

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

REnaissance of PLaces with Innovative Citizenship And Technology

Project no. 691735

H2020–SCC–2015 Smart Cities and Communities

Innovation Action (IA)

D10.1 Report on indicators for monitoring at project level

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1. REPLICATE

The REPLICATE project will generate smart city business models, and tailor-made solutions in the areas of energy, transport and ICT starting from the districts: Urumea Riverside (San Sebastián), Novoli (Florence) and Ashley, Easton and Lawrence Hill Neighbourhood (Bristol). In summary there will be pilot actions in energy efficiency, efficient and sustainable transport and integrated infrastructures, being the latter the key elements for the integration and development of cross-sectorial solutions. Three follower cities participate in the project: Essen (Germany), Nilufer (Tutkey) and Lausanne (Switzerland).

Being a demonstration project, the main concept that is on the top of the project is REPLICABILITY: it will be necessary that the project results could be applicable throughout the lighthouse cities and in other cities which want to evolve towards the 'smart city' concept, and could grow of scale too. To assure the large scale deployment of innovative technologies successfully demonstrated in the lighthouse districts specific studies will be necessary for each of the demonstrated solutions to ensure that they are scalable and can be replicated.

Prior to REPLICATE project San Sebastian, Florence and Bristol have already collaborated in a STEEP project (Systems Thinking for Comprehensive City Efficient Energy Planning) which have allowed to the cities generate Smart City Plans. STEEP project has defined a collaborative and participatory methodology to reach the objective of defining an Action Plan for particular districts of each city.

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

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2. INTRODUCTION

The monitoring of the different interventions that will be implemented in the three lighthouse cities can contribute to understand better the actual performance of each actuation respect to the expected performance during the planning and design phase. This is a critical step to prove the viability of some new technologies and smart solutions that can be implemented in our cities during the following years. Validation of the performance of interventions through monitoring can facilitate future integration of the different low carbon solutions in the current energy system.

Methodology procedure described in the document is defined in a way that aims to facilitate the replicability and easy adaptation to different urban realities of other cities. The project has been proposed thinking in the replicability of solutions and their deployment in the rest of the city (not only in the own district of the lighthouse city) and in follower cities: Essen (Germany); Laussane (Switzerland); and Nilüfer (Turkey).

In this context, 33 interventions are in progress in the lighthouse cities, as it is summarized in table 1.

Table 1: Summary of the interventions in progress in REPLICATE project

City	Total	Energy	Mobility	ICT
San Sebastian	10	3	3	4
Florence	13	3	3	7
Bristol	10	4	3	3
Total	33	10	9	14

The different interventions included in the table above are intergrated in several categories defined in the project. This aims to serve to define a common monitoring structure for all the cities of the projects.

2.1 Relation to Other Project Documents

Following relationship of this deliverable with other deliverables and with other WPs developed within the Replicate project should be considered along with this document for further understanding of its contents.

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- Direct relation with the deliverable 10.2 “Report on indicators for monitoring at city level”. This deliverable complements the monitoring framework defined for Replicate project, providing specification for the evaluation of the intervention side of the cities.
- Relation with the D10.10. “Yearly reports monitoring city level indicators for the three lighthouse cities” where the framework defined and the indicators defined in this deliverable will be used for the yearly monitoring.
- This deliverable is also related to the replication part of the project (WP8) considering that the process described here has to serve also to other cities in the case that they are interested on following a similar process.
- The deliverable is also related to the WP of the business models considering that some of the KPI defined for the interventions and the economic parameters collected in the process will serve as input data for the evaluation of the business models.
- Finally, the work described in this deliverable is also linked to the WP7 considering that it supports the comparison among the lighthouses and it details the content of the D7.1 “Report on peer-review methodology including templates and supporting materials”.

2.2 Reference documents

This document is based in the following projects level documents:

Ref.	Title	Description
REPLICATE Grant Agreement signed 240713.pdf	Grant Agreement	Grant Agreement no. 691735
DoA REPLICATE (691735)	REPLICATE Annex 1 – DoA to the GA	Description of the Action
REPLICATE Consortium agreement signed December 2015 (7 th December version)	Consortium Agreement	REPLICATE project – Consortium Agreement
REPLICATE Project Management Plan	D1.1 Project Management Plan (v.1) (29/04/2016)	REPLICATE Project Management Plan
REPLICATE	D1.4 District Management	REPLICATE District

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District Management Plans	Plan San Sebastian D1.5 District Management Plan Florence D1.6 District Management Plan Bristol	Management Plans
REPLICATE Communication Plan	D11.1 Communication Plan	REPLICATE Communication Plan

These will also be stored on the shared online platform.

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

2.3 Abbrevations list

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

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3. DELIVERABLE DESCRIPTION

The indicators for monitoring at project level are described under the present document which covers:

- Monitoring framework. First of all deliverable 10.1 provides a general description of the monitoring framework defined within the project. This section is useful to contextualize the deliverable and to understand how the presented results are connected to the rest of the tasks. This section is repeated in deliverable 10.3, where is useful to contextualize too.
- Common categorization of the interventions of the 3 lighthouse cities. This section defines in a schematic way the different categories of interventions that will be used for the definition of the monitoring for the three lighthouse cities within the Replicate project.
- Structure for monitoring of interventions. This section describes in detail the structure defined for monitoring Replicate project interventions. Each of the steps of the structure is defined in detail for each category group of interventions. The structure is common for the three lighthouse cities.

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4. Monitoring Framework

This section describes the monitoring framework defined in the REPLICATE project. This framework describes the methodology that is followed in the project for the measurement and evaluation of the performance of the different interventions implemented in the lighthouse cities as well as for the measurement of the impact that the implementation of specific interventions have in their respective cities. This monitoring framework will be common for the three lighthouse cities involved in the project and has to be replicable also for the follower cities as well as for other cities that can be interested on following an equivalent process. Besides, this technical monitoring protocol is defined in order to be able to provide information to existing and developing databases such as the CONCERTO technical monitoring database on the Smart Cities Information System.

The next figure describes the framework for the monitoring and the links between different levels of KPIs.

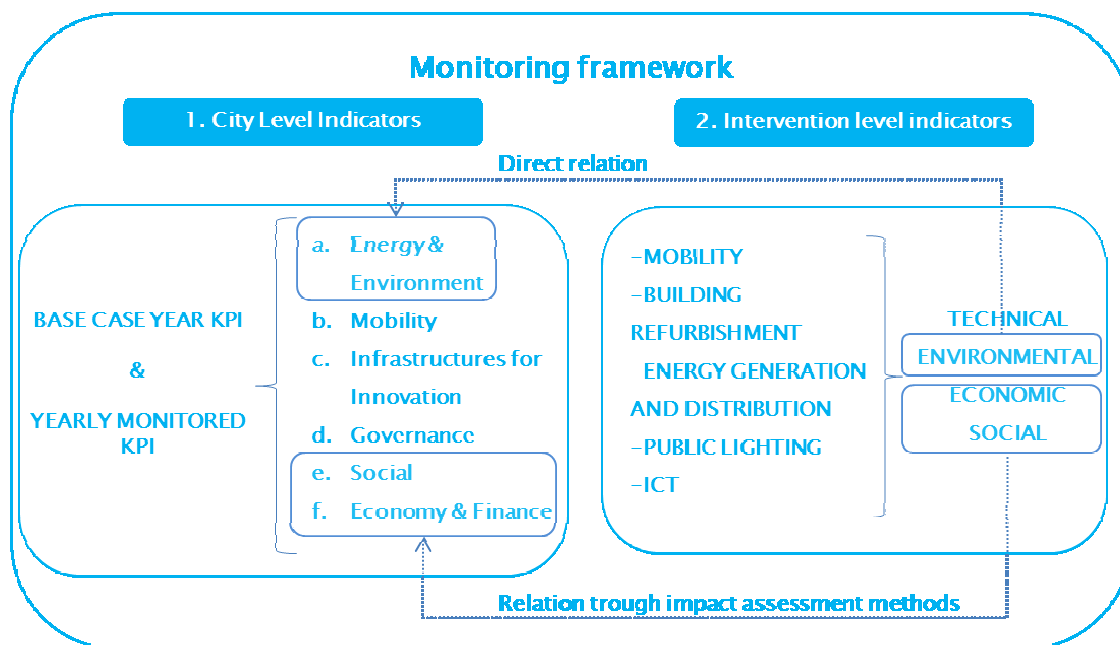


Figure1. Monitoring framework of the REPLICATE project

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First of all, it is important to note that two different levels are differentiated in the monitoring framework depending on the scale that is being monitored. These two levels are corresponded with the two levels evaluated in the project; (1) City level and (2) interventions level.

The first level of the monitoring refers to the city level which corresponds to the many dimensions that can be considered on a wider sustainability assessment of cities including economy and finance, energy and environment, mobility, governance, etc. This set of key performance indicators will serve for the baseline analysis of each city and for the comparison and benchmarking between different types of cities. In the same way it will be useful to measure the evolution of the city in the following years and in order to measure the improvements that will happen in the city due to the implementation of the most relevant interventions at city or district scale proposed in the project. City level indicators are explained in detail in chapter 4 and annex 1 of the deliverable 10.2. The next figure shows the most relevant indicators defined at this level.

