at building and dwelling level. As the reconstruction projects of the buildings were prepared by different companies, the monitoring equipment in the renovated buildings

is often from different manufacturers. The smart home solution was procured centrally and is the same in all buildings and apartments, manufactured by EnLife OU.

The list of equipment for monitoring energy use and energy production in retrofitted buildings is as follows: gas meters, heat meters, electricity meters, flowmeters for hot and cold water, temperature thermostats, CO₂ sensors. Below are the illustrations for the equipment.



Figure 17: Smart Home System apartment unit



Figure 18: CO₂ sensor



Figure 19: Electricity meter – apartment unit



Figure 20: Electricity meter – building unit



Figure 21: Gas meter



Figure 22: Water meter



Figure 23: Heating energy meter



Figure 24: Inverter – PV plant



Figure 25: Thermostat – apartment unit

District heating and cooling. The block of cooling energy measuring devices is the measuring block of the Kamstrup 801 cooling meter (Type 67G06770N519, qp 500 m³ / h). The flowmeter is Siemens SITRANS FUE080, the flowmeter is Siemens SITRANS FUE080 7me3410-3bc31-4br2-z Y17 DN400.

The block of the heat energy measuring device for district heating is the measuring block of the Kamstrup 801 heat meter (Type 67G0677B1231, qp 250 m³ / h). The flow meter on this circuit is Kamstrup ULTRAFLOW 54 (Type 65-5-FDCN-219, DN150 PN25 dP 0.055bar).

The electricity meter for solar panels is ISKRA MT174-D1A52R62-G22-M3K03Z, a 3-phase electricity meter.

The solar panel inverters are from Solaredge SE17K, SE17K and SE25K.



Figure 26: Inverters



Figure 27: Electricity meter



Figure 28: Heat meter



Figure 29: Flowmeter

The public street lighting is controlled by the controllers installed in each luminaire and centrally also by the cabinet controllers installed in the electrical cabinets of the street lighting. The luminaires communicate with the management system via controllers and gateways. Controllers and complex sensors are produced by Cityntel OÜ.

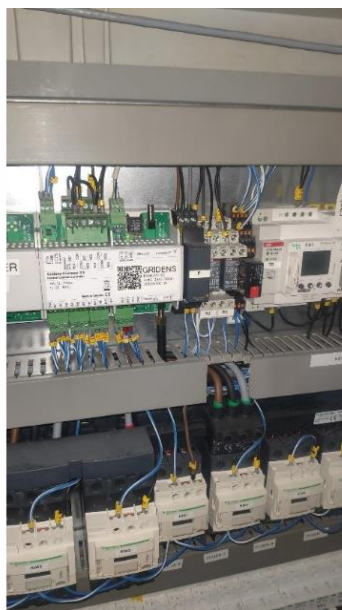


Figure 30: Cabinet controller



Figure 31: Environmental complex sensor

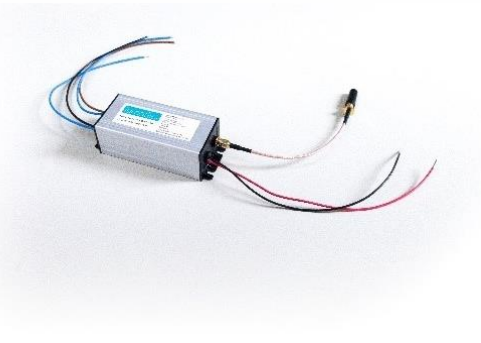


Figure 32: Luminaire controller



Figure 33: Movement sensor

In the case of **EV-chargers**, the main indicator is the charged electricity, which is measured by an electricity meter. In addition, the charger is equipped with automation from the manufacturer, which controls the operation of the device and allows to get information about other indicators: number of charges, length of charging sessions, etc.



Figure 34: EV-charger



Figure 35: Electricity meter of EV-charger

GPS devices installed on bicycles and buses by manufacturers are mainly used to monitor **mobility** activities (**bike-sharing, biogas buses**).

4.3 Sonderborg

4.3.1 Monitoring programme review

The main change in the data collection approach was introduced in the middle of the project, when Sonderborg's ICT partner (Vikingegaarden) exited the project. It was then decided to have ET as the new ICT partner who would implement the same ICT system as in Tartu called **CIOP – City Information Open Platform**. The Vikingegarten proprietary devices had to be changed to standard devices that were purchased from the open market.

Other change that came with the CIOP change, was the open API that allows multiple data providers to send data to the CIOP and/or interested and validated partners to request data from the CIOP.

The final equipment installed in Sonderborg is related to the **energy retrofitting of the housing** associations a part of the SEC project in the city. The main purpose of the equipment is described below and is referring two demo phases – Phase 1 is the originally planned retrofitting projects implemented 2017-2019 and Phase 2 is the solar PV and battery projects implemented in 2020-2021 according to the Amendment 3:

Housing associations Phase 1: Energy efficiency measures in buildings are monitored from 2019. Heating consumption and electricity consumption are monitored in all buildings. Electricity production in buildings with solar PV installed.

Housing associations Phase 2: Solar PV and battery systems installed and monitored from 2021. Phase 2 covers buildings additional to buildings in Phase 1.

A list of the equipment type, main characteristics and purpose is seen in the table below.

Equipment type	Description / Main characteristics	Purpose (EV, buses, housing association, etc)
Phase 1: Gateway IMON U300	Collects all the data from local devices (EM24; ModBus) and send it to the CIOP	For datalogging electricity meters
Phase 1: Traditional electricity meters EM24-DIN	Reads the buildings electricity consumption and where applicable also PV panels production	Monitoring solar PV production
Phase 1: High gain outdoor antenna 3G 900/2100	To increase the GSM reception in the basement, external antennas were installed.	Transmission of data from datalogger to CIOP
Phase 1: Kamstrup Modbus module 67-00-67	Reads Modbus registries in the local heating meters and sends the data to the gateway	For transmissions of monitored district heating consumption to CIOP
Phase 2: Solar PV + batteries: Huawei Sun2000 KTL inverters.	Data monitored by the 2 inverters for solar PV and for batteries are stored in the inverters, Access to the data via the website for the Danish dealer of Huawei batteries, the company Photomate. Work is ongoing to establish connection from Huawei Inverters to CIOP.	One inverter for the solar PV system monitors energy consumption in buildings and solar energy production from PV panels to the battery. Another inverter for batteries monitors distribution of the solar stored electricity to the building consumption and to the grid.

