TOWARDS SMART ZERO CO_2 CITIES ACROSS EUROPE

VITORIA-GASTEIZ ✣ TARTU ✣ SØNDERBORG

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Abbreviations and Acronyms

Abbreviation/Acronym	Description
SmartEnCity	Towards Smart Zero CO2 Cities across Europe
LH	Lighthouse
KPIs	Key performance indicators
WP	Work Package
DoA	Description of Action
RES	Renewable Energy Sources
EV	Electrical Vehicle
ECM	Energy Conservation Measure
PMV	Predicted Mean Vote
GCV	Gross Calorific Value
CFs	Characterization Factor
FAETP	Eco-toxicity Potential
HTP	HTP
IPCC	Intergovernmental Panel on Climate Change

Table 1: Abbreviations and Acronyms

0 Publishable Summary

This report describes the methodology for evaluating the performance of the interventions in the Lighthouse Cities (LH) participating in SmartEnCity Project from a holistic point of view. This methodology consists of a set of objectives to be reached with interventions and the set of indicators which allow to measuring the level of achievement.

These indicators have been selected from Key Performance Indicators Guides developed by SCIS and CITYkeys projects and will be tested by partners implicated in the deployment of the interventions in order to take into account the real possibilities for their whole application. Thus, indicators will be refined in D7.3 (at M12) once there is more knowledge on the availability of sensors, meters and infrastructure to communicate the measurement equipment with the ICT platform, the citizen engagement strategy and other factors that can influence in the suitability of this preliminary set of indicators selected.

CAR and TEC have been the main authors of the current deliverable as main responsible of the methodology's scope, being reviewed by partners in charge of certain interventions in order to assure that the approach is suitable. In addition, this methodology has been provided during the first months of the project to key partners of the project involved not only in WP7 but also in WP3, WP4, WP5 and WP6 in case something is not suitable for the deployment of the corresponding work packages.

1 Introduction

Indicators and key performance indicators (KPIs) can be a valuable tool for evaluating the performance of interventions and the integrated impact produced at city level.

This report D7.2 intends to define a set of KPIs to be used in the SmartEnCity project for assessing the foreseen interventions (district renovation, sustainable mobility and citizen engagement) which conduct to the establishment of protocols of evaluation (D7.3) and monitoring programs (D7.6, D7.7, D7.8) in a next phase. On the other hand, indicators, which were identified in the previous D7.1, take part of the methodology focused in the deployment of city diagnosis (D2.4) and procedures for evaluating the impacts of interventions in cities (D7.4).

¡Error! No se encuentra el origen de la referencia. shows the workflow for indicators and KPIs in the project SmartEnCity.

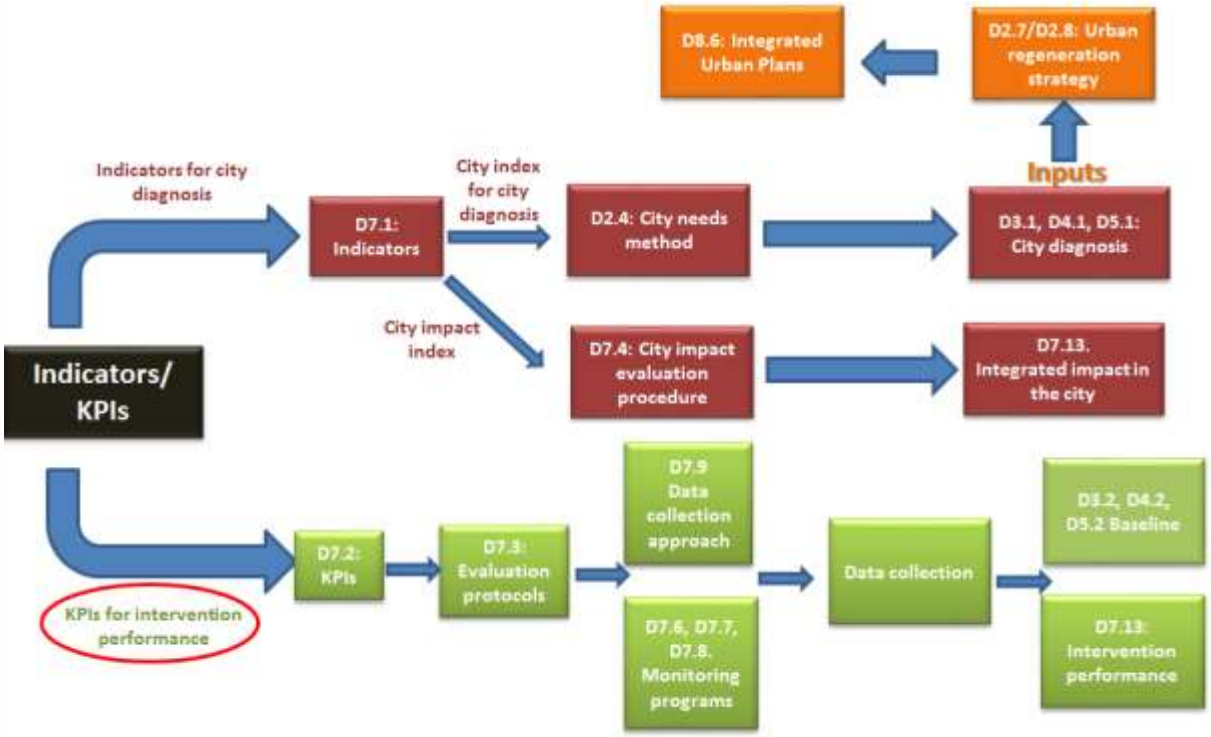

Figure 1: SmartEnCity Indicators Scheme

Definitions of both terms are described below in order to set the basis for their use in the framework of the SmartEnCity project.

- Indicators will be used for describing the conditions of Lighthous (LH) cities; before and after interventions.

  We refer them as *City index for city diagnosis* for analyzing the features of the city at the beginning of the project when the interventions have not started (M9) and *City impact index* for analyzing the features of the city once the interventions have been concluded (M66). CITYKEYS Project is one of the main sources used for the indicators.

- KPIs will be used for reporting the performance of all the interventions (district renovation, mobility action and citizen engagement); before and after interventions.

  They have been defined according to the objectives to be achieved in the project (e.g. energy efficiency, energy savings, CO_2 savings, a better quality of citizen's life, reduction of energy costs). As a consequence, they will consist of technical indicators, environment indicators, social indicators and economic indicators.

  The intervention assessment will be done in two stages: baseline (before the intervention) and final performance (once all the actions have been executed). A proper definition of baseline will allow to knowing the change and improvement on the system due to the energy efficiency measures. SCIS Key Performance Indicators Guide has been the main source for their definition.

Figure 2 and Figure 3 show the details of the types of indicators (indicators and KPIs) to be used in the project and the deliverables where they will be used.

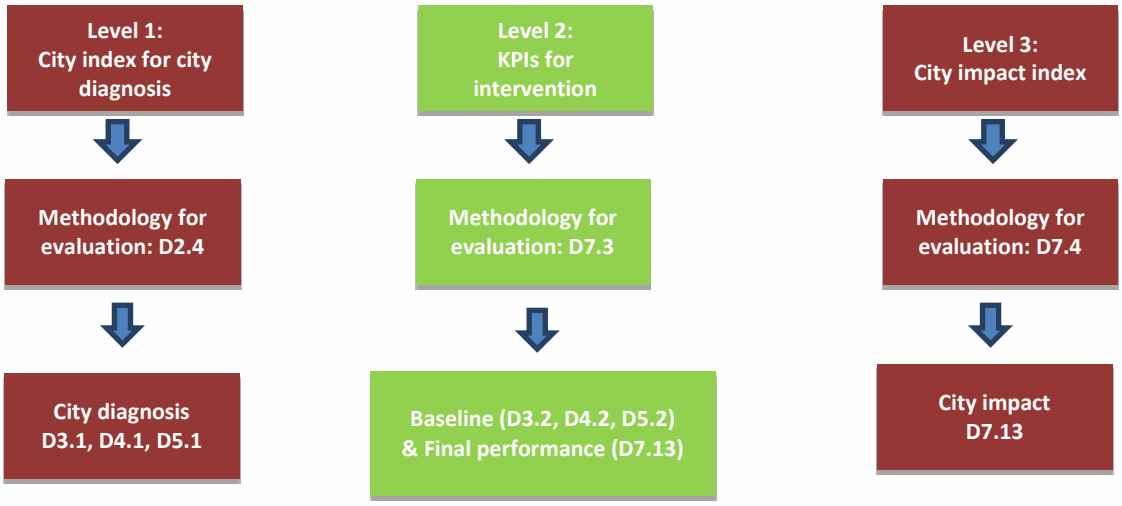

Figure 2: SmartEnCity Indicators levels

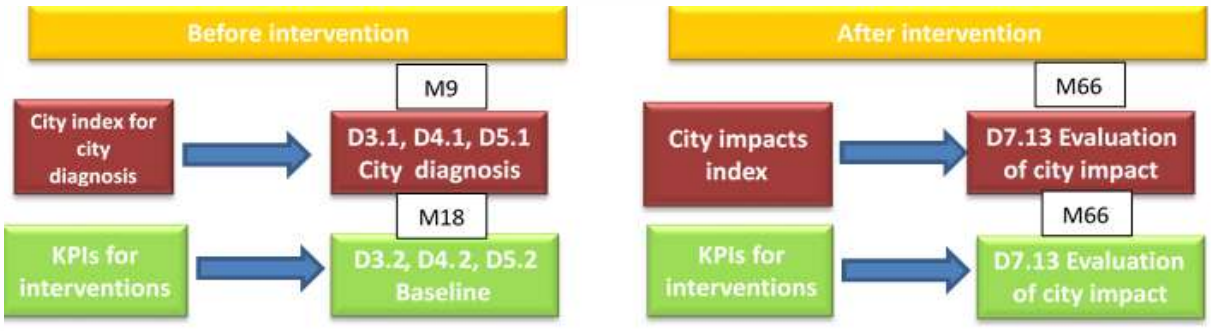

Figure 3: SmartEnCity Indicators details

1.1 Purpose and target group

A holistic evaluation of the three lighthouse projects will be deployed in order to cover a whole analysis of the impacts produced with the implementation of energy efficiency measures in dwelling and vehicles. The purpose of this deliverable is to present the methodology to evaluate the effects of the interventions in the three demo cities during the demonstration phase of SmartEnCity project in the areas of energy, urban mobility, ICT platform and integrated infrastructures.

Through this methodology, it is expected to measure the energy efficiency reached in the district and in the sustainable mobility actions, the energy and CO_2 saving, the contribution of renewable energies in the whole energy consumption and the fossil fuel consumption reduction. But also, it is foreseen to know how these energy efficiency measures can contribute to increase the quality of life in the whole city, e.g. in terms of air quality and traffic, the improvements in the economy of the users and to evaluate the citizen engagement through the acceptance of the project and intervention by resident, drivers and citizens.