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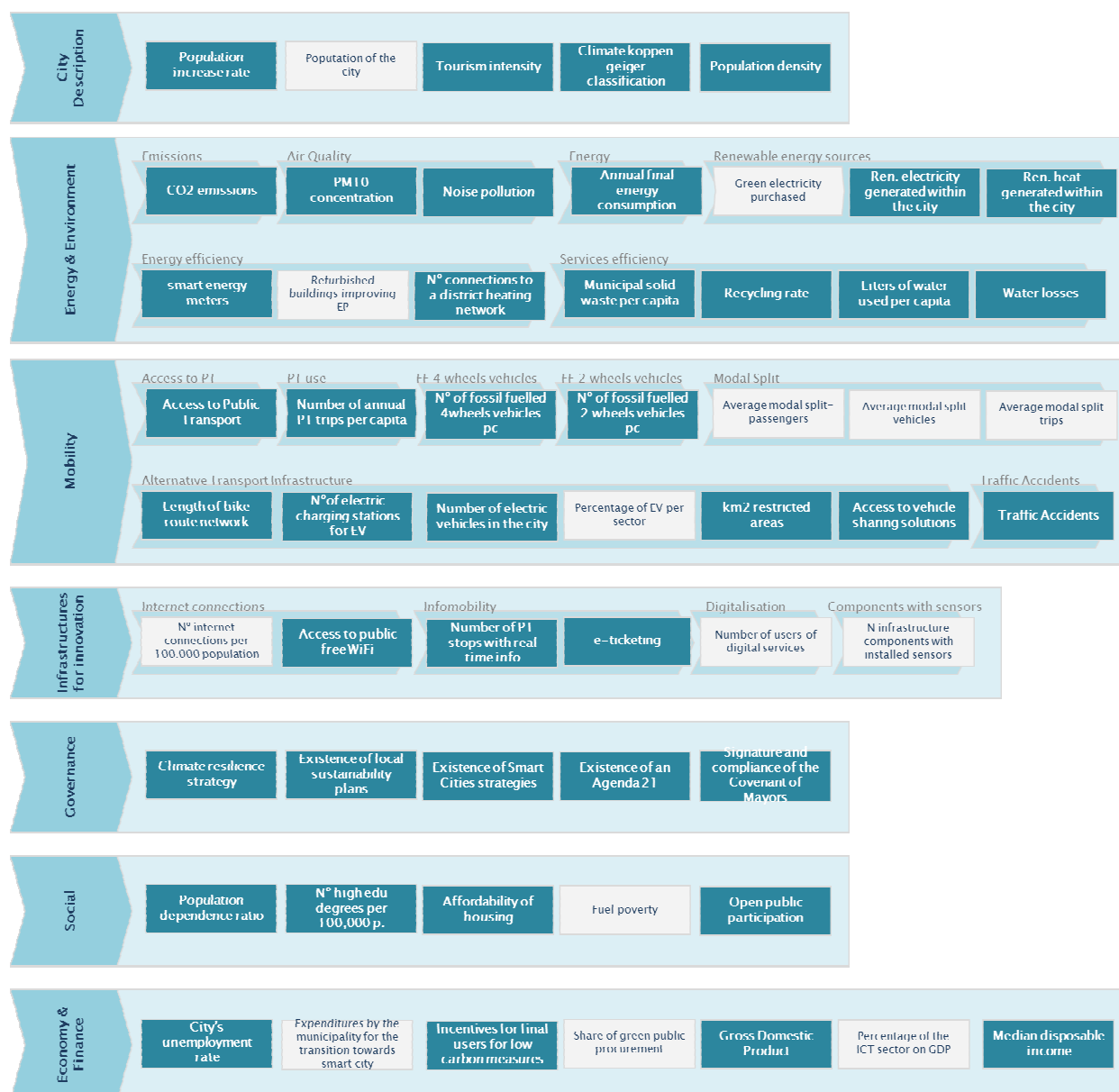


Figure2. City level indicators that will be used in relation with intervention level indicators.

On the other hand Monitoring at intervention level and the key performance indicators at this level are explained in detail in this deliverable. These indicators are useful for a detailed evaluation of the technical and financial viability of the different interventions. Data aggregation and de definition of the technical, environmental, economic and social indicators to monitor each of the interventions are defined in detail in the next sections. Within the intervention level

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it will be necessary to distinguish between the parameters that will be measured and a more reduced set of KPIs that will be provided. The parameters are related to the information that will be gathered in order to calculate the KPIs for this level. Those parameters can be classified in the next three dimensions; economic dimension, social dimension and another dimension related to physical parameters. This information will consist in most cases of real-time data (i.e. energy consumption in buildings, temperatures, etc.) or estimated using surveys or other periodic information. With this information the intervention level KPIs will be calculated and can be aggregated when necessary into sectoral KPIs in order to make easier the evaluation of the effects that will have in the city level KPIs.

Finally, the link between the two levels, i.e. how and to what extent the implementation of interventions at district scale will affect to other wider socioeconomic aspects of the city, and how this will be reflected as a change of the value of these city level indicators seems to be one of the biggest challenges in the field. With this regard, the way that the indicators for both levels have been selected and defined is very relevant. In the same way, it can be said that the evaluation of impacts of the different interventions at city level will follow different methodologies, depending on which indicators are being reported.

For city level indicators that are related to areas such as mobility or energy, the impact evaluation method will be a simplified methodology, and in cases when indicators at intervention level and at city level will be the same or at least comparable.

Evaluation of the impact of the interventions in social or economic indicators for the city is more complex in some cases. In this case, the effects that an investment on a particular sector will have on the local economy and on the citizen needs to be evaluated more carefully. The impacts will be different if an investment is made by a local company, which employs local citizens and redistributes the profits between employees (eg a local cooperative), than on a company whose employees and profit do not revert directly on the city. It is also important to know if the investor company will subcontract local companies or not, if their employees will be local, as well as their subcontractors, etc. To evaluate social and economic impacts of an intervention at city level, a value chain analysis of the investment and of the project implementation over its lifetime is therefore needed.

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The figure below illustrates the building value chain as an example. Economic data for each of the suppliers, discerning whenever possible if the business is local or not and the type of business entity would be helpful.

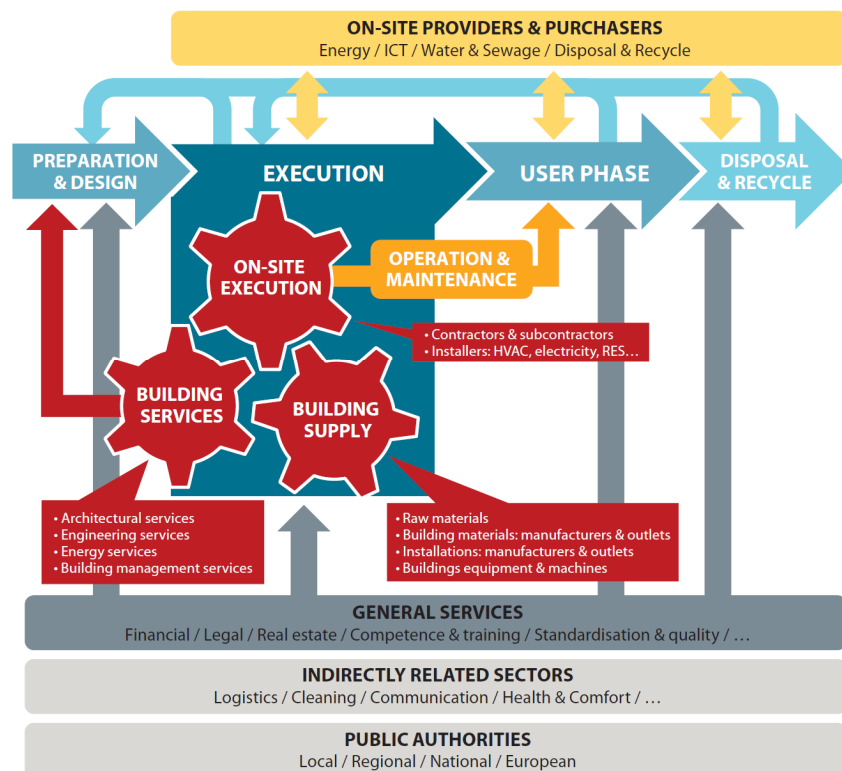


Figure3. The building value chain: interactions between actors in the process of value chain (source: BIPIE)

Once this data is collected, the impact evaluation methodology employed could vary depending on the local socioeconomic data available. If just basic data is available in the city, the number of direct and indirect economic activity and jobs generated by the investment could be inferred from the gathered supply chain data. If detailed data on the city is available, and input/output economic tables for the sector could be applicable for the city, there is a possibility to calculate these direct and indirect impacts in more detail, and also the induced impacts at city level.

Taking this in mind, the potential link between the data generated during the interventions monitorization and the city level indicators has been studied. As a result of this study, the city level indicators have been classified in 4 different categories:

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1. Not considered to relate with project level indicators. For different reasons (i. e. not related to project indicators, because the relation is very complex, etc.), this city indicator is not going to be considered in the link between the 2 levels.
2. Considered to relate with project level indicators through a direct relation. This means that a direct relation exists between the data or the indicators obtained at intervention level and the city level indicators.
3. Considered to relate with project level indicators through a direct calculation. This means that the relation is not direct but could be made through simple or direct calculations.
4. Considered to relate with project level indicators through impact assessment methods. This category is the one for which the relation is more complex. The link between intervention and city indicators will be made through value chain analysis and impact assessment methods.

Indicators related to the Governance dimensions are not in this case easily linked to the intervention level indicators. On the other hand, City description indicators could be briefly affected by interventions, but will be difficult or even not possible to understand in which measure the changes in the indicator annual values are due to the interventions and not because of other issues that affect these indicators in a stronger way.

The dimensions of energy and environment, mobility, infrastructures for innovation, social and economy and finance have indicators linked with intervention level data/indicators. Therefore, the monitoring done at intervention will provide relevant information to understand how project interventions affect the city performance.

Therefore, next sections of this deliverable focus on describing how cities that are interested on replicating the interventions carried out within the Replicate project can structure and carried out the monitoring of interventions. Besides, different set of indicators are proposed as representative for the evaluation of the behavior of each of the intervention types implemented in the three lighthouse cities of the project.

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5. List of interventions of the 3 lighthouse cities

This section shows in a schematic way the different interventions that will be implemented in the three lighthouse cities within the Replicate project. The table2, table3 and table3 of the next pages classifies the interventions depending on the sector affected, distinguishing between energy, mobility and ICT.