Table 10: Monitoring equipment

Regarding GDPR aspects in connection with the monitored data of energy consumption, the project partners do not have access to the consumption for the individual families or apartments, but only the consumption for the whole housing blocks aggregating all values from the different apartments.

4.3.2 Monitoring equipment commissioning

After Vikingegaarden was terminated from the project, Sonderborg decided to use the same **CIOP** that was already implemented in Tartu city within SmartEnCity project. After analysing the Vikingegaarden installed data-loggers, it turned out to be both faster and cheaper to change the equipment to the Telia recommended universal loggers than to reprogram all the Vikingegaarden proprietary devices. Mainly the change was smooth, but during installation there were some issues encountered with reception of 4G that needed additional antenna instalments.

After physical system upgrade, the CIOP was able to collect monitoring and third-party data as described in D7.9. To further automate the data collected from citizens by surveys, a new questionnaire module was developed into the CIOP.



Figure 36. 60 kWh battery installation in the basement in SAB Department 13.



Figure 37. EV-charger at the court Sonderborg.



Figure 38. Battery storage facility at SAB.



Figure 39. PV and battery systems at SAB department 22.



Figure 40. PV and battery storage at SOBO department 21 with board members.

5 Update on other data acquisition methods: questionnaires and other sheets

5.1 Vitoria-Gasteiz

Social Acceptance and **Citizen Engagement** data were retrieved through a phone survey among the beneficiaries of the project. The questionnaire was prepared by an iterative process with involved partners during last reporting period.

The communication process with the beneficiaries was carried out by an external third party to ensure its impartiality, fairness, neutrality and objectiveness. The questionnaire was announced in advance through posters (in Basque and Spanish) in each building entrance to maximize the results (Figure 41).



Koroatze auzoko birgaikuntza energetikoa

ASEBETETZE INKESTAK

Bizilagun agurgarriak:

Datozen egunetan, Visesa ATARI aholkularitza-enpresaren eskutik egiten ari den laguntza-prozesuaren barruan, telefono dei bat jasoko duzue, azken urteotan parte hartu duzuen SmartEnCity proiektuari buruzko asebetetze inkesta labur bat egiteko.

Parte hartzeri eta zuen iritzia gurekin partekatzera animatzen zaituztegu. Irizki konstruktiboak jaso nahi ditugu, etorkizunean hobetzen lagunduko digutenak eta 2017ko otsailetik egindako lanetik ondorioak ateratzeko aukera emango digutenak.

Datozen egunetan zuekin harremanetan jarriko gara, baina horri buruzko zalantzarik baduzue, ATARI CONSULTORA SOSTENIBLEeko Maite ekin harremanetan jar zaitzekete telefonoan.

Laguntzeko prozesua ixteko, ATARI, zuen esku egongo da Aldabeko Gizarte Etxean ekainaren 1ean (10:30etatik 13:30etara) eta ekainaren 2an (16:30etatik 19:30etara) argitu gabe dauden zalantzak azaltzeko.

Eskerrik asko urte hauetan izan duzuen adeitasun eta lankidetzagatik!

Rehabilitación energética del barrio de Coronación

ENCUESTAS DE SATISFACCIÓN

Estimados vecinos y vecinas:

Durante los próximos días, en el marco del proceso de acompañamiento que Visesa está llevando a cabo de la mano de la consultora ATARI, recibiréis una llamada telefónica para realizaros una breve encuesta de satisfacción sobre el proyecto SmartEnCity en el que habéis participado durante los últimos años.

Os animamos a participar y compartir vuestras impresiones con nosotros. Queremos recoger opiniones constructivas que nos ayuden a mejorar en el futuro y que nos permitan extraer conclusiones del trabajo realizado desde febrero 2017.

A lo largo de los próximos días contactaremos con vosotros y vosotras, pero, si tenéis cualquier duda al respecto, podéis contactar con Maite de ATARI CONSULTORA SOSTENIBLE en el

Como cierre del Proceso de Acompañamiento, ATARI, estará a vuestra disposición en el C.C. Aldabe para atenderos personalmente en la resolución de cualquier duda pendiente durante los días 1 de junio (de 10:30h a 13:30h) y 2 de junio (de 16:30h a 19:30h)

¡Muchas gracias por vuestra amabilidad y colaboración durante estos años!

SmartEnCity has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement 10101883
SmartEnCity está cofinanciada por el programa H2020 de Investigación e Innovación de la Unión Europea bajo el acuerdo de subvención 10101883
SmartEnCity Europar Batasunak H2020 ikerketa eta berrikuntza programatik funtziatzen da. Funtziatzen duen akordioa 10101883 zenbakiaren bidezkoa da.



Dear neighbours:

Over the next few days, as part of the accompaniment process that Visesa is carrying out with the consultancy firm ATARI, you will receive a telephone call to carry out a brief satisfaction survey on the SmartEnCity project in which you have participated over the last few years.

We encourage you to participate and share your impressions with us. We want to collect constructive opinions that will help us to improve in the future and that will allow us to draw conclusions from the work carried out since February 2017.

Over the next few days, we will contact you, but if you have any question, you can contact Maite XXXX from ATARI CONSULTORA SOSTENIBLE on XXX XXX XXX*.*

To close the Accompaniment Process, ATARI will be at your disposal in the Aldabe Civic Centre to help you personally to solve any pending doubts during June 1st (from 10:30h to 13:30h) and June 2nd (from 16:30h to 19:30h).

Thank you very much for your kindness and collaboration over the years!

*Hidden values because of privacy issues

Figure 41. Information poster for the survey and its translation.