1.2 Contributions of partners

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

Participant short name	Contributions
CAR	Main contributor to all sections. Definition of KPIs for all categories
TEC	Contribution in the definition of KPIs, mainly for energy assessment, ICT and citizen engagement
PLAN, CEE	Deliverable reviewers
VIS, CEA, MON, ACC, CEE, TAR, TREA, IBS, SONF, PLAN, ZERO	Main recipients of the document

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
D7.1 (M3)	This deliverable introduces the scheme for evaluating the interventions of the project. This approach is refined in D7.2 according to the progress made in the project
D2.4 (M6)	Some details about the baseline definition has been included in this deliverable
D6.2 (M12)	The design of CIOP architecture will take into account the KPI to be measured in the project
D7.3 (M12)	This deliverable will provide the evaluation plan for assess the performance of SmartEnCity interventions, updating the set of KPIs provided in D7.2 according with the real possibilities for evaluating the intervention performance. This deliverable will incorporate the protocols and procedures for calculating KPIs
D7.6, D7.7, D7.8 (M18)	Monitoring program describes the requirements for monitoring, metering and acquire data according to the KPIs defined
D7.9 (M18)	Data collection approach will be defined according to the evaluation strategy defined in this current deliverable
D3.2, D4.2, D5.2 (M18)	Baseline of intervention will be evaluated making use of these KPIs
D3.7, D4.7, D5.7 (M42)	The design of Urban ICT infrastructure will take into account the set of KPIs defined in order to guarantee the acquisition of required data
D7.12 (M66)	This deliverable will collect the data for evaluating the KPIs agreed
D7.13 (M66)	Final performance of intervention will be evaluated through the use of KPIs
WP8	The evaluation methodology could be taking into account to be delivered to the follower cities

Table 3: Relation to other activities in the project

2 Objectives and expected Impact

2.1 Objective

SmartEnCity aims to contribute to create Smart Zero CO_2 Cities across Europe through urban regeneration strategies, integrated urban plans and district integrated interventions. WP7 will help to support cities for reaching this objective by providing them an evaluation methodology for assessing the final performance of interventions and quantifying the impact generated.

T7.1 is focused in the creation of an evaluation plan constructed on indicators collection process. This deliverable D7.2 “KPIs definition” establishes the evaluation strategy and provides an overview of the potential KPIs that can be used in the project in order to obtain the needed information that allows to quantifying the effects of interventions.

2.2 Expected Impact

The set of KPIs identified can be used for any city which intends to transform into a Smart Zero City. Using these indicators, cities can know the effects achieved with the interventions from a holistic point of view which includes not only technical and environmental improvements but also social and economic issues which help to know the integrated impact of sustainable actions. In addition, the strategy depicts in this deliverable includes also the evaluation approach for individual actions (building retrofitting, integrated infrastructures and ICT platform, mobility and citizen engagement). Consequently, the set of indicators will be very useful for the three LH cities where this evaluation strategy will be implemented but also for other cities participating in the project (follower cities and cities interested to join the Smart Cities Network) and since the deliverable will be public any city that intends to become a Smart Zero City.

3 Overall Approach

The content of this deliverable is structured as follows:

- Introduction, objectives and expected impacts: Previous sections introduce the purpose of the report, the relation with other tasks of the project and contributions from different partners.
- Section 4: This section describes the strategy to be implemented in SmartEnCity Project in order to evaluate the objectives to be achieved with the implementation of the interventions in the three LH cities. An introduction to the evaluation scheme is widely detailed with a set of objectives and KPIs to be finally validated in a further step of the project. Some clarifications about the next stages of the project are provided at the end of this section.
- Section 5: It is about the minor deviation to the initial plan of Task 7.1.
- Section 6: This chapter deals with the use of outputs obtained in this deliverable for other tasks and WPs.
- Annex I: It includes the exhaustive list of KPIs for evaluating the interventions from a holistic point of view with a brief description of each indicator. The list is associated with each type of intervention (district renovation, mobility and citizen engagement).

4 Strategy for the evaluation of SmartEnCity actions

This part of the SmartEnCity project aims to assess the performance of the interventions carried out in the 3 LH cities from a holistic point of view. An evaluation plan will be designed which consist of objectives to be reached through the project interventions, the set of KPIs for measuring the intervention performance and the procedures for their quantification. This evaluation plan will be defined in D7.3, whereas in this report, it will describe the evaluation strategy which will be setting the basis for the evaluation plan design.

The strategy for the evaluation of SmartEnCity actions covers the following issues:

- Description of the objectives to be reached in the SmartEnCity project.
- Detail the indicators that should be measured to evaluate the interventions performance from a holistic point of view.
- Anticipate the structure of the evaluation plan to be defined in a further stage.

The strategy of evaluation (as well as the evaluation plan) will be defined according to the scheme shown below in Figure 4 where the relationship with the objectives and KPIs to be defined with each type of intervention is shown.

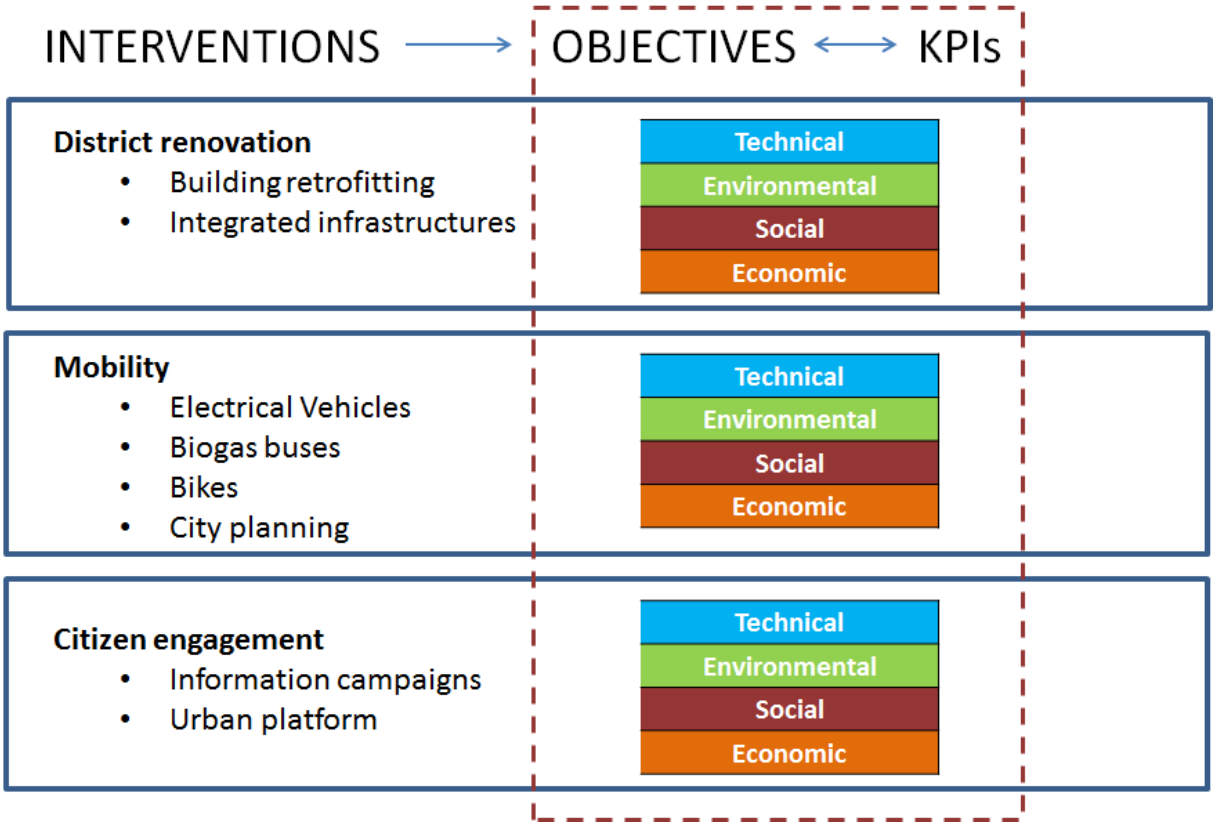

Figure 5: SmartEnCity evaluation scheme

Consequently, it will evaluate the technical and economic performance of the three interventions defined in the project: district renovation, urban mobility and citizen engagement actions as well as the social acceptance and the environmental benefit. In order to apply such scheme, KPIs are grouped by type of interventions and they encompass 4 categories: technical, environmental, social and economic. Such structure is aligned with the scheme proposed by SCIS in the Key Performance Indicators Guide.

Each LH city will contribute to reach certain objectives with different type of interventions which are briefly described below in order to understand the framework of this evaluation strategy.

Foreseen district renovation interventions

The three LH cities will perform deep renovation interventions in districts which include energy efficient measures such as building envelope insulation, new low energy windows and doors, installation of ventilation systems with heat recovery, among other measures which will significantly drop the energy demand of buildings. In addition, each city will maximize the use of local renewable energy sources (RES) for the electric grids and thermal networks through the installation or the upgrading of district heating and cooling networks. Specifically, Vitoria-Gasteiz will install a new wood chips biomass based district-heating network, Sonderborg plans to integrate electricity production from a possible near-shore wind-farm to feed a large heat-pump in the district heating system (to be upgraded in the project) and Tartu will improve the existing biomass cogeneration based electrical and thermal network by installing district cooling and seizing its output as a thermal make-up for the district heating network. Furthermore, the city of Tartu will introduce solar panels and street lighting with intelligent controlling systems.

Integrated infrastructures, such as smart infrastructure based on Information and Communication Technologies (ICT) and monitoring solutions, will be implemented in the demoareas of the three cities. As a result, it will optimize the operation of energy units, increasing smart grid connectivity and resulting in a higher energy efficiency of these energy systems.

Foreseen sustainable mobility interventions

The three cities will introduce sustainable vehicles (e.g. electric cars, last mile logistic EV services, electric bikes or biogas buses) for public and private use and will deploy public and private EV charging infrastructures. In addition, in Tartu is foreseen the implementation of a bike sharing system, the development of a participatory transport planning tool and action for re-using EV batteries which allow to storing and using renewable energy.

Foreseen citizen engagement strategy

A coordinated strategy will be defined in each city in order to convince residents and drivers about the benefits of the interventions. In specific, a strong strategy will be designed for transmitting the advantages of building intervention and sustainable vehicles through information campaigns, involving key stakeholders and end-users in workshops. Furthermore, a physical place as information point will be established as well as financing formulas to reduce the upfront costs. Once the interventions have been started, ICT solutions

will be deployed and residents and drivers will be receiving guidelines to improve the management of the energy in dwellings and will be involved in activities for data collection.