The different interventions included in those tables for each city will be evaluated from a monitoring point of view in the following sections of this deliverable. In order to define the information that will be included in the monitoring structure, rather than the classification of the table, the following reclassification of intervention categories (that covers the interventions of the tables) will be used:

ENERGY RELATED INTERVENTIONS:

- District energy generation and distribution infrastructures
 - Different district heating configurations (Biomass, cogeneration, STES, etc.)
 - Energy demand management for district heating
- Building scale interventions
 - Building refurbishment
 - Energy demand management for buildings
 - Building integrated renewable generation

MOBILITY RELATED INTERVENTIONS:

- Electric vehicles fleet
 - Urban Electric Bus
 - Public electric four-wheeler mobility fleet
 - Public electric two-wheeler mobility
 - Private EV fleet
 - Private Electric Taxi fleet
 - Electric bike

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- Transport Infrastructure
 - Conventional recharging points
 - Fast recharging points

LIGHTING AND OTHER ICT RELATED INTERVENTIONS:

- Lighting
- ICT Smart City Platform
- Services & Networks

Therefore the next sections will follow the classification defined above for the definition of the aspects that are relevant for each of them. In this sense, the category of district energy generation and distribution infrastructures will include the information gathering for the different district heating configurations that will be implemented in the different lighthouse cities as well as the information related to the energy demand management system that can be integrated for district network in order to optimize its performance. The effect of the energy management related actions are included within the effects of the intervention in which is applied since it is very difficult to distinguish the overall effect and the proportional improvement due to a better management. Something similar happens in the case of the category of building scale intervention that includes not only the critical aspects of the building retrofitting interventions but also the information to be gathered in the case of the energy demand management systems and the different renewable energy generation technologies that can be integrated in the buildings of the pilots of the three cities. The mobility related interventions can be divided in two main categories, the first one related to the vehicle fleet and the mobility infrastructure that will be included in the city and the second one related to the mobility services that can be provided by cities. The first one is included in this case within the categories of electric vehicle fleet and transport infrastructure and the second one is included in this case within the category of Lighting and Other ICT. Finally this last category also includes the most relevant aspects of the actions carried out in the smart city platform of the city, the main interventions related to other services provided by cities and to the lighting interventions.



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		SAN SEBASTIAN	FLORENCE	BRISTOL
ENERGY	Building retrofitting	156 dwellings + 34 commercial premises=18.350m2 and the general connection of the buildings to the District Heating system	2 buildings, including 300 flats=20.000 m2.	240 residential buildings=20.400m2
	District Heating	Two gas boilers (2x2600kW) and two biomass boilers (2x1500kW) will be the heat generation equipment. The District Heating Project will serve over 1.500 dwellings (almost 5.000 inhabitants) and will provide an operation platform for monitoring purposes to citizens.	High Performance Micro DHS with innovative thermal seasonal storage. the solar plant will cover more than 900 m2 and produce 750 MWh/y	999kW Biomass Boiler and deployment of piping, infrastructure and control system for heat generation for the 6 buildings
	"Smart Grids" measures, smart meters and Energy Demand Side Platform	A demand side platform will help residents to monitor how they are using their heating and understand better how savings can be achieved. This platform will be integrated into the general DSM system/platform.	Implementation of DSP, Smart and resilient Grid. Smart Info and integrated devices for monitoring of electricity consumption, like display or Smart Info Application. Smart metering heating (DHS and gas)	An energy demand management system to serve DSM services: Installation of home automation units, home energy control technology, permission for a time of day tariff from OFGEM, Energy Management system, Energy Management.
	Development of local renewable energies			Development of Community Solar Investment Program and Installation of 587kW of Photo Voltaic cells to 20 public and community buildings in the district.

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Table2. Summary of the energy related interventions to be implemented in the three lighthouse cities

		SAN SEBASTIAN	FLORENCE	BRISTOL
MOBILITY	Electric vehicles fleet	Implementation of a complete electrical urban bus line: 2 electric buses with 2 charging stations at the bus depot for a complete bus line, 2 electric vans, 4 electric vehicles, 6 e-moto (granted))	100 EV cars to the taxi fleets and Agreements with the producers/resellers in order to provide special favorable conditions to users.	Impact on the grid of EV proposals assessed. 32 e-bikes with docking boxes and telematics 6 electric Renault Zoe's (CAR CLUB) 2 on-demand EV mini-buses
	Transport Infrastructure	12 charging points at the gas stations, 15 slow-charging points at underground parking facilities for cars, 4 charging points in the four dissuasive parking areas, 50 private charging points in garages (granted).	Recharging points with a control system able to provide information to users: more than 170 stations in the whole city, 40 in the district, 4 Fast recharging stations (43 kW). Electric Mobility Management" system (EMM) for fast recharging stations	New 24 charging points will be deployed. Development of advanced mobility services for citizens.
	Transport Management, payment and control systems	Sustainable Transport Management System (Electro mobility management, services provision). Mobility-related	Advanced mobility services for citizens: suggestions to citizens, suggestions to public administrator decision makers, definition of strategies for dynamic pricing, special treatments for vulnerable citizens with special needs.	

Table3. Summary of the mobility related interventions to be implemented in the three lighthouse cities

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		SAN SEBASTIAN	FLORENCE	BRISTOL
ICT	ICT Smart City Platform based on FIWARE and Open Data	High Speed wireless network based on postWIMAX technology, Advanced Mobility Services for Citizens, Energy Services, Citizen participation and open-government services provision.	ICT Smart City Platform concept that will act as a city wide dashboard regarding Smart City measurements	ICT Smart City Platform concept
	Services	Mobility related services, Citizen Participation and Open-Government Services Provision	Local service management services: mobility management (Parking Manager, E-Taxi Manager, Electric Car Manager, Traffic Flow Sensors Manager, Digital Signage Manager, Intelligent Transportation System Manager, Restricted Traffic Zone Manager ZTL), energy management (Smart Grid Manager, Smart Light Manager, Energy Metering Manager,...), TELCO& security services (WiFi Service Manager, Video Cameras manager,...), Smart city services (smart waste, smart gathering, smart benches), Data management (Big data, open data), Digital Services.	Deployment of ICT services
	Network	Mobile communications network based on postWIMAX technology,	Networking innovations for the Smart City. Networking Sensors and capillary networks	Network Operating System for network control and virtualization.
	Public Lighting	Public Lightning LEDs replacing and Intelligent lighting systems	New LED lighting system integrated with technological equipment for value-added services.	Sensors deployed on intelligent public lightning

Table4. Summary of the ICT related interventions to be implemented in the three lighthouse cities

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6. Structure for monitoring of interventions

6.1 Review of relevant existing monitoring frameworks

As presented in the review carried out in the section 3 “State of the art on indicator frameworks for cities” of the deliverable D10.2 *“Report on indicators for monitoring at city level”* there are several frameworks that propose different set of indicators in order to measure the development of both the cities and of the interventions implemented on them. The table below shows a summary of the main frameworks evaluated and the scale of application. It can be seen that most of them are more focused on evaluating the sustainability at city scales covering various dimensions rather than proposing specific indicators at intervention level. Some exceptions such as BREEAM, LEED, CITYKEYS, or DGNB propose also some indicators to measure the developments carried out at district or project level, but most of them are very focused to buildings.

Table5. Evaluation of the related frameworks

Framework	N° Indicators	Dimensions covered							Scale		
		Energy	Environment	Mobility	Infr. For innovat.	Governance	Social	Econ.& finance	Nat / Reg	Local /City	District
Eurostat City statistics: Urban Audit	100	x	x	x	x	x	x	x		x	
PLEEC European project methodology	60	x	x	x						x	
White Paper on Sustainability of Spanish Urban Planning	102	x	x	x		x	x			x	
System of indicators and conditions for large and medium-sized cities	52	x	x	x			x		x	x	
Emerging and Sustainable Cities Initiative (ESCI)	23	x	x	x	x	x		x		x	

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ISO 37120 Sustainable development of communities	100	X	X	X	X	X	X	X		X	
UN Habitat: City Prosperity Index	35	X	X	X			X	X		X	
KPI definitions for Smart Sustainable Cities of the ITU-T	17	X	X		X		X	X		X	
BREEAM Communities 2012	40	X	X	X		X	X	X		X	X
LEED 2009 for Neighbourhood Development	56	X	X	X			X				X
DGNB New Urban Districts	45	X	X	X		X	X	X			X
HQE2R project for Urban Planning and Development	51	X	X	X		X	X				X
Sustainability Profile of a Location (DPL)	25	X	X				X	X			X
EU Sustainable Development Strategy (EU SDS)	28	X	X	X		X	X	X			
STEEP Project	46	X	X	X	X	X	X	X		X	X
CITYkeys project	110		X			X	X	X		X	X
European Energy Award	100	X	X	X		X		X		X	

The most remarkable reference for this section that aims to propose indicators at intervention level is the framework proposed in CITYKEYS project that defines KPIs for both the city and the intervention levels. In any case the indicators proposed in this project aim to cover a wide variety of actions that can be taken in different areas of the city and can result generic for the purposes of the Replicate projects that aims to define and evaluate KPIs that are specific for the evaluation of interventions.

This is why other type of initiatives have been taken into consideration in this task such as the CONCERTO initiative among others that can result more interesting since they follow a more technical approach to the monitoring of interventions. In this regard, different projects that focus on a single sector have been evaluated. Here are the most relevant projects that have been evaluated for the definition of the intervention level indicators and for the definition of the structure of the monitoring framework.

- Mobility: The recently developed KPIs for intelligent transport systems (AECOM, 2015), the indicator framework developed for sustainable urban mobility in the CIVITAS

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initiative and the indicators related to mobility developed in CITYKEYS project are the most relevant framework evaluated in the Replicate project for the mobility sector.

- Energy of the built environment: In this section, interventions such as the building refurbishment and the distributed energy generation and distribution interventions can be included. In this regard, the most related framework is proposed in the CONCERTO initiative that suggests very detailed indicators for the technical, environmental, economic and social dimensions.
- Information and communications technology (ICT): There is not much agreement regarding the monitoring and the indicator definition of the ITCs, but indicators presented in initiatives such as the International Telecommunication Union (ITU, 2014) or the Green Digital Charter (Symons & Wolfram, 2011) have been taken into account.

In this regard, the SCIS (Smart Cities Information System) initiative has served as reference due to the effort that are doing for extending the existing monitoring and indicator framework mainly for energy in buildings to a wider perspective and evaluation that can be more adequate for the analysis of smart cities. This initiative proposes to extend the scope of the analysis from energy in the built environment to other aspects including mainly mobility and ICTs.

Another aspect considered for the definition of indicators at intervention level is that the relation between the two levels, (city and intervention) has to be ensured for as many indicators as possible. The city level indicators that are susceptible to be related to the intervention level KPIs are described in the deliverable 10.2 where the different options for establishing the relation between the two levels are described. There are four types of relations that can be distinguished; direct relation, relation through direct calculations and relation through impact assessment methods. In the case of the intervention level indicators this relation is showed in each of the template for indicator definition that are presented in the Annex II.