The questionnaire includes a series of (maximum) 57 questions related with social acceptance, citizen engagement, general satisfaction and personal data. The survey was carried out during May 2022, from 18th to 25th. The response rate was good – 170 questionnaires from 268 possible answers were retrieved (63,4%). 2,9% of the questionnaires were carried out in Basque and 97,1% in Spanish. Average length of the questionnaire was of 11'02". Longer one took 23' and shorter one 6'. Main reported reasons for not answering the questionnaire were:

- Rejection to answer
- Erroneous contact data
- Not the owner anymore, the dwelling was sold during the project.
- Impossible to reach
- Trust level: 95%, p=q=0,5 for total data.

5.2 Tartu

In order to measure the **Social Acceptance, Citizen Engagement** and satisfaction of the performed actions in Tartu, numerous surveys and studies have taken place. Five studies (surveys and individual interviews) have been conducted and they are listed below in the order in which they were conducted. First survey was conducted in order to map the residents' interest towards energy-efficient reconstruction of buildings in the pilot area and the means of communication people prefer at the very start of the project. Second, a survey of the residents of the pilot area was conducted before the start of the renovation to map the baseline (pre-reconstruction survey). Thirdly, in-person oral interviews were conducted with dwellers living in 8 different khrushchevka-type buildings in the pilot area. Fourth, a city-wide



and mobility survey was conducted as part of a bigger survey called “Tartu citizens and the environment”, which is regularly carried out. Fifth, the survey after the reconstruction was conducted (post-reconstruction survey). An initially planned focus group study (see D7.9) was cancelled because the topic was covered in sufficient detail in the post-reconstruction survey.

In addition to these surveys, feedback sheets from every pilot area event were collected by partner IBS and used for internal engagement activities. Continuous media monitoring took place during the project. In 2016-2022, more than 220 media coverage was published in the national or local media channels.

Preliminary survey of the demo area. For designing the project activities, getting an overview of the interest towards participating in the project and finding out which communication channels pilot area residents prefer, a survey was conducted in summer 2016. The questionnaire could be filled on paper and in the website. 213 responses were received. The results are published in [Tark Tartu website](#) and used in an open access academic publication ([Ahas et al 2019](#)). The results of this survey are not used for calculating the KPIs.

The preliminary survey was anonymous. The survey was sent to people by mail, and there were asked only the house number, which allowed to ensure people's privacy.

Pre-reconstruction survey. A questionnaire survey was conducted in the pilot area of Tartu before retrofitting works of the apartment buildings had started. The aim of the questionnaire survey was to evaluate the satisfaction with indoor climate, household bills, overall SmartEnCity Tartu activities, and environmental awareness before the large-scale retrofitting works. The survey is an important input for measuring the results of SmartEnCity Tartu project because change in the satisfaction scores in comparison of before and after retrofitting helps to evaluate the impact of renovation activities from social perspective. The results of this survey is used for calculating the KPIs and were published in [Tark Tartu website](#) and used in a popular science magazine Horisont article.

The topics of the pre-renovation survey were as follows: satisfaction with household bills, satisfaction with indoor climate, opinions about the SmartEnCity project, opinions about the environmental problems, everyday practices of tracking energy consumption, socio-demographic background and indicators of the apartment.

The questionnaire survey was conducted in the pilot area of SmartEnCity Tartu consisting of 22 apartment buildings in total of 816 apartments (checked with official Building Register). Most of the apartments were residential but a few were also for businesses. The survey was conducted in March 2018 and responses collected within a 2-week period. The total population was comprised of apartments, i.e. max number of responses could have been 816. One response from every apartment was expected, regardless of the age or gender of a respondent. The decision, who fills out the form, was up to the people living in the apartment.

The data was collected by using paper survey and an online survey. The online survey was conducted in University of Tartu survey environment (www.survey.ut.ee). Paper questionnaire forms and filling instructions (including the webpage for online survey) were placed in the mailbox of each apartment. A respondent had to choose whether to answer on

paper or in the Internet. Paper survey was in Estonian and Russian, online survey was in Estonian, Russian, and English.

Various measures were taken to ensure the collection, storage and processing of the data could be in accordance with the GDPR. The survey did not collect personal data (name, phone number, etc.). As the goal was to link the pre-reconstruction survey and post-reconstruction survey answers, the ID codes for each apartment were used to ensure anonymity. Every apartment was assigned a random unique ID code which was listed on the paper survey form. It wasn't not known exactly who answered the survey. Filled paper forms were asked to put in closed envelop (included to the sent survey) the apartment association's mailbox where it was later collected by the chairman of the association and given to University of Tartu team. The answers from paper forms were then entered in the online survey webpage. The table with the IDs connection to the apartment numbers was kept separate and secure from the survey responses and it was only available to the survey organisers on University of Tartu. Analysis of survey responses was anonymous (there were no apartment numbers in the data). The data table with survey responses was only available to project partners.

To encourage more people to fill out the forms, all respondents were included in the lottery, where they could win either a gift token to Ahhaa Science Centre in Tartu or a LED-bulb collection. There was also a separate lottery for the apartment associations. The most active apartment association (most participants/apartments per building) won a prize.

The **interview study** was conducted to understand people's opinions, fears and motivations in participating the project activities. Based on the study, open access academic articles ([Mooses et al 2022](#); [Ahas et al 2019](#)) were written. As the interview data is qualitative, no specific KPIs were calculated based on this data, however, they help to understand the reasons behind people's perceptions and satisfaction scores. Data collection method was in-person oral interview. Interview study was conducted in two stages. In the first stage, interviews were conducted in 2017. Invitations to participate in the interview study were sent to dwellers living in 8 different khreshchevka-type buildings in the pilot area. The houses were chosen depending on their activity level (active or inactive) to participate in the SmartEnCity project and the level of previous retrofitting activities (more retrofitted, less retrofitted). Apartments in every building were chosen by random sampling. There were two waves of invitations (the second wave invitations were sent to those who had not replied in the first wave). The invitations were sent to the letter boxes both in Estonian and Russian. 100 invitations were sent out to participate in the interview. The participants were offered a 10€ gift token as a reward for participating. The invitation allowed to be interviewed in Estonian, Russian or English.