These ICT solutions will be also deployed to extend the project towards the citizens as well as dissemination actions in order to inform to the general public about the project. Thus, whole these actions (urban platforms, the services and added value services and dissemination actions) will help to raise awareness on energy efficient measures.

4.1 Objectives pursued in SmartEnCity

SmartEnCity will measure the expected results proposed in the document DoA. These effects are mainly related to reduce the energy demand and the energy consumption, to improve the use of RES and the energy efficiency in the city as well as to decrease the CO_2 emissions. Additionally, it is expected to contribute to improve the quality of life of citizens through a reduction of emissions to the atmosphere and traffic congestion, a reduction in the energy costs and a better thermal comfort at home. Finally, it is expected an increase in the environmental awareness in the three LH cities where the interventions are implemented.

Impacts related to energy and CO_2 savings have been previously quantified at proposal phase, however, there is not any target objective for other desirable effects, specially related to economic and social aspects. Consequently, we will take into account this differentiation in the strategy and plan of evaluation to be elaborated.

Specific objectives related to energy and CO_2 to be reached in each city are compiled in the Table 4.

			Energy Saving (kWh/y)	CO_2 Emission Reduction (Tn/year)
Vienna-Gasometer	Building Retrofitting	750 dwellings / 60.000m2 Envelop insulation (façade & roof) Connection to the district heating		
	Integrated Infrastructures	New biomass (wood chips) district heating network Integrated electrical and thermal network energy management systems, at home, building and district level (HEMS/BEMS/DEMS)		
	Sustainable Mobility	Granting EVs acquisition (taxis and private cars) Extending the recharge network Electric last mile logistic		
	ICTs	Urban Management System (UMS)	7.584.425	2.476
Tenlo	Building Retrofitting	900 dwellings / 39.000m2 Envelope insulation (façade & roof) New low energy windows and doors PV panels in the South façade Connection to the district heating and removing old electric boilers Heat recovery ventilation system		
	Integrated Infrastructures	Integrating heating and cooling in the current DH through a new heat pump Smart public lighting		
	Sustainable Mobility	Granting EVs acquisition for rental services Granting the EVs acquisition (taxes and private cars) Extending the recharge network Bikeshare Biogas buses Reuse of EVs batteries as storage system for PV panels		
	ICTs	Urban Management System (UMS), including public transportation	14.828.325	12.594
Sonderborg	Building Retrofitting	844 dwellings / 66.181m2 Envelop insulation (façade & roof) New low energy windows and doors LED outdoor lamps Lighting control PV panels		
	Integrated Infrastructures	New high efficiency heat pump Integration with geothermal, solar and biomass RES Electrical supply form a dedicated wind park		
	Sustainable Mobility	Biogas buses Granting the EVs acquisition (taxes and private cars) Extending the recharge network		
	ICTs	Urban Management System (UMS)	7.017.788	3551
			29.430.538	18.623

Table 4: SmartEnCity measures saving overview

Below the scheme for evaluating the objectives to be expected in the SmartEnCity project after the implementation of the energy measures and the execution of whole actions foreseen is provided. This Table 5 is the result of merging all the expectations described in the document DoA.

Type of intervention	Technical objectives	Environmental objectives	Social objectives	Economic objectives
DISTRICT RENOVATION: Building retrofitting Integrated infrastructures	Reduce energy demand of buildings Reduce home thermal energy consumptions with desired comfort at dwelling level Improve the energy efficiency of district Maximizing the use of RES and the self-sufficient energy consumption in the district	Reduce the CO_2 emissions generated from the district Reduce the environmental impact of the district intervention	Improve the quality of life of residents (thermal comfort) Improve the acceptance of the project by residents	Reduction of the energy costs of residents Decrease the payback of investment intervention
SUSTAINABLE MOBILITY Electrical Vehicles Biogas buses Bikes sharing City mobility planning	Reduce the traffic congestion Improve the efficiency of urban transport systems Decrease energy consumption in urban transport	Reduce the CO_2 emissions associated to urban transport	Improve the quality of life and the acceptance of the project by drivers	Reduction of the energy costs of drivers Decrease the payback of investment intervention
CITIZEN ENGAGEMENT STRATEGY Information campaigns Urban platform	Achieve the engagement of citizens Improve the current urban infrastructure	Increase the environmental awareness of residents, drivers and citizens	Improve the acceptance of the project by citizens	Contribute to the reduction of the energy costs of the citizens

Table 5: Overview of effects of SmartEnCity interventions

4.1.1 Objectives pursued in SmartEnCity related to district renovation

Technical objectives

The effect of specific actions in the district will contribute to achieve the objectives detailed below:

- *Building retrofitting actions, as facade and roof insulation, replacement of old windows or doors, installation of ventilation systems with heat recovery, will contribute to:*
    - Reduce energy demands in buildings.
    - Reduce home thermal energy consumptions with desired comfort at dwelling level.
- *Integrated infrastructures as ICT solutions, for the management of district heating facilities, the electric grid and the integration of RES in the distribution grid, will assist to:*
    - Improve the energy efficiency of the district due to the possibility of collecting data from interventions that contributes to assist the energy units in an optimized, controlled and secure manner and strengthening of the distribution grid through the integration of management of the district heating with the management of the electrical network.
    - Maximizing the use of RES in the district and the self-sufficient energy consumption due to reinforcing the distribution grid by providing control systems, management and decision support tools that enable the integration of renewable energy sources.

Environmental, social and economic objectives

The result of whole intervention in the district leads to all the following objectives:

- Reduce the CO_2 emissions to the atmosphere as a consequence of a decrease in the energy consumption in buildings and the generation of energy with renewable energy sources after a replacement in the use of the fossil fuel systems.
- Improve the life quality of citizens because of an increase in thermal comfort and a reduction of the energy costs of residents as a consequence of a reduction of energy demand, making use of the energy produced in the demo area and a better access to better energy pricing or cheaper fuel.
- Improve the social acceptance of residents on project and interventions after the implementation of energy solutions (e.g. gains in comfort conditions, aesthetical satisfaction, reduction in energy costs, etc)
- Decrease the payback of investment intervention due to the decrease of the energy consumption and the reduction of the energy costs.

In addition, building retrofitting actions and the integration of RES will help to reduce the environmental impact of district through the implementation of Life Cycle Impact focused in the materials replacement in buildings as well as due to the use of renewable energy sources as alternative to fossil fuel used previously.

4.1.2 Objectives pursued in SmartEnCity related to sustainable mobility

The implementation of specific sustainable actions in the cities will bring the accomplishment of the following objectives:

Technical and environmental objectives

- The implementation of mobility actions (city mobility planning and bikes) and the possible increase of use of public services (taxis and buses) will contribute to reduce the traffic congestion in the city. The introduction of EV or biogas buses are not considered for evaluating the influence in the city flow since it is not expected to increase the number of vehicles but a replacement of the existing ones.
- The substitution of old vehicles for more efficient vehicles (electrical vehicles and biogas buses) will contribute to decrease the energy consumption in urban transport at the same time that emissions to the atmosphere are reduced. In addition, it will evaluate the possible increase of use of public services (taxis, buses and bikes) that would affect the energy consumed.
- The introduction of measures for last mile vehicles will improve the efficiency of freight deliveries due to a better quality of service measured as accuracy or a reduction of delivery times.
- The implementation of mobility actions in public transport (electrical taxis and biogas buses) could increase the efficiency of public transport measured as arriving/departing on time.

Social and economic objectives

- Introduction of electrical vehicles and biogas buses could increase the social acceptance of drivers towards this type of vehicles because of the reduction in the operation cost as well as an enhancement in the opinion about the initiatives promoted by SmartEnCity project. In addition, this reduction in the energy costs will contribute to improve the quality of life of drivers/companies because of higher money availability.
- Finally, as a consequence of the access to a better price (for EV) or a cheaper fuel (in the case of biogas buses), it could decrease the payback of investment for this type of vehicles.

4.1.3 Objectives pursued in SmartEnCity related to citizen engagement strategy

Technical and environmental objectives

The use of ICT solutions, such as apps, social networks and website, and the information campaigns will help to strengthen citizens' awareness and engagement in the project. It will consider that the citizen strategy is successful if:

- Interventions have been accomplished in the cities according to the implementation plan.
- ICT solutions have been widely used by residents, drivers, citizens, companies and municipalities and a significant number of beneficiaries have attended to information campaigns arranged for explaining the benefits of the interventions.
- A better management of energy consumption has been produced due to a change in the energy consumption behaviour of end consumers (e.g. residents, drivers and citizens) as well as it has produced an increase of environmental awareness conditioned by the use of ICT solutions and the use of guidelines promoted in information campaigns.

On the other hand, it is expected that SmartEnCity contributes to extend the existing Urban Platform by increasing the capacity of ICT infrastructure due to the higher number of data that are managed, stored and controlled after the installation of sensors and meters in dwellings, buildings, energy supply units and vehicles and the deployment of services and added value services.

Social objectives

The use of ICT solutions (e.g. apps, social networks and website) will contribute to promote the project and the benefits to be obtained at all scales in each LH participating in SmartEnCity, from beneficiaries of interventions, until the administration, companies and citizens in general. As a consequence, it will contribute to increase the acceptance and perception of the advantages of this type of project in the society.

Economic objectives

Concerning the economic objectives, it is expected to contribute to the reduction of energy costs of citizens by the use of economic resources from municipalities and/or companies.

4.2 Proposed KPIs

KPIs will be used for evaluating the objectives expected to be reached in terms of energy and CO_2 reductions as well as other objectives that are desirable.

In this section, it is included the potential list of KPIs to be used in SmartEnCity which deal to evaluate the interventions performance from a holistic point of view following the scheme previously described in figure 4.

List KPIs for each category (technical, environmental, social and economic) and by type of intervention (district renovation, mobility and citizen engagement) is provided in the sections below. The complete definition of indicator is incorporated in the Annex 1.