All these aspects have been considered in order to define the structure for the monitoring of interventions that is described in detail in the next section.

6.2 Proposal for monitoring structure

This section describes the structure proposed in the Replicate project for the characterization, data gathering, monitoring and key performance indicators evaluation for each of the interventions that will be evaluated within the WP10 of the project. The next figure shows the 4 main steps that can be distinguished in the monitoring structure of the interventions: General



data and base case definition, Intervention characterization, Data monitoring, Key Performance indicators.

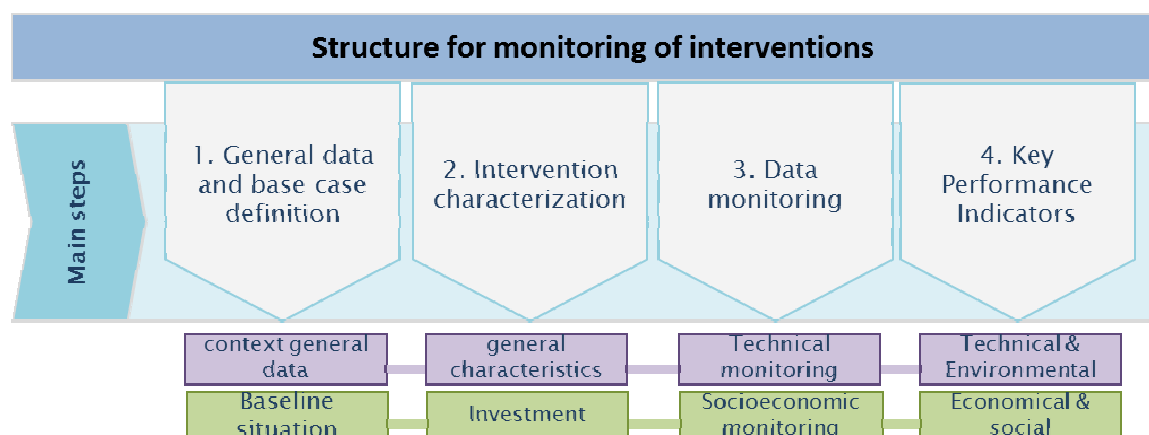


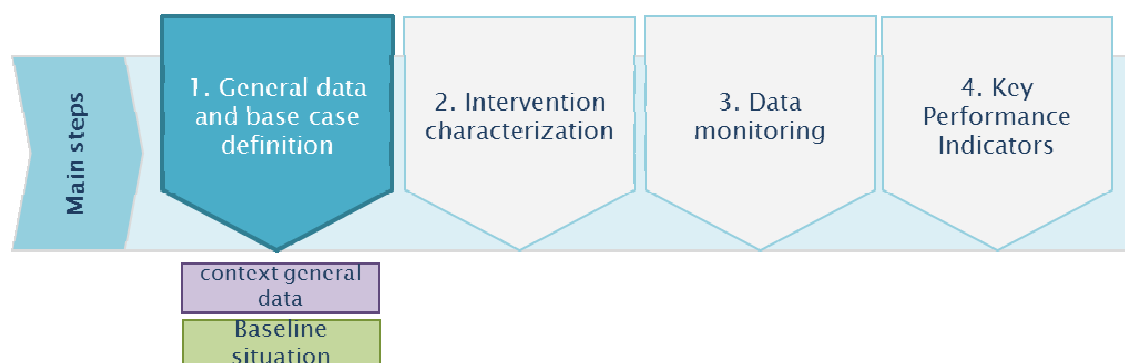
Figure4. Main Steps of the structure for monitoring of interventions

This structure will be common not only for the different interventions within a city but also for the all the interventions that will be implemented in the three lighthouse cities. The main purpose of the definition of a common structure is to guarantee the coverage of all the process of the KPI definition at intervention level from the baseline situation definition to the final evaluation of the indicators and also to facilitate the replicability of the process for other cities that are interested on following a similar process.

The following subsections describe more in detail each of the steps of this structure and explain which type of information is gathered and the main purpose of it.

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6.2.1 General data and base case definition



The first section of the structure defined for the monitoring of the different interventions is “General data and base case definition” and the aim of this step is to define the context in which each of the interventions are implemented and gathers the most relevant information related to them that will be useful in the next steps of the monitoring framework. More concisely, the information gathered in this step will be useful at the end of the task in order to get a better understanding of the results obtained with the monitoring.

This section can be divided in two main subsections, **the first subsection is focused on defining and gathering of the main context general data of the intervention** that will be evaluated in the monitoring. In this regard, this subsection will deal with data related to context of the area in which the intervention will be implemented such as the type of area (urban/rural), number of inhabitants, changes in community demographics or the total surface of the area affected. This information will also serve to other cities that are interested in evaluating the results of the Replicate project as potential interventions to be replicated on their cities since there can be used to relativize the result of the Key Performance Indicators reported in the WP10. The data set required will be different for each of the intervention and has been defined specifically in the project for each of the interventions as it is described in the section of this document corresponding to each of them.

On the other hand the **second subsection aims to collect the most relevant information that is needed in order to define the baseline situation of each intervention**. This aspect results relevant since many of the Key Performance Indicators defined and that will be reported are provided as “savings”. Therefore it has to be clearly defined this savings which case are referred to. This reference case following the nomenclature used in the case of the life cycle analysis studies can be called the replaced technology. For example, if the intervention analysed is the

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implementation of a district heating with some specific characteristics such as the heat supply performance among others, the replaced technology would be the most common technology that would be implemented in the case that this district heating is not implemented. However, in the case of existin buildings, the replaced technology is the one that is implemented currently. It is important here to notice that the most common replaced technology can be different in each city depending on the innovation level of the heating systems in their country among other factors. In this way in some cities the replaced technology could be the low temperature natural gas boilers with very high energy performance of 0,95 while in other cities the replaced technology could be a common boiler with an energy performance of 0,85 or a heat pump with a coefficient of performance of 3. Result evident that the resulting energy, economic and CO₂ emission saving obtained in the three cases mentioned will be very different. This is why the base case and the replaced technology have to be carefully defined for each of the interventions and for each of the cities.

In this task several templates have been developed in order to guide the users through the process of monitoring and to gather the information that will be used during the monitoring period of the project. This Annex I of the document presents the templates developed in the WP for each of the intervention categories, where the information to be provided in each of the subsections is described.

With the aim of explaining better the content of the section, here is presented an example of application for the case of the District energy generation and distribution infrastructures.

Example: Application for the case of the district energy generation and distribution infrastructures:

This case covers the interventions related to the different configuration of district energy generation systems as well as the interventions related to, smart meters and Energy Demand Side Platform at district scale. Each city will have to complete the next tables for each of the interventions that will be implemented in the cities. Here, the data already gathered in the WP7 will be automatically filled in and deeply evaluated according to these specifications.

District General data:

This is the information required in the general data section for this type of interventions for the base case year:

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- Type of area (urban/rural)
- Inhabitant principal residence
- Inhabitant secondary residence
- Changes in community demographics (increasing/decreasing)
- Changes in community demographics (persons in the last 5 year)
- Total surface area of the site (Km2)
- Population density (persons/Km2)
- Coverage ratio (The ratio of overbuild area to the total area of site)
- Floor space ratio (The ratio of total floor-space to the total area of site)
- Type of building and land use
 - Residential (%)
 - Tertiary (%)
 - Industrial (%)
 - Mixed use (%)

Baseline situation:

In the same way, here is presented the second data set required for the definition of the baseline situation of the district heating intervention. As mentioned above the baseline situation is composed by three main aspects; the definition of the main characteristics of the replaced situation related to the energy consumptions and system characterization, information related to the demand management systems and information related to energy carriers replaced by the new technology implemented.

Replaced energy systems and consumptions:

- Heated area of the buildings that will be connected to the district heating network [m2]
- Energy consumption of the buildings that will be connected to the district heating network before the project
 - Consumption energy carrier 1 [MWh/year]
 - Consumption energy carrier 2 [MWh/year]
 - Consumption energy carrier 3 [MWh/year]

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- Total energy cost (Actual energy COST in households before the project)
 - Total energy cost energy carrier 1 [€/year]
 - Total energy cost energy carrier 2 [€/year]
 - Total energy cost energy carrier 3 [€/year]
- Total GHG Emissions [kgCO₂eq/year]
- Total Primary Energy consumption [PE kWh/year]
- Total Non-Renewable Primary Energy consumption [PE kWh/year]
- Peak load – DHW (kW)
- Peak load – Heating (kW)
- Peak load – Electricity (kW)

Characteristics of the energy demand management (For heating, hot water and electricity):

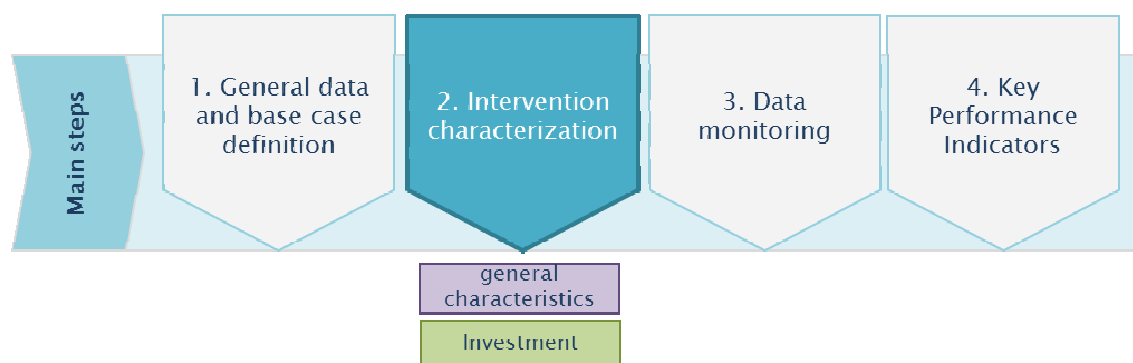
- Type of Implemented ICT Interventions
 - Building Energy Management System
 - District Energy Management System
 - Demand Side Management
 - Mobile applications for citizens

Baseline situation: energy carriers (For each energy carrier)

- GWP (CO₂ Equivalent) (gCO₂eq/kWh)
- PE Consumption (kWh PE/kWh)
- NR-Primary Energy (kWh NR-primary/kWh) Energy Cost (€/kWh)

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6.2.2 Intervention characterization



This section is probably the most intensive with regard to the volume of data that is necessary to gather before the actual monitoring is carried out in the next step. The main aim of this step is to carry a complete characterization of the intervention evaluated including both the technical and the economic perspectives. This step can be disaggregated in two main subsections “**general data**” and “**investment**”.