In the first round 14 interviews with pilot area khreshchevka-dwellers were done, all participants wished the interview to be conducted in Estonian. Two interviewers carried out the interviews based on the interview questionnaire. Respondents were at first introduced about the study aim and focus. Then a consent letter describing data collection and data analysis procedures and confidentiality measures, were signed by the participants. Participants were promised full confidentiality upon publishing the study results. Interview questions were both closed and open-ended. In the second stage, additional 6 in-depth interviews were conducted in June 2019. Two additional respondents per each specific research category were chosen for making extra in-depth interview. Interviewees were dwellers from SmartEnCity Tartu project houses. Interviewees were reached through the



established contacts from social innovation experiment (Housing Association Ambassadors program) and also by using snowball sampling (interviewees recommended their neighbors for interview and provided their contact information). Interview aimed at letting informants freely talk about their understanding and opinion towards environment, environmental views, consumption habits, experience and fears with technology. Interview was structured into three pre-given themes: (1) everyday mobility, (2) consumption behaviour and (3) domestic practices. At the end of the interview, also socio-demographic data was asked, such as gender, age, ethnicity, education, income, ownership status (owner, renter). Interviews in the second stage were conducted by one researcher.

The average duration of interviews in the first stage was 60 minutes; in the second stage 1h and 14 minutes. Interviews were audio-recorded.

Voice recordings from the first stage do not contain the name or the address of the respondent, a person was given an ID code and voice recordings were renamed according to this ID code. Although, there's a chance that a respondent mentioned some information (e.g. address) during the interview that gives hints to his residential location or personality. Voice recordings, transcripts and ID codes are kept in a separate computer and external memory drive that can be accessed only by certain researcher with password in certain internet network.

Voice recordings from the first stage were transcribed at first by using open-source web-based speech recognition for Estonian language developed by Tallinn University of Technology. It is fully automated system, no one listens to the voice recordings or reads the transcriptions. However, it is stated that for research purpose, some parts of the randomly selected recordings from all uploaded recordings might be used for discovering transcription mistakes. Nevertheless, the probability of our audio-recordings to be picked is very small. After getting the transcriptions, we discovered that the transcription quality was very poor. Some parts of the text were missing, some sentences were merged, wording and spelling mistakes occurred. To enhance the readability of the text, a person was hired to check the spelling and wording of the transcriptions with actual voice recordings. A data agreement with the person was signed and she was obliged to delete all the transcriptions and voice recordings after handing over improved transcriptions.

In the second stage voice recordings were transcribed by the researcher who conducted the interviews by using NVivo software.

City-wide and mobility survey. All the KPI's listed in D7.9 were thoroughly checked and discussed within Tartu engagement working group. A collective decision was reached among the Tartu SmartEnCity partners, that separate survey for mobility action is not feasible. Firstly, the KPIs outlined in D7.9 were not sufficient enough to conduct a separate survey to monitor mobility action. Secondly, in D7.9 it was anticipated that mobility action users will be reached through service providers, however, under the different data protection regulations, it is not possible to deliver surveys on behalf of University of Tartu (who is responsible for data collection in social acceptance protocol in Tartu) to bike-share users. For this reason, it was decided that city-wide survey and mobility action surveys are united into one survey.

City-wide and mobility KPI questions were integrated to the periodical city-wide survey "Tartu citizens and the environment" which is regularly carried out after every 5 years. City of Tartu orders regular surveys (conducted by a survey company) among city inhabitants based on



representative sample. Luckily, next survey was about to be conducted in Spring 2021 and we got the permission to add SmartEnCity block of questions to the survey. It is reasonable, because city-wide and mobility actions were finished by the time when survey data was collected, the sample is representative, professional survey company is hired to collect the data and it is possible to generalize the results to the whole city. Since a limited amount of space was dedicated to us in the questionnaire form, we carefully went through the initial list of KPIs in D7.9, and selected the most important, clear and appropriate questions to be included in the city-wide survey. Some KPI questions were modified for clarity and some were eliminated due to unclear content and for being inappropriate.

The questions and KPIs about SmartEnCity actions in general and mobility actions in specific were added to the survey, which were then overlooked and modified by Tartu city and survey company. The survey was conducted among Tartu citizens from 8th of June to 4th of July 2021 by a survey company. It was a combination of telephone and online survey. The ones who decided to opt for online survey, a web link with a specific password was sent to the person's e-mail. Reminder letters were sent, when necessary. It was possible to answer in Estonian and Russian language. It was not possible to answer to the survey from the same e-mail multiple times.

The target group for the survey were Tartu citizens aged 16 and above. The size of the sample was 1000 citizens. The basis of the sample was constructed based on Tartu's population statistics. From the population register, a systematic random sample of Tartu citizens aged 16+ was taken. Unfortunately, it was not possible to retrieve the information on the residential districts of the people from population register.

Professional survey company was responsible for the collection and storage of the city-wide survey "Tartu citizens and the environment" data. This company transmitted the data to the project partners, where the respondents were anonymous.

The aim of the **post-reconstruction survey** was to find out the satisfaction of the residents of the house with the reconstruction. The results of this survey is used for calculating KPIs and the results are published in popular science portal [ERR Novaator](#) and [Tark Tartu website](#). The survey consisted of five thematic blocks: project satisfaction, indoor climate, project involvement, environmental awareness and mobility, and personal issues. The survey was conducted among pilot area residents from 4th to 20th of March 2022. The survey was sent by post to all apartments in the pilot area houses, total to 688 apartments. The survey could be answered both on a paper form sent by post and on the Internet in University of Tartu survey environment (www.survey.ut.ee; <https://survey.ut.ee/index.php/411513?lang=en>). A web link had been written on the paper survey sent by post. The paper forms were accompanied by a return envelope, which was used to return the answers to the survey organisers by regular mail. The answers from paper forms were then entered in the online survey webpage. It was possible to answer in Estonian, Russian and English language. The questionnaires were coded so that the answers could be linked to the apartments, and to the answers of the pre-reconstruction survey. We asked each apartment to answer once. We received 132 responses to the survey, out of which 127 could be linked to a specific apartment. One answer was excluded from the analysis because there were two answers per apartment, but we expected one answer from each apartment.