4.2.1 KPIs identified for district renovation

Type	Action	General objective	Category	List of indicators
Technical indicators	**Implementation of energy performance measures in district**	Reduce the energy demand of buildings	Energy performance indicators	Delivered energy
				Primary energy
				Density of energy demand
		Reduce home thermal energy consumptions with desired comfort at dwelling level	Thermal comfort indicators	Internal air temperature
				Internal relative humidity
				Internal air speed and distribution
				Thermal comfort
	Implementation of ICT solutions and RES	Improve the energy efficiency of district Maximizing the use of RES and the self-energy consumption in the district	Efficiency indicators- Demand side management	Peak load and load profile of electricity demand
				Peak load and load profile of thermal (heating/cooling) energy demand
				Specific yield
				Degree of congruence of calculated annual final energy demand and monitored consumption
			Efficiency indicators- ICT as enabler of information	Number of dwellings and buildings managed by ICT solutions
				Number of sensors in buildings connected in dwelling and building
				Amount of data that can be managed and controlled in the district

Technical indicators	**Implementation of ICT solutions and RES**	Improve the energy efficiency of district Maximizing the use of RES and the self-energy consumption in the district	Efficiency indicators-Control of energy systems	Use of information generated by end consumers
				Degree of energetic self-supply
				Share of renewable energy
			Efficiency indicators-Reliability system	Ratio of power interruptions avoided in a year
Environmental indicators	**Implementation of energy performance measures, RES and ICT solutions in district**	Reduce the CO_2 emissions	Emission indicators	CO_2 emissions
	Implementation of energy performance measures and RES in district	Reduce the environmental impact of the district intervention in the environment	LCA index	Cumulative energy demand
				Climate change
				Ecotoxicity
				Human toxicity
				Fossil depletion
				Ecological footprint
Social indicators	**Implementation of energy performance solutions, RES and ICT solutions in district**	Improve the life quality of residents & social acceptance of residents	Statistical indicators-Demographic resident data	Age of inhabitants
				Highest level of completed education of inhabitants
				Nationality
				Number of people living in the house
				Number of households without employment
				Number of households receiving housing subsidies
				Net monthly income of the households
			Statistical indicators-Housing characteristics	Size of the household
				Ownership structure
				Building types
				Construction year categories
				Years of occupancy in the current home
				Size of the dwelling

Social indicators	**Implementation of energy performance solutions, RES and ICT solutions in district**	Improve the life quality of residents & social acceptance of residents	Individual perception indicators- Project acceptance	Residents project satisfaction
				Residents information satisfaction
				Residents involvement degree
				Residents energy awareness
				Satisfaction with the information accessibility
			Individual perception indicators- Intervention acceptance	Technical solution satisfaction
				ICT tools satisfaction
				Aesthetical satisfaction
				Energy savings satisfaction
				Comfort conditions
				Energy bill reduction
				Business models
				Further investments in energy related projects
Economic indicators	**Implementation of energy performance solutions, RES and ICT solutions**	Reduce the energy costs of residents	Indicators related to cost	Investment
				Grants
				Total annual costs
		Decrease the payback of investment intervention	Indicators related to incomes	Total annual revenues
			Indicators related to viability	Net present value
				Internal rate of return
				Dynamic payback period
				Economic payback period

Table 6: KPIs proposed for evaluating district renovation

4.2.2 KPIs identified for mobility

Type	Action	General objective	Category	List of indicators
Technical indicators	**Implementation of mobility actions** *(Last mile vehicles, bikes, city mobility planning)*	Reduce the traffic congestion	Logistic indicators	Traffic flow by vehicle type - peak
				Traffic flow by vehicle type - off peak
				Flow (at a specific reference point)
				Average vehicle speed (peak / off-peak)
				Average time for a reference distance
				Average occupancy
	Implementation of mobility actions in freight *(Last mile vehicles)*	Increase the efficiency of freight deliveries	Logistic indicators	Accuracy of timekeeping for freight
	Implementation of mobility actions in public transport *(Electrical taxis, biogas buses)*	Increase the efficiency of public transport		Accuracy of timekeeping for public bus
	Replacement of old vehicles for more efficient vehicles *(EV and biogas buses)* **and an increase of use of public services** *(Taxis, buses, bikes)*	Decrease energy consumption	Energy performance indicators	Vehicle fuel efficiency
Environmental indicators	**Use of high performance green vehicles** *(EV, biogas buses, public transport)*	Reduce the CO_2 emissions	Emissions indicator	CO_2 emission by travelled distance
			Use of cleaner vehicles	Total number of recharges per year (biogas and EV)
				Total kWh recharged in the EV charging stations (biogas and EV)

Social indicators	**Implementation of mobility actions** *(EV and biogas buses)*	Improve the life quality of drivers & social acceptance	Statistic indicators	Age of driver
				Highest level of completed education of drivers
				Gender
				Years working as driver
				Years of vehicle to be replaced
			Individual perception indicators	Inhabitants project satisfaction
				Inhabitants information satisfaction
				Satisfaction with the information accessibility
				Technical solution satisfaction
				ICT tools satisfaction
				Comfort conditions
				Energy bill reduction
				Business models
Economic indicators	**Implementation of mobility actions** *(EV and biogas buses)*	Reduce the energy costs of residents	Indicators related to cost	Investment
				Grants
				Total annual costs
		Decrease the payback of investment intervention	Indicators related to incomes	Total annual revenues
			Indicators related to viability	Net present value
				Internal rate of return
				Dynamic payback period
				Economic payback period

Table 7: KPIs proposed for evaluating sustainable mobility actions

4.2.3 KPIs identified for citizen engagement

Type	Action	General objective	Category	List of indicators
Technical indicators	Implementation of information campaigns and urban platform	Achieve the engagement of citizens	Citizen engagement indicators through information campaigns	Number of dissemination activities carried out
				Number of people reached in dissemination activities
				Number of persons who were against project
				Number of surveys fulfilled
				Quality of the information delivered to the citizens
			Citizen engagement indicators through ICT solutions	Number of citizens using web application
				Number of citizens (registered users) using web application
				Number of visits
				Increase of new visitors
				Maximum concurrent users/requests
				Time spent of the web
				Number of Apps developed
				Number of mobile app downloads
				Number of active users of Apps
				Quality of services/added value services
		Improve the current urban infrastructure	Performance indicators of ICT platform	Number of sensors connected to the Local ICT platform
				Types of measurements
				Types of energy measurements
				Types of mobility/transport measurements
				Types of environment measurements
				Amount of data generated
				Massive data management: storage capacity
				Use of information generated by end consumers

Environmental indicators	**Implementation of information campaigns and urban platform**	Increase the environmental awareness of residents, drivers and citizens	Awareness indicators	Environmental awareness
				Awareness of environmental problems in the city
				Knowledge about efficient energy measures
Social indicators	**Implementation of information campaigns and urban platform**	Increase the social acceptance of project	Statistical indicators	Age of citizens
				Highest level of completed education of citizens
				Project involvement degree
			Individual perception indicators	Citizen project satisfaction
				Citizen information satisfaction
				Satisfaction with the information accessibility
				Technical solution satisfaction
				ICT tools satisfaction
				Business models
				Further investments in energy related projects
Economic indicators	**Implementation of information campaigns and urban platform**	Contribute to the reduction of the energy costs of the citizens	Indicators related to costs	Investment
				Grant
				Total annual costs

Table 8: KPIs proposed for evaluating citizen engagement strategy

4.3 Plan of evaluation: work to be done

Once the KPIs have been defined in the current deliverable, as described in this deliverable, an evaluation plan will be designed for evaluating the effects of interventions from technical, economic and social points of view.

For the development of this evaluation plan, small groups will be defined around specific topics, taking part partners from each LH. These mentioned topics are the protocols of evaluation which group indicators described in the current deliverable.

Protocol	Scope	Type of KPIs
Energy assessment	Energy and emissions savings in district Thermal comfort	Technical and environmental indicators for district intervention
ICT	Energy efficiency achieved in district Share of RES/self-energy supply due to the use of ICT	Technical indicators for district intervention
LCA	Impact of the district intervention in the environment (life cycle approach)	Environmental indicators for district intervention
Mobility	Energy and emissions savings Traffic reduction	Technical and environmental indicators for mobility action
Cross-cutting	**Social:** Social acceptance **Citizen engagement:** Success of citizen engagement strategy by the number of people reached in workshops and people using ICT platform (added value services, apps, social network). This can influence in the decrease of energy demand and increase the environmental awareness **Economic:** Economic savings & payback	Social and economic indicators for district intervention, mobility action and citizen engagement Environmental indicators for citizen engagement

Table 9: Protocols of evaluation: scope and type of KPIs

Some KPIs will be evaluated through sensors, requiring a monitoring for two years. However, other indicators (mainly related to social and economic issues) will be evaluated through surveys to be delivered at the beginning of the project and the final of the project.

Therefore, the selection of KPIs will depend of the type of sensors and meters selected and the possibilities to distribute questionnaires to residents and drivers or to ask certain questions.

5 Deviations to the plan

Task 7.1 intends to define a plan for evaluating the interventions performance as well as the city performance based in the definition of KPIs.

Current deliverable is named “KPIs definition”, but it does not consist of the definitive set of KPIs to be used in the project. Instead, it has proposed to define the KPIs for evaluating interventions into two steps in order to count with enough time for a proper selection. In a first stage, a list of KPIs have been suggested by CAR and TEC (current D7.2 at M6) and they will be validated by partners involved directly in the interventions according to the possibilities to implement the strategy here defined. Such selection will be done at M12 in the D7.3.

This approach does not affect any other tasks. In fact, the final identification of KPIs in a further step of the project will allow to knowing more details of interventions and monitoring scheme and define the evaluation plan which can be really deployed in the cities. This same process was deployed with indicators for city diagnosis. They were proposed by main responsible of evaluation plan (CAR and TEC) in D7.1 at M3 for a posterior selection by partners from cities in D2.4 at M6.

6 Outputs for other WPs

The evaluation scheme will take part of other tasks and WPs of SmartEnCity project following the descriptions below.

This evaluation scheme starts with the definition of a strategy of evaluation (D7.2) which consists of objectives to be reached and KPIs as tool for evaluating the level of progress achieved in the project. Then, this strategy will be validated by partners participating in interventions and will conclude with a plan of evaluation (D7.3). This plan will define the procedures which allow to assessing the baseline and final performance of the interventions.

In a further step, the baseline (this is the status of district and mobility actions in terms of energy, social and economic issues) will be evaluated in each city as part of D3.2, D4.2 and D5.2 through the use of specific KPIs and applying the methodologies described in D7.3. In parallel, it will build the monitoring programs and the data collection approach which allow to collect and gather data from dwellings, buildings, district and vehicles to be used for evaluating the final performance. In a final step, the final performance obtained will be evaluated, taking into account the methodologies described in the plan of evaluation.

Figure below shows the stages of this evaluation scheme and the corresponding deliverables.