The general data subsection is focused on gathering data related to the intervention monitored distinguishing between the general characteristics and the technical specifications. In the first one “**general characteristics**”, information such as the name of the plant, location, general description of the intervention used or the construction period among other general information requested combined also with a more specific information of the intervention such as the description of the technology used or the main characteristics of the different components taking part in the intervention. This information will serve as mentioned above to contextualize and understand better what is referred to the information monitored. The “**technical specifications**” section on the other hand, aims to gather the main design technical characteristics of the interventions entering more in detail in aspects such as the capacity of the system, the energy performance, the energy carrier used among others depending on the intervention analysed.

All those specification to be reported have been defined in the WP10 for each of the interventions evaluated in the three cities and are described more in detail in the following subsections of this document.

Regarding the “investment” subsection, it can be said that it cover a double purpose the first one related to data gathering about the **costs of the interventions** and the second one related to

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the ***data gathering about the supply chain of the technology*** associated to the intervention evaluated.

In the first case “*costs of the interventions*” the costs associated to the initial investment made due to the implementation of the intervention is evaluated with the mayor disaggregation level possible. As general rule the minimum disaggregation required for all the interventions covers the costs associated to the planning, engineering and consulting of the project, cost associated to the investment on the most relevant components of the intervention and the costs associated to of the installation phase. All the costs have to be provided excluding VAT and distinguishing for each of them between the total costs and the grants received. This information will be used in the following steps of the structure of the monitoring intervention in order to evaluate several indicators defined such as the *dynamic return of the investment*.

In the second case, “*data gathering about the supply chain associated to the intervention*”, extra information is requested for the case of all the costs concepts described in the case of costs of the interventions. This extra information is mainly related to the type of companies that are involved in the different phases of the supply chain of each intervention and will be focused on their general characteristics such as the type of business it is, the registered office location, annual revenue, annual profit and the number of employees. This information will be difficult to obtain in detail in some cases but it is interesting for two main reasons. The first one is related to WP9 and WP10, Task 10.3. “Monitoring business models where the business models” related to the cities and to the information will be monitored and where the information requested in this section will be useful for the analysis. The second reason is related to one of the main purposes of the monitoring framework defined as part of the Task 10.1. “Selection of indicator frameworks for the monitoring program and baseline analysis” that describes how the link between some of the socio-economic indicators of the cities and the socioeconomic indicators of the interventions will be made through different methodologies of impact assessment and supply chain analysis. For both cases the information requested will be a necessary input for the methodologies used and in both cases the level of disaggregation obtained in the data collected will influence the reliability and the accuracy of the results that will be obtained in the impact assessment.

As in the case before, here is presented an example of the data defined for this section for the case of the district energy generation and distribution infrastructures, but the Annex I includes all the templates developed for each of the intervention categories.

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Example: Application for the case of the district energy generation and distribution infrastructures:

Here are presented the main characteristics to be gathered for an adequate characterization of the interventions from a technical, economic and descriptive point of view. All the information requested in this section has to be completed and provided only once before the monitoring period starts and is not updated with the monitoring data gathered in the following years.

General data:

In the first case, at the beginning the first subsection of the template general information related to the plant is requested. In the next subsection the information requested is divided in several information blocks distinguishing the energy generation systems, the storage and the distribution network.

Characteristics of the district scale energy generation and distribution

- Name of the plant
- location: address (Street, No., City) or GPS coordinates
- Operator of the plant/network
- Owner of the plant/network
- % of plant/network owned by public institutions
- Construction period
- Date of commissioning
- Energy generation
 - Name of the technology used
 - Description of the technology used
 - Peak load supply – please specify the technology used
- Energy distribution network
 - Characteristics of the network –Type (District heating / District Cooling)
 - Characteristics of the network – Construction (New/existing/extension of an existing network)
- Thermal storage

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- Type of storage (daily/seasonal)
- Technology used (hot water tank/fluid storage/aquifer storage/etc.)
- Solar Thermal
 - Location of the solar thermal collectors
 - Integration of solar thermal collectors (flat roof, sloped roof, facade)
 - Tracking system (Yes/No)
 - If not tracking: azimuth angle of the collectors [°]
 - If not tracking: tilt angle of the collectors [°]
 - Type of collectors (flat plane/evacuated tube)
 - Operator of the solar thermal plant
 - Owner of the solar thermal plant
 - % of solar thermal plant owned by public institutions

Technical specifications of the intervention

- Energy generation
 - Thermal output of the plant
 - Maximum thermal output of the plant excluding peak load boiler [KWth]
 - Maximum thermal output of the plant including peak load boiler [KWth]
 - Thermal output excluding peak load boiler in the preferred operation point [KWth]
 - Electrical output of the plant
 - Maximum electrical output of the plant excluding peak load boiler [KWel]
 - Maximum electrical output of the plant including peak load boiler [KWel]
 - Electrical output excluding peak load boiler in the preferred operation point [KWel]
 - Design power to heat ratio [KWel/KWth]
 - Set temperature of heating energy input into district heating network [°C]
 - Set input heat temperature

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- Type of Implemented ICT Interventions for (heating, hot water and electricity)
- Energy distribution network
 - Temperature level of the district heating network
 - Set temperature of fluid at feed-in district network in winter [°C]
 - Set return temperature of fluid in district network in winter [°C]
 - Average temperature of fluid in district network in winter [°C]
 - Set temperature of fluid at feed-in district network in summer [°C]
 - Set return temperature of fluid in district network in summer [°C]
 - Average temperature of fluid in district network in summer [°C]
 - Maximum thermal capacity of network connection [KW th]
 - Installed capacity of pumps [KW]
 - Maximum pipe cross section (diameter) [cm]
 - N. Of connections (to households)
 - Thermal capacity of each connection to households [KWh th]
 - Network losses [%]
 - Local primary energy factor for district heating
- Thermal storage
 - Volume of storage [m3]
 - Installed capacity [KWh]
 - Set temperature of fluid at feed-in storage [°C]
 - Set return temperature of fluid from storage [°C]
- Solar Thermal
 - Installed surface [m2]
 - Maximum thermal output of solar thermal plant [KW th]
 - Maximum collector efficiency [%]

Investment of the intervention

- Total investment (excl. VAT)

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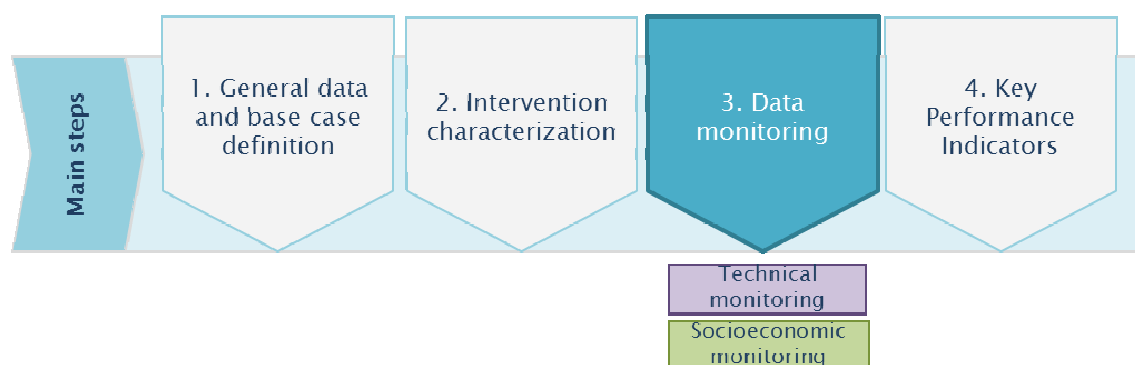
- For the entire intervention
 - Costs for planning, engineering and consulting
 - Costs for approval procedure
 - Costs for custom duties and license fees
 - Costs for construction interests
 - Contingencies
 - Costs for plot of land
- Energy generation (excl. VAT)
 - Total cost of the energy generation
 - Construction costs for: (building of the generation plant, and storage)
 - Cost for CHP station (including delivery and fitting)
 - Costs for peak load boiler (including delivery and fitting)
 - Cost for management, control and monitoring systems (equipment)
 - Cost for management, control and monitoring systems (fitting)
 - Costs for electrical grid connection
 - Costs for connection to district network
 - Cost of the installation of the energy generation systems
- Energy distribution network (excl. VAT)
 - Total costs of the network (incl. Delivery and fitting)
 - Piping
 - Trench works, etc.
 - Cost for management, control and monitoring systems
 - Cost of the installation
- Thermal storage (excl. VAT)
 - Total cost for thermal storage (incl. Delivery and fitting)
 - Overwrite Component 1 Tank
 - Overwrite Component 2 Insulation of the tank, etc.
 - Cost for connection to energy supply units

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- Cost for connection to energy demand units (e.g. DH network)
- Solar Thermal (excl. VAT)
 - Total cost of the solar plant (inc. delivery and fitting)
 - Overwrite Component 1 Solar panel
 - Overwrite Component 2 Pumps, valves, expansion vessel, etc.
 - Cost of the installation of the solar system
 - Cost for connection to district heating network and storage

For each of the concepts described in this last section of Investment of the intervention, the next information is requested in the templates prepared for data gathering; Total cost (euros), Grants (euros), Type of Business of the supplier, Registered office location, Annual revenue, Annual profit N° of employees and Cost referred to which year. This information will be used internally for the evaluation of the economic indicators as well as for the supply chain analysis of the intervention that will be used to understand the relation between the socioeconomic effects generated in the city due to the implementation of the interventions.

6.2.3 Data monitoring



This third section of the structure for monitoring of interventions is the one where the actual monitoring data is gathered in an aggregated way. The level of aggregation depends on the type of intervention evaluated and also on the type of information. This section will be linked to the task 10.2. “Elaboration of the monitoring program at project level”, and more concisely to the subtask related to the definition of the monitoring protocols where how to arrive to this data will be defined in detail.