Various measures were taken to ensure the collection, storage and processing of the data could be in accordance with the GDPR. The same ID codes were used in the post-



reconstruction survey as in the pre-reconstruction survey. Every apartment was assigned a random unique ID code which was listed on the paper survey form. Survey forms were sent by mail. The survey form was accompanied by a return envelope, with which the paper questionnaire could be mailed to the survey organizers at the University of Tartu. When answering online, had to add the ID code to the answer. The answers from paper forms were entered in the online survey webpage. The table with the IDs connection to the apartment numbers was kept separate and secure from the survey responses and it was only available to the survey organisers on University of Tartu. Analysis of survey responses was anonymous (there were no apartment numbers in the data). The data table with survey responses was only available to project partners.

To encourage more people to fill out the forms, all respondents were included in the lottery, where they could win a gift (one iPhone 8, five Xiaomi Redmi battery banks, three pairs of Sony wireless headphones from Telia and three Tartu bike sharing 1-year membership cards). The most active apartment association (most participants/apartments per building) won a prize worth 300 euros from gardening store.

5.3 Sonderborg

The data collected outside the sensor/logger-based data are regarding: Mobility, Social acceptance, Citizen engagement, LCA and Economic performance protocols. The data was acquired using questionnaires, surveys, interviews, Excel files and getting in contact with direct suppliers/owners of data. **Social Acceptance and Citizen Engagement.** Resident surveys have been implemented as part of the SmartEnCity project. A paper-based questionnaire was distributed to involved resident-families in June 2019 and an online questionnaire was distributed in May 2022. First survey was distributed to all originally app. 800 resident-families. Feedback received was less than 15%, the answers were coded manually and reported in the D5.8 report. The second survey was distributed to a larger population of app. 1,800 families as it also included the Amendment 2+3 extensions regarding PV battery systems. Almost 200 families have responded from the three housing associations. The change from a paper/manual-based survey to an online questionnaire has further implications than just technology, as also a lack of email addresses had to be considered. However, it was concluded that a paper-based survey would be considered too old-fashioned for the residents and too time-consuming for the staff implementing the survey.

Mobility bus-data have been collected frequently as part of the D7.9 periodic reports from Sydtrafik (regional public transport operator) regarding reliability of arrival/departures, Sonderborg Municipality regarding consumption of gas and the Umove (local operating company) regarding km-driven.

Charging data regarding the 24 EON EV-chargers have been collected frequently as part of the D7.9 periodic reports from EON.

The input data for the **LCA** is a mix of general data from standard LCA databases (primarily Ökobau.dat) and local Sonderborg data including specific data regarding local energy production and supply. Data about energy production and supply in Sonderborg is gathered via an Excel based tool called Energy Balance. The Energy Balance is created by PLAN by collecting various energy data for Sonderborg from local and national stakeholders and results with an energy balance for the geographical territory of the municipality. After that, the



results are used for the LCA data reporting in regard to assessing the impact of energy consumption as part of the LCA perspective.

The data for the **Economic Performance** is gathered from one of ZERO's project managers and then is applied manually in the formulas defined in D7.9. The results will be reported in D7.13.

6 Data quality aspects

Regarding the information coming from the different LH demo sites concerning data quality aspects, as a general comment, it should be noticed that some information gathered comes from external sources and, in these cases, the data quality surveillance is not possible, because it is done by external entities (the information is already pre-processed before being sent to the project partners).

Subsections below describe some of the aspects taken into consideration on the quality of the data coming from the demos.

6.1 Vitoria-Gasteiz

Sections 4.1 and 5.1 presented the different data sources and equipment used to collect data for the pilot in Vitoria-Gasteiz. This section addresses how that data was commissioned in each domain (energy, comfort, mobility ...) and level (dwelling, building, district) in order to assure quality of data at platform level, so applications and KPIs can function properly.

Data is stored in the CIOP platform built for Vitoria-Gasteiz by the partners in the project. These partners provided the means to upload the data from different sources. Those data are stored in different database repositories and are consumed by applications developed within the project (added value solutions). Refer to Deliverable 3.8 for more information on the data collection techniques employed, the data repositories available and the applications developed for Vitoria-Gasteiz LH in the project.

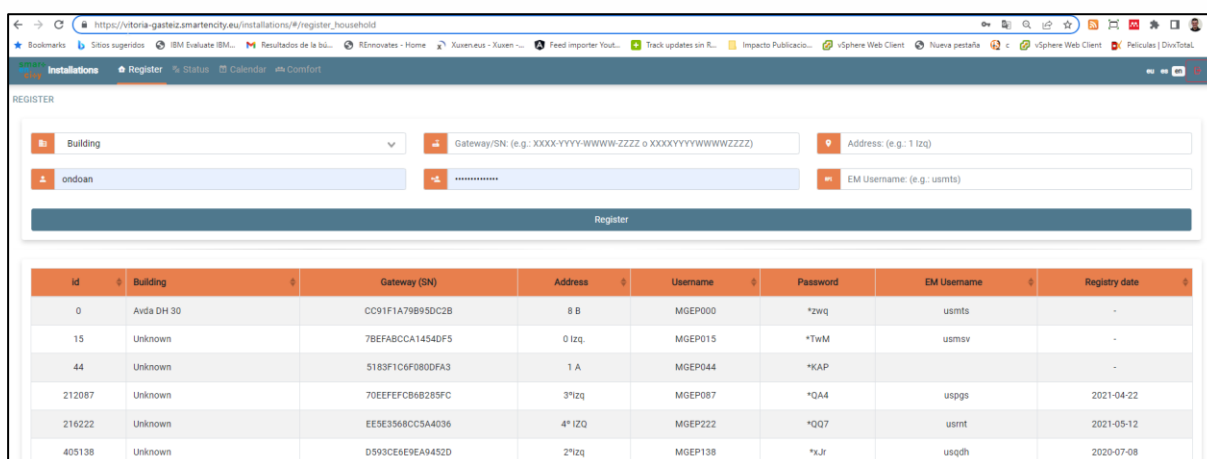
Most data sources come from commercial solutions (SCADAs, CPS, sensors ...) which interfaces for communication are well known (APIs, OPC-UA, data bases ...). Communication between those solutions and the CIOP platform was prepared and commissioned once for municipality infrastructures, mobility, energy data providers, etc. From that point data collection was managed automatically and unless a network failure occurred data collection took place without human intervention. For municipality infrastructures, mobility and ESCO data sources data collection converged in one point that sent all the information. Guaranteeing the connection between that central point and the CIOP platform meant that data collection functioned correctly.