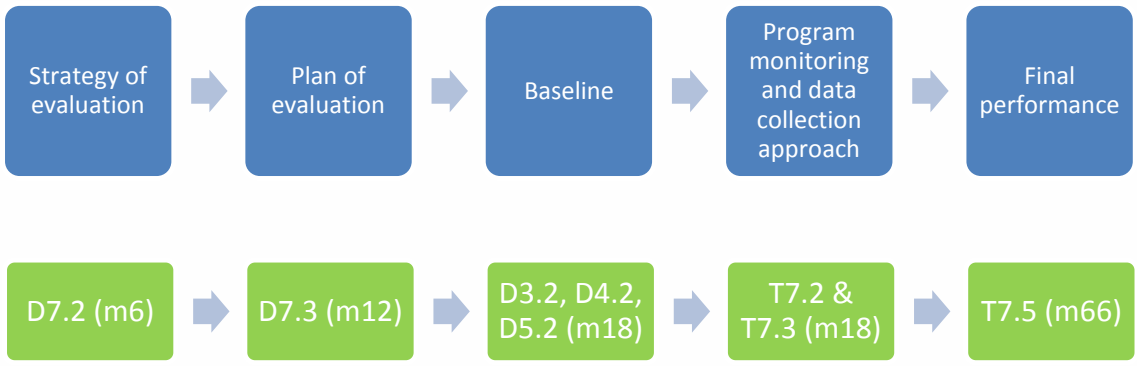

Figure 5: KPIs as outputs for other WPs

7 List of indicators

DISTRICT INTERVENTION

	List of indicators	Definition	Unit	Data source	Inputs parameters
Energy performance indicators	Energy demand	Energy that the building requires to meet its needs/uses (i.e. heating, DHW, cooling, electricity…)	kWh/ m²a	Simulation/ theoretical calculation	
	Delivered energy (for buildings)	Delivered energy is energy, expressed per energy carrier, supplied to the technical building systems through the system boundary, to satisfy the uses taken into account (heating, cooling, ventilation, domestic hot water, lighting…) or to produce electricity (EN 15603:2008). Often, comparability with respect to electricity can be achieved if only lighting and auxiliary energy are considered. Thus, user-dependent electricity consumer (computer, refrigerator etc.) are not considered. To enable the comparability between buildings, the delivered energy is related to the size of the building (e.g. gross floor area or net floor area, heated floor area) and the considered time interval (e.g. year).	kWh/m²a	Energy meters	Delivered energy per energy carrier Floor area of the building Reference time period
	Delivered energy (for energy supply units)	The delivered energy of a large-scale or building-integrated energy supply unit corresponds to the energy entering the energy supply unit (e.g. energy content of light oil, electricity, district heat). To enable the comparability between energy supply units, the total delivered energy is related to the energy output of the energy supply unit (e.g. electricity, heat, cold). In case of cogeneration the input is matched to the output using an exergy based approach. This indicator represents the reciprocal efficiency of the energy supply unit. * Exergy factor: In case of polygeneration the raw energy used as input has to be allocated to the different outputs. The exergy-based approach only considers that part of energy that can be converted into mechanical work. If e.g. a CHP plant produces heat and power, the exergy of one KWh electricity is higher than the exergy of the same amount of thermal energy. Therefore the major part of the input can be assigned to the generated electricity and the smaller portion to the generated heat. This approach therefore considers how useful the forms of energy are for the final consumers.	kWin/kWout	Energy meters	Delivered energy per energy carier Output per energy carrier Exergy factor for the output of energy carrier (*)

Energy performance indicators	Primary energy (for buildings)	The primary energy approach makes possible the simple addition from different types of energies (e.g. thermal and electrical) because primary energy includes the losses of the whole energy chain, including those located outside the building system boundary. These losses (and possible gains) are included in a primary energy factor. The energy performance of a building is the balance of the delivered energy and the exported energy. The annual amount of primary energy (net delivered primary energy) is calculated as the difference between the weighed delivered energy, summed over all energy carriers and weighed exported energy summed over all energy carriers (EN 15603:2008).	kWh/m²a	Energy meters and primary energy factors (standards, tables)	Delivered energy per energy carrier Exported energy per energy carrier Primary energy factor for the delivered energy carrier Primary energy factor for the exported energy carrier Floor area of the building Reference time period
	Primary energy (for energy supply units)		kWin/kWout		Delivered energy per energy carier Primary energy factor for the delivered energy carrier Exergy factor for the output of energy carrier Output per energy carrier Exergy factor for the output of energy carrier
	Density of energy demand	The indicator is defined as ratio of final energy demand (for heating or cooling) of a cohesive set of buildings and a simple figure representing the effort that a district heating or cooling network operator would have in order to supply these buildings. For the latter the territory area or the number of buildings is chosen in order to represent the length of the network and the number of connections that are required.	kWh/m²a	Estimated	

Thermal comfort indicators	Internal air temperature	This parameter is directly involved in the determination of internal comfort condition but it also allows to investigate (with another parameter as the heat quantity for set point achievement) how much energy is necessary to reach a particular desired condition known as set point. Use both this parameter (before and after an Energy Conservation Measure (ECM) considering the same set point condition) allows to know how much heating energy has been saved thanks to the ECM's interventions.	ºC	Meters	
	Heat quantity for set point achievement	This parameter allows to collect information about the quantity of energy that is needed to reach a particular temperature condition known as set point. Using this data before and after an ECM (considering the same set point condition) allows to know how much heating energy has been saved thanks to the ECM's interventions.	kWh	Meters	
	Internal relative humidity	This parameter is a percentage ratio between the quantity of vapour included in an air mass and the maximum quantity of vapour that the same air mass could include under the same conditions of temperature and pressure. This data gives information about the level of saturation of the atmospheric & vapour which value, primary for comfort conditions and ambient healthfulness, should be comprehended between 55% - 65%.	%	Meters	
	Internal air speed and distribution	Through this parameter it's possible to know the movement of the air inside the internal ambient. The movement of the air contributes to the healthfulness of the internal air quality level but, this same movement, in function of its speed, could also produce changes in individual comfort conditions due to the augment of the convection heat dissipation or to improper air flows.	m/s	Meters	
	Thermal comfort	This indicator represents the level of thermal comfort measured as the number of hours that the indoor temperature and relative humidity conditions are within range of values defined. The range of comfort values varies with the seasons (as it depends on the metabolic rate and clothing of the building users) and the climatology of each city (average monthly temperatures (max & min) and average monthly relative humidity).	-	Meters	

Efficiency indicators	Peak load and load profile of electricity demand	The load profile describes the demand characteristics over time, while peak load is what the electricity supply has to be able to cover. The load profile gives information about the possibilities or potentials of storage, demand-side management and self-supply via photovoltaic etc.	kW	Energy meters	
	Peak load and load profile of thermal (heating/cooling) energy demand	The peak load and the load profile of the thermal (heat and cold) energy demand require a high temporal resolution. The load profile describes the demand characteristics over time. The thermal energy supply has to be able to cover the peak load. The load profile gives information about the possibilities or potentials of storage as well as supply-side and demand-side management.	kW	Energy meters	
	Specific yield	The specific yield is the calculated or metered output energy of a supply system related to the size (capacity) of the system. It often is provided as an annual or monthly value, for closer studies a higher resolution is adequate. All energy supply units have a peak power load, heat exchangers all have a surface area, and so these are taken as the related size of the system. The system size is either described by the surface area (e.g. collector area of solar thermal systems) or the peak power (e.g. electrical power of a wind turbine).	W/(m².K)	Estimated	Annual output energy Size (system area) Size (peak power)
	Degree of congruence of calculated annual final energy demand and monitored consumption	Ratio of the theoretical energy demand of a building or set of buildings (calculated) and the final energy consumption of a building or set of buildings (measured) over a period of time (e.g. year)	%	Estimated	
	Number of dwellings and buildings managed by ICT solutions	Number of dwellings and buildings with metering devices, sensors or other components installed to collect data (e.g. electrical or thermal consumption) or to control thermal citizen with respect to the final number of buildings retrofitted.	Number	Estimated	
	Number of meters and sensors connected in dwelling and building	Number of meters and sensors installed in district (identified by dwelling and building).	Number	Estimated	
	Amount of data that can be managed and controlled in the district	Number of data gathered through meters and sensors in the district in a period of time defined.	Number	Estimated	

Efficiency indicators	Degree of energetic self-supply	The degree of energetic self-supply is defined as ratio of locally produced energy and the local consumption over a period of time (year). The indicators are separately determined for thermal energy (heat or cold) and electricity. Furthermore, the quantity of locally produced energy can be interpreted as by renewable energy sources (RES) produced energy or by combined heat and power (CHP) plants produced energy.	%	Estimated	
	Share of renewable energy	Total share of renewable energy sources in a complex energy supply system.	%	Estimated	
	Ratio of power interruptions avoided in a year	Avoiding failures revert on higher reliability, meaning fewer stops on the normal operation of the building and associated systems. With the application of ICT measures it is possible to correct a potential misbehaviour of the system and avoid unexpected stops.	%	Estimated	
Emission indicators	Greenhouse gases emissions (for buildings)	The greenhouse gases of a building correspond to the emissions that are caused by different areas of application (space heating, space cooling, domestic water heating, electrical appliances). To enable the comparability between buildings, the emissions are related to the size of the building (e.g. gross floor area or net floor area, heated floor area) and the considered interval of time (e.g. year). The greenhouse gases are considered as t of CO_2 or CO_2 equivalents.	t/m²a	Estimated	
	Greenhouse gases emissions (for energy supply units)	The greenhouse gas of a largescale or building-integrated energy supply unit correspond to the emissions that are caused by the energy output. To enable the comparability between energy supply units, the total energy demand is related to the energy output of the energy supply unit (e.g. electricity, heat, cold). In case of cogeneration the input is matched to the output using an exergy based approach.	t/(m²a)	Estimated	

LCA index	Cumulative energy demand	The aim of the method is to quantify the primary energy usage throughout the life cycle of a good or a service. The method includes the direct and indirect uses of energy, but not the wastes used for energy purposes. The gross calorific value (GCV) of the different fuels and materials is used for determining the characterization factors (CFs).	MJ	Method published by Ecoinvent version 1.01 and expanded by PRé	
	Climate change	Climate change can be defined as the change in global temperature caused by the greenhouse effect that the release of "greenhouse gases" by human activity creates. The Environmental Profiles characterization model is based on factors developed by the UN's Intergovernmental Panel on Climate Change (IPCC). Factors are expressed as Global Warming Potential over the time horizon of different years, being the most common 100 years (GWP100), measured in the reference unit, kg CO_2 equivalent.	kg CO_2equiv	Intergovernmental Panel on Climate Change (IPCC)	
	Ecotoxicity	This category indicator refers to the impact on freshwater, marine and land ecosystems, as a result of emissions of toxic substances to air, water and soil. Eco-toxicity Potential (FAETP) is calculated with USES-LCA, describing fate, exposure and effects of toxic substances for an infinite time horizon and is expressed as 1,4-dichlorobenzene equivalents/kg emission. The indicator applies at global/continental/ regional and local scale.	kg 1,4-dichlorobenzene equivalent (1,4-DB)	Method published by RIVM and Radboud University, CML, and PRé	
	Human toxicity	This category concerns effects of toxic substances on the human environment. Health risks of exposure in the working environment are not included. Human Toxicity Potentials (HTP) is calculated with USES-LCA, describing fate, exposure and effects of toxic substances for an infinite time horizon. For each toxic substance, HTP's is expressed as 1,4-dichlorobenzene equivalents/ kg emission. The geographic scope of this indicator determines on the fate of a substance and can vary between local and global scale.	kg 1,4-dichlorobenzene equivalent (1,4-DB)	Method published by RIVM and Radboud University, CML, and PRé	
	Fossil depletion	The characterization factor of fossil depletion is the amount of extracted fossil fuel extracted, based on the lower heating value. The unit is kg oil equivalent.	kg $_{\text{oil e}}$	Method published by RIVM and Radboud University, CML, and PRé	