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With regard to the structure of this section 3 main subsections can be distinguished;

- Technical monitoring
- Economic monitoring
- Social monitoring

The type of information requested in each of the subsections is explained here:

a) Technical monitoring

The technical monitoring subsection gathers information aggregated in most of the cases in a monthly basis. Therefore for each monitoring period, information related to the more technical parameters associated to each of the interventions is covered here. The type of data gathered depends on the intervention that is being evaluated in each case and is described in detail in the section 8 of this document.

The raw data that is used and aggregated in order to feed this section is gathered in each pilot of the corresponding city following the defined specifications in the task 10.2. "Elaboration of the monitoring program at project level".

The information of this section will be the most relevant information that will be used for the definition of the Key performance indicators described in the Annex II of the document. In some cases it will be necessary the aggregation of part of the information monitored to yearly values in order to comply with the units of the key performance indicators.

b) Economic monitoring

The economic monitoring subsection gathers information aggregated in annual basis. The information covered here is related mainly to the operational phase of the different interventions since the investment data has already been gathered in the intervention characterization section. Three main group of information can be defined in this subsection:

- Grants/Revenues: It covers all grants and revenues that occur during the operation phase of the intervention. The revenues can be associated for example in the case of the district heating intervention to the net energy sales of energy and the grants related to the electricity fed into the grid.
- Costs: It covers all the costs that occur during the operational phase of the intervention. And following with the example of the district heating, would be related to the costs of the energy consumption for the operation of the plant, the auxiliary energy fort the distribution and other type of non-energy related costs such as the maintenance costs of the systems.

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- Supply chain information: It covers the information related to companies involved in the phase of operation of the supply chain of each intervention. The information would be as mentioned previously: Type of business, the registered office location, annual revenue, annual profit and the number of employees

c) Social monitoring

The social monitoring subsections aim is to gather other social aspects that have not been gathered yet in any of the previous sections. This information includes the feedback or the opinion regarding the interventions implemented from a point of view of the occupier or citizen. As in the case of the economic monitoring the information is gathered yearly in period of time covered by the intervention monitoring. The information is requested via survey following a questionnaire format that is focused on answering aspects related to the acceptance level of the intervention, the level of information related to the intervention and the project, etc. In most of the cases the gathered information is the likert scale.

The Annex I includes all the templates developed for each of the intervention categories.

Example: Application for the case of the district energy generation and distribution infrastructures:

The information groups that are presented in this section include all the information that will be gathered after the aggregation of the monitoring data. Despite most of the information that will be used to feed the concepts defined here will be gathered through monitoring in a more frequent time steps (specially, in the case of the more technical data), this information will be provided in the templates on a monthly basis in the case of the technical monitoring and in an annual basis in the case of the economic and social monitoring.

Technical monitoring

- In the Energy generation
 - if biomass is used as energy carrier in the generation
 - Place where biomass is collected
 - Average distance between the collection and generation plant [Km]

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- Transportation type, e.g. truck, rail etc.
 - Primary energy factor of the biomass used [kWh primary / kWh final]
- Energy demand [input]
 - Energy carrier 1 [kWh/period]
 - Energy carrier 2 [kWh/period]
 - Energy carrier for peak load supply [kWh/period]
 - Auxiliary energy used for energy generation [kWh/period]
- Energy generation [output]
 - Total electricity generation [MWh/period]
 - Peak load of electricity [kW]
 - Total heating energy generation incl. peak load supply – metered on the output of the plant (= input into district heating network) [MWhth/period]
 - Total heating energy production from peak load supply [MWhth/period]
- In the energy distribution network
 - Operation hours of the pump [h/period]
 - Average inlet and return temperature in network during operation [°C]
 - Auxiliary energy used of the network during operation [MWh/Monit. period]
 - Subtotal amount of energy fed and extracted in the network [MWh/Monit. period]
 - Subtotal energy supplied to the buildings for heating and DHW [MWh/Monit. period]
 - Peak load – energy for heating and DHW extracted from network [kW]
- In the thermal storage
 - Heating energy fed into the thermal storage [MWh/Monit. period]
 - Heating energy extracted from the thermal storage [MWh/Monit. period]
- Solar Thermal
 - Global solar radiation on horizontal surface [kWh/(m² Monit. period)]
 - Global solar radiation on collectors (if available) [kWh/(m² Monit. period)]
 - Auxiliary energy (e.g. for pumps, tracking system, etc.) [MWh/Monit. Period]

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Economic monitoring (annual basis)

- Revenues/Grants Monitored data. Year 1
 - Electricity
 - Net energy sales revenues for electricity fed into the grid (euro/year)
 - Grants for electricity fed into the grid (euro/year)
 - Total revenues for electricity (euro/year)
 - Heating
 - Net energy sales revenues for delivered heating energy (euro/year)
 - Grants for delivered heating energy (euro/year)
 - Total revenues for heating energy (euro/year)
- Costs
 - Energy costs
 - Net energy costs for energy carrier 1 (euro/year)
 - Net energy costs for energy carrier 2 (euro/year)
 - Net energy costs for peak load energy carrier (euro/year)
 - Net energy costs for auxiliary energy (euro/year)
 - Further Non–Energy related costs of the generation and distribution system
 - Net non–energy related costs (specify) (euro/year)
 - Net operation related other costs 1 (specify) (euro/year)
 - Further Non–Energy related costs of the solar thermal
 - Net non–energy related costs (euro/year)
 - Net operation related other costs 1 (specify) (euro/year)
 - Further Non–Energy related costs of thermal storage
 - Replacement and substitution costs (specify) (euro/year)
 - Operation related costs 1 (specify) (euro/year)

Finally, in the economic monitoring for each of the supplier of components (Supplier of the energy carrier “X” , Supplier of the energy carrier for peak load, Supplier of the Non–Energy

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related services of the generation and distribution system, Supplier of the Non-Energy related services of the other systems) the following information is requested: Type of Business of supplier, Registered office location, Annual revenue and Annual profit N° of employees.

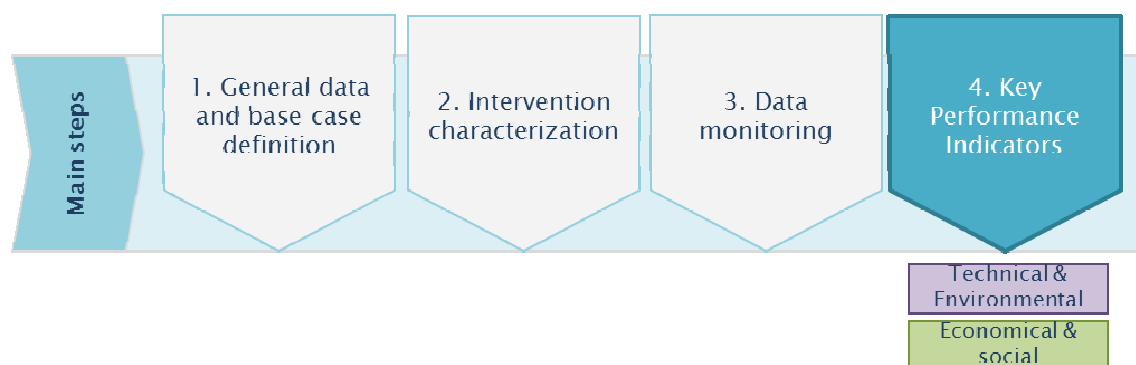
Social monitoring (annual basis and from the point of view of owner-occupiers)

- Degree of satisfaction with the energy supply
- Degree of satisfaction with the level of information intervention/project
- Degree of satisfaction with the information received about energy topics
- Degree of satisfaction with the involvement in decision making of the project
- % of households taking part in the feedback (compared to the total households affected by the intervention)
- Actual heating consumption in households after the project
- Actual electricity consumption in households after the project
- Actual heating energy COST in households after the project
- Actual Electricity COST in households after the project

For each of the first four concepts described above the number of each type of responses will be collected distinguishing between the very satisfied, satisfied, neither satisfied nor dissatisfied, dissatisfied and very dissatisfied responses.

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6.2.4 Key Performance Indicators



This last sections objective is to gather all the information generated in the section 3 and evaluate the Key performance Indicators that will be presented as representative of the development of the interventions. The indicators have been defined specifically for each intervention depending on the objective that is pursued with each of them. Most of all the indicators are evaluated yearly during the monitoring period and as mentioned before some of them are referred not only to the year evaluated but also to the baseline in order to understand the improvements achieved in the city due to the implementation of interventions.

Here we can also find a classification of the indicators evaluated as follows:

- Technical KPI
- Environmental KPI
- Economic KPI
- Social KPI

An effort has been made in order to limit the indicators for each of the dimensions of the classification and not to extend to much the total number of indicators in the same time that the reporting of the most relevant characteristics of the development of each intervention is ensured.

These indicators at intervention level or at least most of the indicators will be linked through different methods to the city level indicators as it has been explained in the monitoring framework description section connecting how the actual implementations of the city influence directly or indirectly the main characteristics and the development of the city. Therefore, these

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indicators will allow to municipalities informing citizens about the developments carried out in their city and how they contribute to the improvement of the environmental performance, the society and the economy of the city in general.

Following the same structure, here is presented the example of application but Annex II includes specific templates defining KPIs.

Example: Application for the case of the district energy generation and distribution infrastructures:

Most of the KPIs presented here can be evaluated both for the baseline situation and for the demo Site specific case allowing in this sense the analysis of the savings or the improvements achieved due to the implementation of each intervention.