While most systems collecting data are commercial solutions that have been tested before commercialization, the main challenge in our case was to assure the correct collection of data from sensors installed in the dwellings. Remember that these sensors collect energy, comfort and CO2 information from the dwellings. These devices are also robust commercial solutions, but they are exposed to conditions where there is no control and maintenance was not guaranteed. This is, sensors are installed in the houses and when something goes wrong (disconnection, network malfunction, battery discharge ...) nobody was assigned to control their behaviour or was prepared to solve issues. To solve that issue we designed and developed an application that detects sensors not providing data to the platform and a procedure to solve issues in the network that stopped data from entering the CIOP platform.

The application is available in the CIOP with the name “Tools to support the installation and management of measurement equipment”¹ and offers several web applications. The web tools support the installation and management of measurement equipment (sensors). The web applications developed in this block support installers and platform managers by providing information on the status of sensor installations and allow monitoring their behaviour. They also make it possible to obtain and download data and provide alarms on the malfunctioning of the installations. The specific objectives of these tools are:

1. Create forms to facilitate the automatic registration of dwellings and metering equipment in the DB during installations.
2. Create a system for monitoring the status of the sensors of the installations
3. Enable data collection and validation. Ensure correctness of data, determine data frequency and completeness, etc.
4. Create an alarm system that reports malfunctioning of the installations
5. Create a tool that facilitates the collection of missing information
6. Create a tool that facilitates data consumption (download).

In the following paragraphs the results proposed to address these objectives are presented. Figure 42 presents the web application that enables the registration of new metering equipment in the CIOP. It consists mainly of a form to introduce building and equipment information but also presents a list of devices installed (Objective 1).



id	Building	Gateway (SN)	Address	Username	Password	EM Username	Registry date
0	Avda DH 30	CC91F1A79B95DC2B	8 B	MGEPO00	*zwq	usmts	-
15	Unknown	7BEFABCCA1454DF5	0 Izq.	MGEPO15	*TwM	usmsv	-
44	Unknown	5183F1C6F080DFA3	1 A	MGEPO44	*KAP	-	-
212087	Unknown	70EEFECB68285FC	3 Izq	MGEPO87	*QA4	uspgs	2021-04-22
216222	Unknown	EE5E3568CC5A4036	4 Izq	MGEPO222	*QQ7	usmt	2021-05-12
405138	Unknown	D593CE6E9EA9452D	2 Izq	MGEPI38	*xJr	usqdh	2020-07-08

Figure 42: Automatic registration of metering equipment

Figure 43 presents the web application developed to monitor the status for sensors in dwellings. The application shows all the dwellings in a building and the status for the sensors installed in that dwelling. The CIOP receives data from all sensors. The applications show the day the sensor was installed and the last day data was received. If everything is correct the status is green (as in the figure). If data from one sensor has not been received for some time the status of the sensor changes to red and the colour of the dwelling to yellow. If no data from all sensors in a dwelling is received the building turns to red. If there has never been information from a sensor registered in the CIOP platform the sensor turns to black. This tool allows to easily detect malfunctioning devices/sensors (Objective 2). In addition, we have established a data flow in a background application that informs about data collection failures to the maintenance team. These alarms are triggered when data is not received after 72 hours (Objective 4).

¹ <https://vitoria-gasteiz.smartencity.eu/installations>

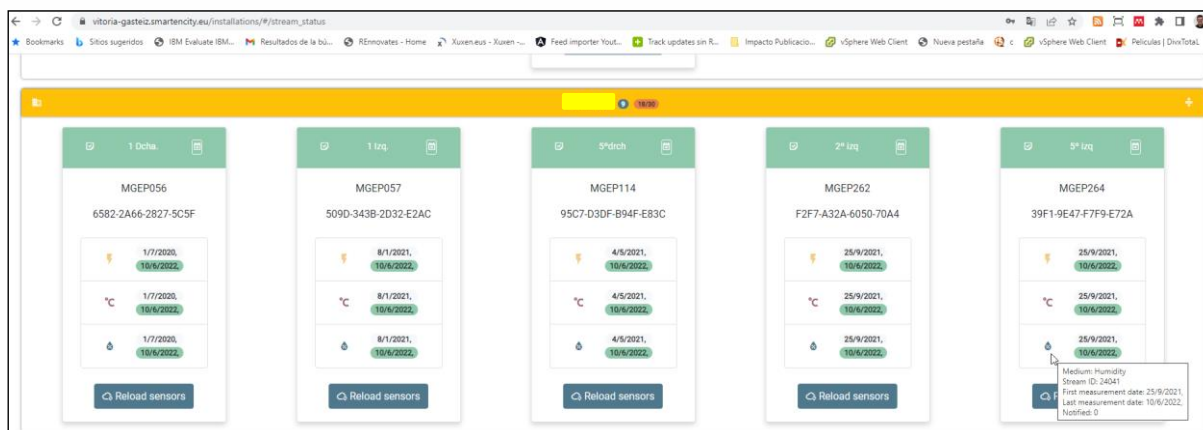


Figure 43: Dwelling Sensor Status

Figure 44 presents a web application deployed at the CIOP platform that allows to commission, validate and download data. This tool allows to easily detect missing data and request it from the data source. This complies with the commissioning and validation strategy established in Objectives 3 and 5. In addition, we have enabled an export utility that allows the download of data (Objective 6).