LCA index	Ecological footprint	A measure of how much area of biologically productive land and water that an individual, population or activity requires to produce all the resources it consumes and to absorb the waste it generates, using prevailing technology and resource management practices. The Ecological Footprint is usually measured in global hectares. Because trade is global, an individual or country's Footprint includes land or sea from all over the world. Without further specification, Ecological Footprint generally refers to the Ecological Footprint of consumption. Ecological Footprint is often referred to in short form as Footprint. "Ecological Footprint" and "Footprint" are proper nouns and thus should always be capitalized.	ha	Method published by Niels Jungbluth, ESU-services Ltd., Uster	
Statistical indicators	Age of residents	The age of residents is classified in five categories, which are (i) under 18 years old, (ii) between 18 and 30 years old, (iii) between 31 and 50 years old, (iv) between 51 and 65 years old and (v) more than 65 years old.	average age, % of a number of suitable categories	Questionnaire	
	Highest level of completed education of inhabitants	The highest level of completed education of residents is classified in five categories, which are (i) without studies, (ii) primary studies, (iii) secondary studies, (iv) vocational education and (v) University studies.	% of a number of suitable categories	Questionnaire	
	Nationality	The nationality data corresponds to (i) the percentage of main nationality and (ii) percentage of foreigners.	% of main nationality, % of foreigners	Questionnaire	
	Number of people living in the house	Number of people living in each house.	Average number	Questionnaire	

Statistical indicators	Number of households without employment	The number of households without employment is defined as a percentage of the total.	% of total	Questionnaire	
	Number of households receiving housing subsidies	The number of households receiving housing subsidies is defined as a percentage of the total.	% of total	Questionnaire	
	Net monthly income of the households	The net monthly income of the households is classified in five categories, which may vary for each state. For Spain, these are the categories defined: (i) less than 1,000 €, (ii) between 1,001 and 2,000 €, (iii) between 2,001 and 3,000 €, (iv) between 3,001 and 4,000 € and (v) more than 4,000 €. If the KPIs is selected, to add information for Estonia and Denmark	Average, % of a number of suitable categories	Questionnaire	
	Size of the household	The size of the household is defined as the number of inhabitants living in a household. This indicator is classified in six categories, which are (i) empty dwelling, (ii) 1 person, (iii) 2 persons, (iv) 3 persons, (v) 4 persons and (vi) more than 4 persons.	average size, % of a number of categories	Questionnaire	
	Ownership structure	The ownership structure is divided in two categories, which are (i) ownership and (ii) rental.	% of a number of categories	Questionnaire	
	Building types	The building types corresponds to seven categories, which are (i) single house, (ii) semi-detached house, (iii) terraced house, (iv) line block building, (v) tower block building, (vi) central patio building and (vii) non-residential building.	% of a number of types	Questionnaire	

Statistical indicators	Construction year categories	Construction year data of the residential and non-residential buildings are classified in eight categories according to Eurostat [ ] classification. Those categories are (i) before 1919, (ii) between 1919 and 1945, (iii) between 1946 and 1960, (iii) between 1961 and 1970, (iv) between 1971 and 1980, (v) between 1981 and 1990 (ii) between 1991 and 1995 and (ii) from 1996 until today.	Average year, % of a number of Eurostat [10] categorie	Questionnaire	
	Years of occupancy in the current home	The years of occupancy in the current home are divided in five categories, which are (i) until 3 years, (ii) between 4 and 6 years, (iii) between 7 and 10 years, (iv) between 11 and 20 years and (v) more than 21 years.	Average years, % of a number of categories	Questionnaire	
	Size of the dwelling	The size of the dwelling corresponds to the surface in m^2 and is classified in five categories, which are (i) less than 50 m^2, (ii) between 51 and 70 m^2, (iii) between 71 and 90 m^2, (iv) between 91 and 110 m^2 and (v) more than 110 m^2.	Average m^2, % of a number of categories	Questionnaire	
Individual perception indicators	Residents project satisfaction	The inhabitant's project satisfaction KPI determines the level of satisfaction of the dwelling's resident with regard to the project in general terms. The project is surrounded by technical solutions, information, costs, intervention phases and external conditions, among others. This KPI is completely subjective and compiles the inhabitant's global opinion from a survey with possible values from 0 to 10 marks. The result of this KPI is a % of satisfied people and it succeeds when, at least, 75% of people evaluate the satisfaction level with 6 marks or more.	%	Questionnaire	

Individual perception indicators	Residents information satisfaction	As stated before, one important part of this kind of projects is the information level provided to the neighbors about the intervention, costs and so on. Similar to the previous one, it is a subjective KPI which assesses the residents' opinion from surveys with score marks between 0-10. The successful mark is considered when, at least, 75% of people answer with 6 points or more.	%	Questionnaire	
	Residents involvement degree	Traditionally, the residents are not involved in these projects, however, the social awareness about energy and sustainability is growing. Due to this fact, people are more involved in the decision-making process, even during the renovation though giving feedback at the operational stage. The result of the KPI is the % of people who feel involved during the intervention project life cycle and it is considered as achieved, when, at least, 20% of people are implicated and give feedback.	%	Questionnaire	
	Residents energy awareness	Complementary to the previous KPI, the energy awareness is related to the involvement degree. Thus, this KPI evaluates the residents' awareness level with regard to the energy worldwide problem, both those citizens who already are concerned and those neighbors who change their consciousness. With this aim, the KPI assesses if more than 60% of people have modified their perspective with regard to energy concerns or, at least, they are aware of the issue (5 score marks or more).	%	Questionnaire	
	Satisfaction with the information accessibility	The improvement of the energy facilities in residential buildings implies the energy measurements at different levels. One of them is the dwelling level which determines the energy consumption for heating, DHW and comfort conditions at individual homes. Normally, this information is used for the control strategies, but also with the objective of providing the energy profiles to the owners. Thus, this KPI determines whether the residents with energy monitoring systems are satisfied with the access to such data. The achievement limit of the KPI is established at 75% of people who score 6 point marks or upper.	%	Questionnaire	

Individual perception indicators	Technical solution satisfaction	Any renovation project has the main objective of improving the performance of the building. However, other problems can arise such as new moisture issues. All the inconveniences during the retrofitting stage may be classified in different levels of impact from an objective point of view, but the residents' perspective is also important. With this aim, this KPI evaluates the satisfaction of the owners with regard to technical concerns. It is measured in percentage terms and it is reached when, at least, 75% of people assess the technical solutions with 6 score marks or more.	%	Questionnaire	
	ICT tools satisfaction	Apart from the renovation at façade and district heating levels, ICT tools are deployed too with the goal of managing the generation and distribution systems, as well as monitoring. On one hand, owners are not normally concerned about the internal control algorithms. On the other hand, monitoring systems require smart metering at dwelling level and visualization platforms. In this regard, the installation of smart devices could be helpful to some citizens, although it could complicate to others taking into consideration technology is not always easy to understand. Therefore, so as to get feedback in this topic, owners assess the ICT tools, achieving the KPI if more than 75% of people with these systems evaluate them with 6 score marks or more.	%	Questionnaire	
	Aesthetical satisfaction	Another important issue from the residents point of view, although less important from the technical solutions is the aesthetics. Nevertheless, for achieving social acceptance, citizens need to be comfortable from the energy perspective (comfort and energy bills), but also from the aesthetic solution. Sometimes, the development of high efficiency solutions is not attractive, whereas if, additionally, it is aesthetically lovely, probably, the neighbors will accept the technical solutions too. With that aim, the citizens opinion is also gathered and evaluated trying to achieve more than 75% of people satisfied with 6 score marks or more.	%	Questionnaire	
	Energy savings satisfaction	One of the main objectives of this kind of projects is the reduction of the energy consumption both at district and building and dwelling levels. However, from the social perspective, not only the numeric value is enough, but also the owners' opinion is required. In this way, the achievement of this KPI is done if more than the 60% of the people feel satisfied with the reached energy savings. Nevertheless, this result is compared with the objective KPI about energy savings, because both must be aligned so that the results would be consistent.	%	Questionnaire	

Individual perception indicators	Comfort conditions	Another goal of this sort of projects is the comfort, even the most important from the end user together the reduction of the energy bills. Nevertheless, the comfort is, perhaps, the most subjective parameter because every person's comfort level differs from each other. The feeling of the citizens varies, but, at least, the 75% of owners have to feel comfortable in their dwellings. In contrast to the subjective evaluation, the objective result gives the real performance compared to the National regulations which limit the maximum and minimum conditions associated to the building typology. Thus, the opinion of the owners can be compared with the regulations to obtain the real context.	%	Questionnaire	
	Energy bill reduction	The most important results in economic terms within the social acceptance in these projects are the reduction in the energy bills that is directly translated into money. The subjective and objective information is available, therefore, the result of the KPI will be compared with the subjective one in order to detect inconsistences. First of all, the objective value gathers the percentage of reduction in the energy bills by comparing the status before and after the intervention. Regarding the subjective, people may be ambitious, wanting higher reduction results, but it is necessary that, at least, 60% of inhabitants evaluate the decrease of the bills upper 6 marks (0-10 score). It is important to note the fuel price can vary from different epochs, then, the % of cost savings ought to be determined from similar economic conditions.	%	Questionnaire	
	Business models	This KPI does not pretend to evaluate the whole success of the project, but it highlights the energy awareness of the people. If more than the 50% of owners want to change the business model of the district (e.g. fuel), it indicates the low satisfaction level with the existing business model.	%	Questionnaire	