Technical KPI

- Total Energy Generation [output] – Heat [kWh/year]
- Total Energy Generation [output] – Electricity [kWh/year]
- Total Final energy consumption of the system [KWh/year]
-
- Thermal output of solar thermal plant [KWh/year]
- (Thermal and electric separately) Degree of energetic self-supply by RES [%]
- (Thermal and electric separately) Degree of energetic self-supply by CHP [%]
- Total energy supplied to the buildings connected to the district heating network – for heating [kWh/year]
- Total energy supplied to the buildings connected to the district heating network – for DHW [kWh/year]

Environmental KPI

- Total greenhouse gas emissions related to heating and electricity production [Kg CO₂ eq./year]
- Total primary energy consumption to heating and electricity production [MJ/year]

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Economic KPI

- Total investment, excl. VAT [euro/year]
- Local cost ratio (related to total cost) [-]
- Grants for energy supply [euro/year]
- Heat production cost [euro/KWh]
- Total energy carrier cost per year [euro/year]
-
- Dynamic Payback Period

Social KPI

- Direct jobs created
- Direct local jobs created
- Electricity bill reduction
- Heating bill reduction
-
- Citizens directly involved
- Degree of satisfaction with the energy supply
- Degree of satisfaction with the level of information intervention/project
- Degree of satisfaction with the information received about energy topics
- Degree of satisfaction with the involvement in decision making of the project

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7. Conclusions

The analysis of the actual performance of the different energy technologies, systems and measures that are deployed in our cities, result necessary to demonstrate both the viability of the new technological solutions and the actual savings obtained by each of them. This document provides a useful framework for the monitoring of interventions that has been structured in a way that can be used independently for each intervention by the follower cities of the project and by other cities that are interested on following a similar process.

In order to facilitate the adaptability of the framework to other cities realities, it has been necessary to define several adaptable steps within the general structure. The first step precisely, allows introducing the main characteristics of the evaluated city in the moment that the project starts.

Besides, it has been necessary to define a wide set of key performance indicators in order to cover the various possible purposes of each city in the case of each intervention category. Therefore, the data gathering and KPI evaluation templates provided in this document for each intervention category, aim to provide the most possible complete set of KPI for each of the four dimensions defined. Taking this framework into account, cities will use the necessary key performance indicators within this list to report the achieved savings depending on their specific objectives.

Finally it can be seen that the intervention level KPIs can be used independently from the entire two scale framework defined in the section 2, in the case of cities that are interested on evaluating only the performance of specific of measures, or that can be used in an integrated way in order to related them with the city scale KPIs.

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9. Annex I: Templates developed for each intervention group

9.1 General data and base case definition

9.1.1 District energy generation and distribution infrastructures

This case covers the interventions related to the different configuration of district energy generation systems as well as the interventions related to, smart meters and Energy Demand Side Platform at district scale. Each city will have to complete the next tables for each of the interventions that will be implemented in the cities.

District general data		For the base year
Type of area (urban/rural)		
Inhabitants principal residence		
Inhabitants secondary residence		
Changes in community demographics (increasing/decreasing)		
Changes in community demographics (persons in the last 5 year)		
Total surface area of the site (Km2)		
Population density (persons/Km2)		
Coverage ratio - <i>The ratio of overbuild area to the total area of site</i>		
Floor space ratio - <i>The ratio of total floor-space to the total area of site</i>		
Type of building and land use		
	Residential (%)	
	Tertiary (%)	
	Industrial (%)	
	Mixed use (%)	

Baseline situation: Characteristics of the energy demand management

Type of Implemented ICT Interventions	Building Energy Management System	District Energy Management System	Demand Side Management	Mobile applications for citizens
Heating				
Hot water				
Electricity				

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Baseline situation: replaced energy systems and consumptions

Heated area of the buildings that will be connected to the district heating network [m2]	
Energy consumption of the buildings that will be connected to the district heating network before the project	
Consumption energy carrier 1 [MWh/year]	
Consumption energy carrier 2 [MWh/year]	
Consumption energy carrier 3 [MWh/year]	
Total energy cost (Actual energy COST in households before the project)	
Total energy cost energy carrier 1 [€/year]	
Total energy cost energy carrier 2 [€/year]	
Total energy cost energy carrier 3 [€/year]	
Total GHG Emissions [kgCO2eq/year]	
Total Primary Energy consumption [PE kWh/year]	
Total Non-Renewable Primary Energy consumption [PE kWh/year]	
Peak load - DHW (kW)	
Peak load - Heating (kW)	
Peak load - Electricity (kW)	

Baseline situation: energy carriers

	type	GWP (CO2 Equivalent) (gCO2eq/kWh)	PE Consumption (kWh PE/kWh)	NR-Primary Energy (kWh NR-primary/kWh)	Energy Cost (€/kWh)
energy carrier 1					
energy carrier 2					
energy carrier for peak load supply					
energy carrier - auxiliary energy					

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9.1.2 Building scale interventions (Building refurbishment and Development of local renewable energies)

This case covers the refurbishment at building scale as well as the implementation of renewable technologies. Each city will have to complete the next tables for each of the interventions that will be implemented at building level.



Building general data

	For the base year
Number of blocks	
Year of construction	
Energy label (if it is available)	
Type of building	
Building use	
Number of residential units	
Number of occupants	
Heated area of the buildings that will be refurbished [m2]	

Baseline situation: building envelope, energy demand and energy systems

Building envelope, surface & heat transfer coefficient	describe the envelope	surface (m2)	heat transfer coefficient [W/(m²K)]	energy transmittance (g-value) [%]
windows				
outside walls				
roof				
ground floor				
Calculated energy demand of the building [kwh/a]				
heating demand [kWh/m2 a]				
DHW [kWh/m2 a]				
cooling demand [kWh/m2 a]				
lighting demand [kWh/m2 a]				
ventilation demand [kWh/m2 a]				
appliances demand [kWh/m2 a]				
Peak load - DHW (kW)				

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Peak load - Heating (kW)					
Peak load - Electricity (kW)					
Energy systems, lighting & appliances		description	individual (select with a X)	central (select with a X)	connected to DH (select with a X)
Space heating					
Domestic hot water					
Cooling					
Ventilation					
lighting					
Appliances					

Baseline situation: Characteristics of the energy demand management

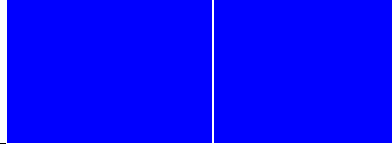
Type of Implemented ICT Interventions	Building Energy Management System	District Energy Management System	Demand Side Management	Mobile applications for citizens
Heating				
Hot water				
Electricity				

Baseline situation: energy carriers consumption and environmental impacts

Energy consumption by energy carrier (from invoices)	Overwrite Energy carrier [MWh/year]	Overwrite Energy carrier 2 [MWh/year]	Overwrite Energy carrier 1 [€/year]	Overwrite Energy carrier 2 [€/year]
Space heating				
Domestic hot water				
Cooling				
Ventilation				
HVAC total				
lighting				
Appliances				
Total GHG Emissions [kgCO ₂ eq/year]				
Total Primary Energy consumption [PE kWh/year]				

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Total Non-Renewable Primary Energy consumption [NR-PE kWh/year]



9.1.3 Electric vehicles fleet

The electric vehicles fleet section covers different types of vehicles and vehicles with different uses as well as the electric bikes that will be deployed within the lighthouse cities of the project. Thus, this section and the followings define the most relevant information that will be requested for each of the vehicles categories defined here. The categories included are:

- Urban Electric Bus
- Public electric four-wheeler mobility fleet
- Public electric two-wheeler mobility Private EV fleet
- Private Electric Taxi fleet
- Electric bike

ELECTRIC VEHICLES “General data”

Main purpose of the electric vehicle
Owner of the EV
Number of EXISTING EV of each type in the city
Number of NEW EV of each type in the city
Area of the city that will be affected by the intervention
Date of commissioning
Lifetime
Short description of the intervention

For each vehicle type

BASELINE SITUATION EV

Accuracy of timekeeping. Number and percentage of services arriving / departing on time
Injuries and deaths caused by transport accidents
Fuel Consumption [Litres of Fuel/km]
Occupancy [number of occupants]
Travel distance of the vehicle per year [Km/year]
Number of trips [trips/year]
Emissions of Nitrogen dioxides (NO2) [tonnes/year]
Emissions of Particulate matter (PM2,5) [tonnes/year]
Carbon dioxide emission (equivalent carbon dioxide units) [tonnes/year]

For each vehicle type

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Investment cost [euro]	
Cost of operation. Cost of the fuel consumed by the vehicle in the operation [euro/year]	
Maintenance costs components [euro/year]	
Maintenance costs labour [euro/year]	

9.1.4 Transport Infrastructure

This section focused in the transport infrastructure deployed in the city, includes the purchase, installation and use of the recharging infrastructure associated to the electric vehicles of the city. This recharging infrastructure can be divided in two main categories, the conventional recharging points and the fast recharging points. It has to be taken into account that the tables showed in this section and in the following regarding the transport infrastructure refer to both categories described.

GENERAL DATA:RECHARGING INFRASTRUCTURE	Recharging point
Number of EXISTING recharging points in the city	
Number of NEW recharging points in the city	
Owner of the recharging infrastructures	
Operator of the recharging infrastructures	
Date of commissioning	
Lifetime	

Baseline situation:

In the case of the recharging infrastructures the baseline situation definition is not applicable. This is because the indicators that will be evaluated with the data collected from monitoring are not focused on comparing the performance of those recharging infrastructures with the infrastructures that are used for recharging conventional vehicles, i.e. the indicators won't be presented as "savings".

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9.1.5 Lighting and other ICT

This case covers the interventions related to the replacement of lights at district scale as well as the interventions related to ICT. Each city will have to complete the next tables.