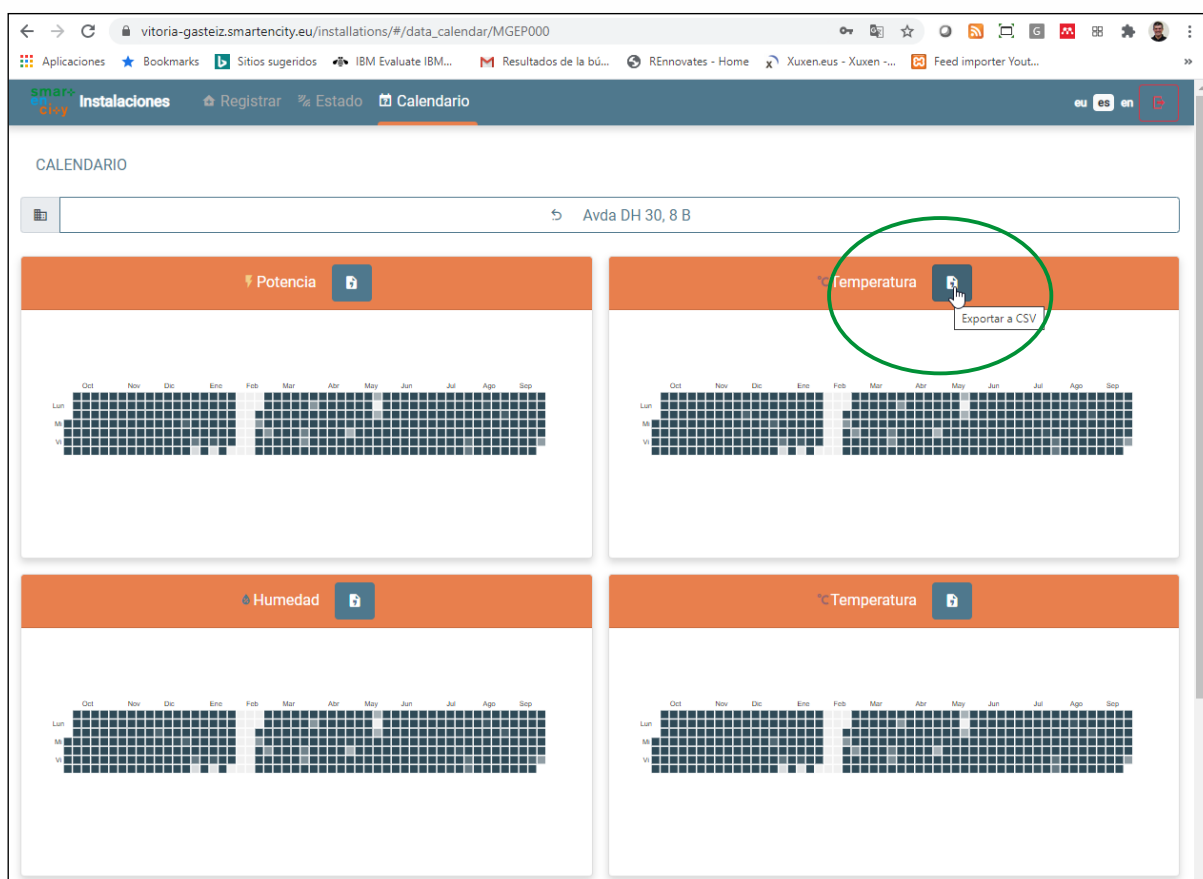


Figure 44: Data collection commissioning, validation and download

At the support level, the team defined several procedures:

1. A procedure for new installations at dwelling level. This was followed by Ondoan when new gateways and sensors were installed.

2. A support procedure in the event of an incident (via telephone or web). This procedure was activated to support residents for equipment malfunctioning or maintenance.
3. A procedure to notify the support team about connectivity lost to a building/dwelling/sensor.

For this second point there are two main alert systems. First, LKS IT, as infrastructures provider, monitors all the equipment that offer building connectivity. When a device goes down, LKS detects it and notifies the support team so that the device can be checked. Second, the data failure detection system has been connected (web background application) to inform the support team about data outbreaks. The support team is informed by email when a sensor does not send information after 72 hours. Both alert systems use a ticketing system provided by LKS that enables registering the incidents. The support team has access to the ticketing platform to monitor the status of incidents. The platform can be accessed through this URL: <https://apps.lks.es/servicedesk/customer.pl>. Incidents can be also reported by telephone at 902.158.717.

6.2 Tartu

The implementation of the monitoring program in Tartu has generally been quite successful, but there have also been several difficulties. The main challenge has been the integration of different data sources into the CIOP platform and fluctuating data quality. The latter is particularly relevant for data from sensors. The main problem here is power outages, energy service provider databases connection timeouts, the technical quality of the sensors and wireless sensors' battery life (shorter than promised). We have had to contribute more to ensuring the quality of data transmission than planned. As data transmission is mainly via mobile communications, radio interference in the urban environment has a significant impact on the quality of data transmission.

Data is stored in the Cumoloccity platform. Regarding bike-share, we get the data from the supplier's database (Bewegen). The overall mileage of the bikes and the number/length of usage session is of particular interest in SmartEnCity project. The data and its quality are closely and continuously monitored by the bike-share system operator and city government. Data about bus traffic is collected from service operator GoBus and accuracy of timekeeping from Ridango. The data passes double-checking procedures. Data from other external sources is usually with a good quality and checked by data providers. However, we perform random checks on the data and in case of deviations, the problem is usually solved quickly by the data providers.

Indicator	Procedure
Data completeness (%) – 90% The majority of data for monitoring of renovations, mobility and integrated infrastructures is gathered through APIs, and a smaller part is gathered either by sensors or manually (measurement readings at locations). The data that is received via APIs or collected manually is of high quality and there are practically no defects. There are quality problems (partially missing data) in data collected by sensors	Frequency of quality checks: Data quality is checked on an ongoing basis using error agents, where an error message is sent to the administrator in case of missing data. More generally, data quality is regularly checked once a month when all incoming data is reviewed. If defects in data quality are discovered during the inspection, the missing data will be restored if possible (if the data is



(mainly street lighting and EV battery re-use).	available on the sender's server). To a lesser extent, it is not possible to recover all the data (mainly in the case of sensors or data transmission failures, when no data was collected).
Out of range [1] (%) – 3%	Frequency of quality checks: same as above

Table 11: Data quality

Next, the data quality issues regarding surveys and interviews are explained.