Individual perception indicators	Further investments in energy related projects	Additional KPI in social acceptance is the further investments. It measures the percentage of inhabitants who would like to invest in further energy projects taking into consideration the results of the SmartEnCity one. Although the KPI has to take into account the economic situation of the families and without the objective of selling any product, the achievement is reached when at least 60% of people wish to invest in energy projects.	%	Questionnaire	
Indicators related to cost	Investment (for the refurbishment of a new set of buildings)	The investment in the refurbishment of a new set of building is defined as cumulated payments until the initial operation of the building after the refurbishment. In case of refurbishments payments for energy efficiency measures, building-integrated renewable energy measures as well as non-energetic measures can be included as components. In order to enable the comparability between buildings, the same components have to be included and the investments are related to the size of the building (e.g. gross floor area or net floor area, heated floor area).	€ €/m2	Questionnaire	
	Investment (for an energy supply unit)	The investment in an energy supply unit is defined as cumulated payments until the initial operation of the energy supply unit. In case of large-scale energy supply units, among others delivery payments (incl. packaging and insurance), labour payments for fitting (incl. insurance and start-up), construction payments (incl. building, foundation, ...), payments for lot of land, payments for monitoring equipment (e.g. meters), planning payments, payments for approval procedure, payments for resource storage, payments for connection to district heating system can be included as components. In order to enable the comparability between energy supply units, the same components have to be included and the investments must be related to the maximum energy output of the energy supply unit (e.g. electrical capacity, heating capacity, cooling capacity).	€/kW (installed or peak)	Questionnaire	
	Grants	The (here: investment-related) grant is defined as the part of the investment that is granted by a grant provider.	€/m2 %	Questionnaire	

Indicators related to cost	Total annual costs (for the refurbishment of a new set of buildings & for an energy supply unit)	The total annual costs are defined as sum of capital-related annual costs, requirement-related costs, operation-related costs and other costs. These costs can vary for each year. Capital-related costs encompass depreciation, interests and repairs caused by the investment. Requirement-related costs include power costs, auxiliary power costs, fuel costs, costs for operating resources and in some cases external costs. Operation-related costs include among other things the costs of using the installation and costs of servicing and inspection. Other costs include costs of insurance, general output, uncollected taxes etc. The total annual costs are related to the considered interval of time (year). To make different objects comparable the same types of costs have to be included in the calculation.	€/a	Questionnaire	
Indicators related to incomes	Total annual revenues	The total annual revenues are defined as sum of capital-related revenues, requirement-related revenues, operation-related revenues and other revenues. These revenues can vary for each year. Capital-related revenues encompass temporally distributed investment-related grants. Requirement-related revenues include sales revenues and grants for electricity, heat, cold and other. Operation-related revenues and other revenues are in this context of minor importance. The total annual revenues are related to the considered interval of time (year).	€/a	Questionnaire	

Indicators related to viability	Net present value	The net present value of an investment causing energy savings or energy production in comparison to a baseline is defined as the sum of the discounted annual incoming cash-flows related to the investment less the discounted annual outgoing cash flows related to the investment less the discounted annual incoming cash-flows related to the baseline plus the discounted annual outgoing cash-flows related to the baseline over a period of time. The latter can be determined by the time of the investment and a planning horizon.	€	Estimated	
	Internal rate of return	The internal rate of return of an investment causing energy savings or energy production in comparison to a baseline is defined as the interest rate that results into a net present value of zero.	--	Estimated	
	Dynamic payback period	The dynamic payback period of an investment causing energy savings or energy production in comparison to a baseline is defined as the smallest planning horizon that causes a non-negative net present value.	Years	Estimated	
	Economic payback period	The payback period is the time it takes to cover investment costs. It can be calculated from the number of years elapsed between the initial investment and the time at which cumulative savings offset the investment. Simple payback takes real (non-discounted) values for future monies. Payback in general ignores all costs and savings that occur after payback has been reached.	Years	Estimated	

SUSTAINABLE MOBILITY ACTIONS

Indicator	List of indicators	Definition	Unit	Data source	Inputs parameters
Logistic indicators	Traffic flow by vehicle type - peak	Average daily vehicle flow during the peak hours. The peak and off-peak hours must be defined by each city to correspond with the local conditions.	N. vehicles/day	Meter	
	Traffic flow by vehicle type - off peak	Average daily vehicle flow during the off-peak hours. The peak and off-peak hours must be defined by each city to correspond with the local conditions.	N. vehicles/day	Meter	
	Flow (at a specific reference point)	Number of vehicles passing a reference point per unit of time. The peak and off-peak hours must be defined by each city to correspond with the local conditions.	N. vehicles/hour	Meter	
	Average vehicle speed (peak / off-peak)	Average vehicle speed in peak and off-peak hours.	Km/h	Meter/ Questionnaire	
	Average time for a reference distance	Time used for covering a reference distance.	minutes	Meter/ Questionnaire	
	Average occupancy	Mean no. persons per vehicle/day.	N. vehicles/day	Questionnaire	
	Accuracy of timekeeping for freight	Number and percentages of services arriving/departing on time.	Number %	Meter/ Questionnaire	
	Accuracy of timekeeping for public bus	Number and percentages of services arriving/departing on time.	Number %	Meter	

Energy performance indicators	Energy consumption	The energy consumption can be measured directly from sensors installed in the vehicles or estimated from multiple parameters: Derived from average consumptions per distance travelled, depending on the type of vehicle and using a fuel mix according to the demonstration site country (which can be retrieved from multiple sources, such as EUROSTAT), and the average fuel consumption per vehicle type (again, can be retrieved from multiple sources, such the EEA or the ICCT). *Energy Consumption = distance travelled * (% of diesel vehicles * diesel average consumption + % of gasoline vehicles * gasoline average consumption)/100* Measured as a function of consumed fuel, assuming a value of 8.79 kWh per litre of gasoline and a value of 9.98 kWh per litre of diesel. [REFERENCIA NIST] *Energy Consumption = total diesel Litres * 9.98 + total gasoline litres * 9.79*	kWh or MW/h	Meters	
	Vehicle fuel efficiency	Total energy consumed for the vehicles measured as a function of consumed fuel per unit of transport activity. This should be derived by vehicle type and fuel type.	MJ/vKm	Meter/ Questionnaire	Fuel consumption by vehicles Total distance completed by vehicles
Emissions indicator	CO_2 emission by travelled distance	CO_2 emission produced by travelled distance. ∑ kms Travelled * Emissions by km by vehicle type	CO_2	Estimated	Distances travelled Emissions CO_2 by Km
Use of cleaner vehicles	Total number of recharges per year (biogas and EV)	Total number of recharges during a year in the public and private charging stations. It will be required to infrastructure operator and vehicle owners in order to compare this indicator with energy consumption and distance travelled.	Number	Meter/ Questionnaire	
	Total kWh recharged in the EV charging stations (biogas and EV)	Number of kWh recharged during a year in the public and private charging stations. It will be required to infrastructure operator and vehicle owners in order to compare this indicator with energy consumption and distance travelled.	kWh	Meter	

Statistical indicators	Age of driver	The age of driver is classified in five categories, which are (i) under 18 years old, (ii) between 18 and 30 years old, (iii) between 31 and 50 years old, (iv) between 51 and 65 years old and (v) more than 65 years old.	average age, % of a number of suitable categories	Questionnaire	
	Highest level of completed education of drivers	The highest level of completed education of inhabitants is classified in five categories, which are (i) without studies, (ii) primary studies, (iii) secondary studies, (iv) vocational education and (v) university studies.	% of a number of suitable categories	Questionnaire	
	Gender	The number of women and men as a percentage of the total drivers.	% of female and males	Questionnaire	
	Years working as driver	The years working as driver are divided in four categories, which are (i) until 10 years, (ii) between 10 and 20 years, (iii) between 21 and 30 years, (iv) more than 31 years.	Average years, % of a number of categories	Questionnaire	
	Years of vehicle to be replaced	The years of vehicle are divided in three categories, which are (i) until 10 years, (ii) between 10 and 20 years, (iii) more than 21 years.	Average years, % of a number of categories	Questionnaire	
Individual perception indicators	Inhabitants project satisfaction	The driver's project satisfaction KPI determines the level of satisfaction of the driver's owners with regard to the project in general terms. The project is surrounded by technical solutions, information, costs, intervention phases and external conditions, among others. This KPI is completely subjective and compiles the inhabitant's global opinion from a survey with possible values from 0 to 10 marks. The result of this KPI is a % of satisfied people and it succeeds when, at least, 75% of people evaluate the satisfaction level with 6 marks or more.	%	Questionnaire	
	Inhabitants information satisfaction	As stated before, one important part of this kind of projects is the information level provided to the vehicle drivers about the intervention, costs and so on. Similar to the previous one, it is a subjective KPI which assesses the owners' opinion from surveys with score marks between 0-10. The successful mark is considered when, at least, 75% of people answer with 6 points or more.	%	Questionnaire	

Individual perception indicators	Satisfaction with the information accessibility	This KPI determines whether the drivers with energy monitoring systems are satisfied with the access to such data. The achievement limit of the KPI is established at 75% of people who score 6 point marks or upper.		Questionnaire	
	Technical solution satisfaction	With this KPI, it wants to evaluate the satisfaction of the vehicles owners with regard to technical issues of new vehicles and charging infrastructures. It is measured in percentage terms and it is reached when, at least, 75% of people assess the technical solutions with 6 score marks or more.		Questionnaire	
	ICT tools satisfaction	Apart from the sustainable vehicles, ICT tools are deployed too with the goal of managing the urban mobility. In this regard, the installation of smart devices could be helpful to some citizens, although it could complicate to others taking into consideration technology is not always easy to understand. Therefore, so as to get feedback in this topic, vehicle drivers assess the ICT tools, achieving the KPI if more than 75% of people with these systems evaluate them with 6 score marks or more.		Questionnaire	
	Comfort conditions	Another goal of this sort of projects is the comfort, even the most important from the end user together the reduction of the fuel costs. Nevertheless, the comfort is, perhaps, the most subjective parameter because every person's comfort level differs from each other. The feeling of the citizens varies, but, at least, the 75% of drivers have to feel comfortable with new vehicle.		Questionnaire	
	Energy bill reduction	The most important results in economic terms within the social acceptance in these projects are the reduction in the energy bills that is directly translated into money. The subjective and objective information is available, therefore, the result of the KPI will be compared with the subjective one in order to detect inconsistences. First of all, the objective value gathers the percentage of reduction in the energy bills by comparing the status before and after the intervention. Regarding the subjective, people may be ambitious, wanting higher reduction results, but it is necessary that, at least, 60% of inhabitants evaluate the decrease of the bills upper 6 marks (0-10 score). It is important to note the fuel price can vary from different epochs, then, the % of cost savings ought to be determined from similar economic conditions.		Questionnaire	

Individual perception indicators	Business models	If more than the 50% of owners would recommend to change the business model of the vehicle (substitution of fuel vehicles by electrical or biogas vehicles), it indicates the low satisfaction level with the existing business model.		Questionnaire	
Indicators related to cost	Investment	The investment is defined as the payment to be done for the acquisition of each one of the vehicles and the cost of charging infrastructure. It can be useful to make a comparison with a standard vehicle of the same category. The same types of costs would be included.	€	Questionnaire	
	Grants	The (here: investment-related) grant is defined as the part of the investment that is granted by a grant provider.	%	Questionnaire	
	Total annual costs	The total annual costs are defined as sum of capital-related annual costs, operation-related costs and other costs. These costs can vary for each year. Capital-related costs encompass depreciation, interests and repairs caused by the investment. Operation-related costs include among other things the costs of fuels/electricity, costs of servicing and inspection. Other costs include costs of insurance, uncollected taxes, battery costs and time loss for fueling The total annual costs are related to the considered interval of time (year) It can be useful to make a comparison with a standard vehicle of the same category. The same types of costs would be included.	€	Questionnaire	
Indicators related to incomes	Total annual revenues	The total annual revenues consist of average incomes gains each year.	Years	Estimated	

Indicators related to viability	Net present value	The net present value of an investment causing energy cost savings in comparison to a baseline is defined as the sum of the discounted annual incoming cash-flows related to the investment less the discounted annual outgoing cash flows related to the investment less the discounted annual incoming cash-flows related to the baseline plus the discounted annual outgoing cash-flows related to the baseline over a period of time. The latter can be determined by the time of the investment and a planning horizon	€	Estimated	
	Internal rate of return	The internal rate of return of an investment causing energy cost savings in comparison to a baseline is defined as the interest rate that results into a net present value of zero	--	Estimated	
	Dynamic payback period	The dynamic payback period of an investment causing energy cost savings in comparison to a baseline is defined as the smallest planning horizon that causes a non-negative net present value.	Years	Estimated	
	Economic payback period	The payback period is the time it takes to cover investment costs. It can be calculated from the number of years elapsed between the initial investment and the time at which cumulative savings offset the investment. Simple payback takes real (non-discounted) values for future monies. Payback in general ignores all costs and savings that occur after payback has been reached.	Years	Estimated	

CITIZEN ENGAGEMENT ACTIONS

Indicator	List of indicators	Definition	Unit	Data source	Inputs parameters
Citizen engagement indicators	Number of dissemination activities carried out	Number of face to face dissemination activities carried out for introducing project and explain the benefits to be achieved with the implementation of interventions in each LH city. This indicator should be calculated separately: for workshops focused in district renovation, workshops for mobility actions and workshops for whole project.	Number	Estimated	
	Number of people reached in dissemination activities	This indicator intends to measure the number of participants in the activities developed in each LH city. This indicator should be calculated separately: workshops focused in district renovation, workshops for mobility actions and workshops for whole project.	Number	Estimated	
	Number of persons who were against project	This indicator intends to measure the level of rejection towards the project. It can be evaluated through the percentage of residents who voted against the retrofitting of buildings and the percentage of residents who voted against to district heating. In addition, if any group is created as a platform against the project, it should include as number of people who took part of these platforms.	%, number	Estimated	
	Number of surveys fulfilled	This indicator refers to the percentage of surveys fulfilled by residents, drivers and citizens from the total distributed surveys.	%	Estimated	
	Quality of the information delivered to the citizens	This indicator will be measured through the surveys distributed. It will be established that the quality of the information is suitable if 75% of people score 6 point marks or upper.	%	Questionnaire	
	Number of citizens using web application	This indicator consists of the number of people (registered users and anonymous) who have connected to the website of the project in a time basis (daily, monthly).	Number	Estimated	
	Number of citizens (registered users) using web application	Number of citizens (registered users) using the web in a time basis (daily, monthly). It is possible, it could evaluate by user typology (e.g. company, administration, citizen).	Number	Estimated	

Citizen engagement indicators	Number of visits (daily/monthly)	Number of daily and monthly visits: registered or anonymous.	Number	Estimated	
	Increase of new visitors	Percentage of increase (or decrease) in registered citizens, monthly.	%	Estimated	
	Maximum concurrent users/requests	Concurrent users accessing the website.	Number	Estimated	
	Time spent of the web	Average time that people spent in the website. It could measure monthly.	Seconds	Estimated	
	Number of Apps developed	Number of mobile app developed during the project, detailing the number addressed to residents, drivers and citizens .	Number	Estimated	
	Number of mobile app downloads	Number of mobile app downloads for each specific core service.	Number	Estimated	
	Number of active users of Apps	This indicator intends to evaluate how many active users are in the whole users of Apps. They are defined as those that log into the applications at least with a certain frequency. To set some threshold, we'll define active users as those that have logged in at least the same number of times than months in the reporting period with a gap no greater than two months between logins.	Number	Estimated	
	Quality of services/added value services	This indicator will be measured through the surveys distributed and it will be established that the quality of the services/added value services is suitable if 75% of people score 6 point marks or upper	%	Questionnaire	

Performance indicators of ICT platform	Number of sensors connected to the Local ICT platform	Number of sensors that the local ICT platform connect to.	Number	Estimated	
	Types of measurements	Number of different kinds of variables and measurement units the platform is able to manage, store and control.	Number	Estimated	
	Types of energy measurements	Number of different kinds of variables and measurement units the platform is able to manage, store and control, regarding energy.	Number	Estimated	
	Types of mobility/transport measurements	Number of different kinds of variables and measurement units the platform is able to manage, store and control, regarding mobility/transport.	Number	Estimated	
	Types of environment measurements	Number of different kinds of variables and measurement units the platform is able to manage, store and control, regarding environment.	Number	Estimated	
	Amount of data generated	Amount of data generated in each LH platform. Total and disaggregated by entities (Building, District, City).	Number	Estimated	
	Massive data management: storage capacity	Number of data which LH platform is able to manage, control and store.	Number	Estimated	
	Use of information generated by end consumers	This indicator is defined as the percentage of the data stored in the global platform that is used by the services a year (to be calculated monthly per service). The utilization of the information generated regarding occupancy, behaviour patterns, etc can contribute to automatize and optimize the systems and therefore to reduce the energy consumption of buildings but also to influence in the energy demand of end consumers due to a change in the individual user attitude and behavior.		Estimated	

Awareness indicators	Environmental awareness	This indicator shows the knowledge and awareness of citizens (direct beneficiaries of the project as residents and drivers and other citizens) on global environmental problems. Through a survey, they will be asked about the level of knowledge and awareness on different environmental problems and it could conclude that they are concerned about environment if more than 50% have heard about these problems and more than 75% score the awareness more than 6. It will be interested to compare the environmental problem related with the energy consumption and energy generation with others.		Questionnaire	
	Awareness of environmental problems in the city	This indicator shows the level of knowledge and awareness of citizens (direct beneficiaries of the project as residents and drivers and other citizens) on the existing environmental problems in the city. Through a survey, they will be asked about the level of knowledge and awareness on different environmental problems and it could conclude that they are concerned about environment if more than 50% have heard about these problems and more than 75% score the awareness more than 8. It will be interested to compare the environmental problem related with the energy consumption and energy generation with others.		Questionnaire	
	Knowledge about efficient energy measures	This indicator shows the level of knowledge of citizens (direct beneficiaries of the project as residents and drivers and other citizens) on the existing efficient energy measures at building and mobility level. Through a survey, they will be asked if they have heard about a list of measures and the benefits obtained. It could conclude that they are concerned about energy measures if more than 70% have heard about them.		Questionnaire	

Statistical indicators	Age of citizens	The age of citizens is classified in five categories, which are (i) under 18 years old, (ii) between 18 and 30 years old, (iii) between 31 and 50 years old, (iv) between 51 and 65 years old and (v) more than 65 years old.	average age, % of a number of suitable categories	Questionnaire	
	Highest level of completed education of citizens	The highest level of completed education of citizens is classified in five categories, which are (i) without studies, (ii) primary studies, (iii) secondary studies, (iv) vocational education and (v) university studies.	% of a number of suitable categories	Questionnaire	
	Project involvement degree	The type of beneficiary is classified as: beneficiary related to building retrofitting, related to mobility action or through dissemination activities addressed for whole citizens	% of a number of suitable categories	Questionnaire	
Individual perception indicators	Citizen project satisfaction	The citizen project satisfaction KPI determines the level of satisfaction of the person with regard to the project in general terms. The project is surrounded by technical solutions, information, costs, intervention phases and external conditions, among others. This KPI is completely subjective and compiles the inhabitant's global opinion from a survey with possible values from 0 to 10 marks. The result of this KPI is a % of satisfied people and it succeeds when, at least, 75% of people evaluate the satisfaction level with 6 marks or more.	%	Questionnaire	
	Citizen information satisfaction	Similar to the previous one, it is a subjective KPI which assesses the citizen' opinion about the information level provided to the citizens about the project from surveys with score marks between 0-10. The successful mark is considered when, at least, 75% of people answer with 6 points or more.	%	Questionnaire	
	Satisfaction with the information accessibility	This KPI determines whether the inhabitants from the cities are satisfied with the access to data available (website, social network, press, brochures, etc). The achievement limit of the KPI is established at 75% of people who score 6 point marks or upper.	%	Questionnaire	

Individual perception indicators	Technical solution satisfaction	Project aims not only to improve the environment but also to increase the satisfaction of citizens with the interventions and actions developed in the city. With this aim, this KPI evaluates the satisfaction of the citizens with new public vehicles in the city, charging infrastructures, district renovation, etc, It is measured in percentage terms and it is reached when, at least, 75% of people assess the technical solutions with 6 score marks or more (e.g. in terms of aesthetic achieved in the district, location of charging infrastructure, quality of public transport service, perception of a reduction in the noise, etc).	%	Questionnaire	
	ICT tools satisfaction	ICT tools are deployed with the goal of managing the citizen engagement. In this regard, it is known that the apps, the website or the social networks could not always easy to use by all the citizens. They will assess the ICT tools, achieving the KPI if more than 75% of people with these systems evaluate them with 6 score marks or more.	%	Questionnaire	
	Business models	If more than the 50% of citizens would recommend to change the business model of the vehicle (substitution of fuel vehicles by electrical or biogas vehicles) or the heating system in building, it indicates the low satisfaction level with the existing business model.	%	Questionnaire	
	Further investments in energy related projects	Additional KPI in social acceptance is the further investments. It measures the percentage of inhabitants who would like municipality to invest in further energy projects taking into consideration the results of the SmartEnCity (e.g. invest in new rechargers infrastructure, biogas buses, district renovation, etc). The achievement is reached when at least 60% of people wish to invest in energy projects.	%	Questionnaire	

Indicators related to costs	Investment	This investment consists of the costs associated for defining the strategy for citizen engagement (e.g. staff, devices/equipments, etc).	€	Questionnaire	
	Grant	The (here: investment-related) grant is defined as the part of the investment that is granted by a grant provider	%	Questionnaire	
	Total annual costs	The total annual costs are defined as sum of all the costs for deployment the strategy for citizen engagement which could include the cost of staff, the purchase of material or the subcontracting cost. The total annual costs are related to the considered interval of time (year)	€	Questionnaire	

8 References

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