The timing of the **first preliminary survey of the pilot area** survey was not great (summer); thus, the number of responses was not very big. The response rate could not be calculated, but since no KPIs are calculated using this data, this is not an issue.

Overall, the **pre-reconstruction** survey was successful, and 255 answers were received out of 816 distributed; 172 received on paper and 83 on the web. The response rate can, thus, be considered rather good – 31% $((255/816) \times 100)$. One apartment answered twice, both on the web and on the paper, but it was counted once. The response rate for the most active apartment association was 45%. Data completeness for most of the questions was 98%-99%. Every question had at least 1 missing answer and the maximum number of missing answers was 6.

Interviews data quality is affected by the small response rate from the first round of the interviews. The response rate was low – 14% $((14/100) \times 100)$. Unfortunately, it was very time-consuming and difficult to find the people who were willing to give interviews, thus, the collected dataset is not as big as was initially hoped. Also, females and people with higher education were over-represented.

City-wide and mobility survey. One response category (“rather don’t agree”) for KPI “Further investment to energy related projects” was missing in the final data file received from the survey company.

Weights based on gender, age and city district were calculated in order to be able to generalize the results a) to the whole Tartu population aged 16+; b) to the Tartu city districts for population aged 16+. The margin error does not exceed 3.1%. Quota sampling was used (1000 residents), thus, response rate is not applicable for this type of sample. Data completeness is 100%.

The responses of the survey were stored in an Excel and SPSS files received from the survey company. All the data related to this survey was kept at the premises of Tartu City government and University of Tartu. The survey was anonymous, i.e. it is not possible to link the answers to specific people.

The response rate for **post-reconstruction survey** was 19%. The responses received on the paper forms were entered in the internet survey form so that the answers would be in one form and in a table. The responses of the survey are stored in an Excel file, which is downloaded from internet platform. All the data related to this survey is kept at the project partners of Estonia: University of Tartu, IBS, Tartu City government. The survey was anonymous, i.e. it is not possible to link the answers to specific people.

It was not possible to link all the responses to the survey to the apartments, because when answering the online survey, 4 codes were entered incorrectly, which did not match the codes given to the apartments in the questionnaires sent by post and one response was missing code. Responses with incorrect codes were taken into account in the calculation of



the overall distribution of answers, but not in the comparison with the pre-reconstruction survey and in the analyses related to houses. The majority of the respondents had completed the questionnaire. 2 respondents had unanswered questions. Data completeness varies from 94% to 100%.

6.3 Sonderborg

Mobility. Quality of bus-operating data seems to be reliable, however there are variations in fuel consumption per km-driven that the stakeholders involved cannot explain.

Extract-data from EON regarding EV-charging events has during each D7.9 report have suffered from EON staff not having sufficient discipline in creating the extract. However, failures have been corrected after several attempts and the concluding/resulting data seems to be reliable. No data quality issues have been found with the BILSTATISTIK.DK data used in the surveys and reports.

Housing associations. In some of the monitoring periods a few of the datalogger equipment has been out of function. This has been reported in all the periodic “Evaluation reports of data collection, quality and surveillance and procedures”. As an example, in one department there are 19 similar buildings, each of them with monitor and datalogger equipment for heating consumption, electricity consumption and electricity production. Occasionally a few of these dataloggers did not transmit data to the CIOP. In these situations, the ZERO engineers have calculated the expected consumption for those specific buildings based on the consumption from similar buildings, from previous similar periods compensated for differences in the “degree-days” (the differences in outdoor temperatures and solar radiations in the specific periods). In this way it has always been possible to report data, which are reliable for the specific periods. In situations with failure on dataloggers, they have been repaired. In a few situations, failures were registered on district heating meters owned by the heating distribution company, and they have replaced the heating meter. In a few other situations it technical was not possible to install dataloggers directly on the official heating meter. In these situations, an extra parallel heating meter was installed. In general, problems with dataloggers primarily occurred in combination with district heating meters and more rarely in combination with electricity meters.

Social acceptance and citizen engagement. Changing from paper-based survey to an electronic survey makes a lot of sense from a technology/efficiency point of view, however, as majority of residents are older than 51 years, citizens might be lost and did never answer the second questionnaire. The survey #2 also showed that 36% of the respondents has lived less than 4 years in the apartment – this indicates that there is a “memory-method challenge” when asking citizens questions about actions in the past. Not asking residents with a foreign background seems to be a wrong decision looking back now, as more than 20% of the residents come from other countries. However, and in case this approach was chosen, there should have been multiple language questionnaires and also language skilled supporters to secure that the questions were understood and answered, based on learnings from other meetings/discussions with the SAB housing association.

7 Deviations to the plan

There were no big changes to the data collection plan., but considerations have to be done to highlight some of the difficulties encountered by the demo teams due to external factors as the COVID-19 pandemic.

Due to the COVID-19 pandemic, the project was extended and two additional internal Data collection and evaluation reports (M61-M67, M68-M74) were added. It has to be kept in mind that due to the pandemic, people's behaviour changed and they were more immobile. This is evident in the data that has been collected during the pandemic and it makes the comparisons with earlier periods more difficult. For example, LH city Sonderborg reports that the number of passengers using the bus has declined more than 30% during COVID-19, citizens were driving less during lockdowns and therefore also charging less, housing association energy consumption has increased as residents have been working from home, eating less out etc.

In Vitoria-Gasteiz, some data loss occurred during the pandemic lockdown when any equipment failed and it was not possible to get into the private homes to repair it. In other cases, delays occurred on the installation of some sensors for this same reason.

In Sonderborg they were reported difficulties too when connecting some meters to the data logger system. The main reason being difficulties with access to the main district heating meters again due to COVID-19 restrictions.