Lighting general data	
For the base year	
Total lit area (m2)	
Total number of lamps of the affected area	
Area X (m2)	
Number of lamps	
Type of lighting	
Lamp electrical power consumption (W)	
Total installed power - lamps + auxiliaries (kW)	
Light efficiency - lamps + auxiliaries (lm2lux/W)	
Annual energy consumption [kWh/year]	
Control system implemented (yes/no and specify type if yes)	
Daily schedule	
Existing black spots in the area (m2)	
Baseline situation: replaced lights and consumptions	
Number of lights substituted (damaged-not planned) per year [n°] - per 1000 lamps	
Total annual electricity consumption [kwh/year]	
Total annual electricity cost [euro/year]	
Total fixed costs electricity - power contracting (euro/year)	
Total annual operation costs - (euro/year)	
Total GHG Emissions [kgCO2eq/year]	
Total Primary Energy consumption [PE kWh/year]	
Total Non-Renewable Primary Energy consumption [NR-PE kWh/year]	

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ICT Smart City Platform

Short description of the current Smart City Platform

For the base year

Services	Short description of the intervention	Number of final users involved	Number of Apps developed	Number of downloads of developed Apps
Smart mobility services				
Active citizenship				
Open-Government				
Other -Data management				
Other -Use of information generated by energy consumers				
Networks				
Mobile communications network				
Networking Sensors and capillary networks				
Network Operating System for network control and virtualization				

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9.2 Characterization of interventions

9.2.1 District energy generation and distribution infrastructures

Characteristics of the district scale energy generation and distribution

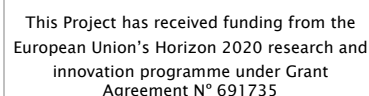
Name of the plant	
location: address (Street, No., City) or GPS coordinates	
Operator of the plant/network	
Owner of the plant/network	
% of plant/network owned by public institutions	
Construction period	
Date of commissioning	
a) Energy generation	
Name of the technology used	
Description of the technology used	
Peak load supply - please specify the technology used	
b) Energy distribution network	
Characteristics of the network -Type (District heating / District Cooling)	
Characteristics of the network - Construction (New/existing/extension of an existing network)	
c) Thermal storage	
Type of storage (daily/seasonal)	
Technology used (hot water tank/fluid storage/aquifer storage/etc.)	
d) Solar Thermal	
Location of the solar thermal collectors	
Integration of solar thermal collectors (flat roof, sloped roof, facade)	
tracking system (Yes/No)	
if not tracking: azimuth angle of the collectors [°]	
if not tracking: tilt angle of the collectors [°]	
type of collectors (flat plane/evacuated tube)	
Operator of the solar thermal plant	
Owner of the solar thermal plant	
% of solar thermal plant owned by public institutions	

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Technical specifications of the intervention

a) Energy generation
Thermal output of the plant
maximum thermal output of the plant excluding peak load boiler [kWth]
maximum thermal output of the plant including peak load boiler [kWth]
thermal output excluding peak load boiler in the preferred operation point [kWth]
Electrical output of the plant
maximum electrical output of the plant excluding peak load boiler [kWel]
maximum electrical output of the plant including peak load boiler [kWel]
electrical output excluding peak load boiler in the preferred operation point [kWel]
design power to heat ratio [kWel/kWth]
set temperature of heating energy input into district heating network [°C]
set input heat temperature *
*In case that the heat source is process heat or waste heat, specify the input heat T°
Type of Implemented ICT Interventions for (heating, hot water and electricity)
b) Energy distribution network
Temperature level of the district heating network
set temperature of fluid at feed-in district network in winter [°C]
set return temperature of fluid in district network in winter [°C]
average temperature of fluid in district network in winter [°C]
set temperature of fluid at feed-in district network in summer [°C]
set return temperature of fluid in district network in summer [°C]
average temperature of fluid in district network in summer [°C]
maximum thermal capacity of network connection [kW th]
installed capacity of pumps [kW]
maximum pipe cross section (diameter) [cm]
N. Of connections (to households)
thermal capacity of each connection to households [kWh th]
network losses [%]
local primary energy factor for district heating
c) Thermal storage
Volume of storage [m3]
installed capacity [kWh]
set temperature of fluid at feed-in storage [°C]
set return temperature of fluid from storage [°C]
d) Solar Thermal
installed surface [m2]
maximum thermal output of solar thermal plant [KW th]
maximum collector efficiency [%]

Investment of the intervention

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9.2.2 Building refurbishment

Characteristics of building refurbishment measures

Construction period	
Date of commissioning	

a) Envelope measures

Building envelope measures, surface retrofitted & heat transfer coefficient	describe the measure	surface retrofitted (m2)	heat transfer coefficient [W/(m²K)]	energy transmittance (g-value) [%]
windows				
W_1				
W_2				
outside walls				
OW_1				
OW_2				
roof				
R_1				
R_2				
ground floor				
GR_1				
GR_2				

Calculated total energy demand of the building after refurbishment [kwh/a]

heating demand [kwh/m2 a]	
DHW [kwh/m2 a]	
cooling demand [kwh/m2 a]	
lighting demand [kwh/m2 a]	
ventilation demand [kwh/m2 a]	
appliances demand [kwh/m2 a]	

b) Energy systems

Energy systems, lighting & appliances measures	description	individual (X)	central (X)	connected to DH (X)
Space heating				
Domestic hot water				
Cooling				
Ventiltion				
lighting				
Appliances				



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c) ICT interventions

Type of Implemented ICT Interventions	Building Energy Management System	Neighbourhood Energy Management System	Demand Side Management	Mobile applications for citizens
Heating (select with an X)				
Hot water (select with an X)				
Electricity (select with an X)				

d) Solar thermal collectors

Installed surface [m2]	
Integration of solar thermal collectors (flat roof, sloped roof, facade..)	
tracking system (Yes/No)	
if not tracking: azimuth angle of the collectors [°]	
if not tracking: tilt angle of the collectors [°]	
type of collectors (flat plane/evacuated tube)	
Maximum thermal output of solar thermal plant [KWth]	
Maximum collector efficiency [%]	
% of hot water demand covered by solar thermal energy (calculated data)	
losses [%]	

e) PV panels

Installed surface [m2]	
Integration of PV (flat roof, sloped roof, facade..)	
tracking system (Yes/No)	
if not tracking: azimuth angle of the collectors [°]	
if not tracking: tilt angle of the collectors [°]	
type of cells (polycrystalline, monocrystalline, etc.)	
Owner of PV	
Maximum electrical output of PV [KWp]	
Performance ratio [%]	
Usage of produced electricity (self consumption, feeding grid, stand alone, net balance...)	

Investment of the intervention

Total investment (excl. VAT)

For the entire intervention

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Costs for planning, engineering and consulting	
Costs for approval procedure	
Costs for custom duties and license fees	
Costs for construction interests	
Contingencies	
a) Envelope measures (excl. VAT)	
Costs for planning, engineering and consulting	
Windows	
Overwrite_Component 1 (if disaggregated cost are available)	
Overwrite_Component 2 (if disaggregated cost are available)	
Outside walls	
Overwrite_Component 1 (if disaggregated cost are available)	
Overwrite_Component 2 (if disaggregated cost are available)	
Roof	
Overwrite_Component 1 (if disaggregated cost are available)	
Overwrite_Component 2 (if disaggregated cost are available)	
Ground Floor	
Overwrite_Component 1 (if disaggregated cost are available)	
Overwrite_Component 2 (if disaggregated cost are available)	
b) Energy system, lighting & appliances measures	
Costs for planning, engineering and consulting	
Space heating	
Overwrite_Component 1 (if disaggregated cost are available)	
Overwrite_Component 2 (if disaggregated cost are available)	
Domestic hot water	
Overwrite_Component 1 (if disaggregated cost are available)	
Overwrite_Component 2 (if disaggregated cost are available)	
Cooling	
Overwrite_Component 1 (if disaggregated cost are available)	
Overwrite_Component 2 (if disaggregated cost are available)	
Ventilation	
Overwrite_Component 1 (if disaggregated cost are available)	
Overwrite_Component 2 (if disaggregated cost are available)	
HVAC total	
lighting	
Overwrite_Component 1 (if disaggregated cost are available)	
Overwrite_Component 2 (if disaggregated cost are available)	
Appliances	

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c) Energy management and control measures

Costs for planning, engineering and consulting	
Smart meters, control and measurement equipment (including delivery & fitting)	
Component 1 (equipment)	
Component 2 (fitting)	

d) Solar Thermal collectors

Costs for planning, engineering and consulting	
Total cost for solar thermal collector (inc.delivery and fitting)	
Overwrite_Component 1 (if disaggregated cost are available)	
Overwrite_Component 2 (if disaggregated cost are available)	
Cost for connection to the network	
Cost for monitoring equipment and control systems	
Cost for hot water storage	

e) PV panels

Costs for planning, engineering and consulting	
Cost for PV panels (inc.delivery and fitting)	
Cost for rack and tracking system of PV modules (inc.delivery and fitting)	
Cost for inverter	
Cost for electrical grid connection	
Cost for monitoring equipment and control systems	

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9.2.3 Electric vehicles fleet

In the case of electric vehicles the definition of the technical specifications is enough to define the characteristics of the intervention. In comparison with other interventions such as the district energy generation and distribution infrastructures this intervention has associated less design parameters, or at least there more standard and are defined by the manufacturer. This is why in this case the section of the “Characteristics of the intervention” is not included since the main characteristics are implicitly integrated in the technical specification definition.

Technical specifications of the EV and infrastructure interventions

ELECTRIC VEHICLES	For each vehicle type
Model of the vehicle	
Seating capacity	
Main features of the motor	
Battery type	
Battery capacity (KWh)	
Type of charge port	
Recharge time	
Recharge time (with fast charge)	
approved autonomy (Km)	
Average consumption (kWhe/100 Km)	

It is also interesting in this section to collect the environmental conversion factors for the electricity mix of the respective country of each city. These factors are dependant of the proportion in which each technology (conventional and renewable) contributes to the overall electricity mix and their performances and will be different in the case of the different cities. It is necessary to reflect this aspect since the environmental savings (CO2 emissions and Primary Energy consumption both for renewable and non- renewable) will be evaluated through the comparison of the emissions associated to the electricity consumption of the electric vehicles with the emission associated to the conventional vehicles that will be replaced. Therefore the conversion factors requested will be:

- Non-Renewable Primary Energy factor of the electricity mix (NRPE KWh/KWh final)
- Primary energy factor of the electricity mix (PE KWh/KWh final)
- CO2 emission factor of the electricity mix (Kg CO2 equivalent/KWh final)

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Investment of the intervention:

For each type of vehicle included within this intervention category the following data will be requested regarding the investment and to the supply chain analysis.

For each vehicle type

	Total cost (euros)
Total investment (excl. VAT)	
Disaggregation of the costs of the electric vehicles	
Component 1 (if disaggregated cost are available) electric battery	
Component 2 Engine	
Component 3 The controller	
Component 4 Drivetrain Components	
Component 5 chassis and body	
Component 6 other (Specify)	

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9.2.4 Transport Infrastructure

As in the case of the electric vehicles and due to the same reasons, this section only includes the subsection of technical specification of the recharging infrastructure. The aim of this subsection is gathering the following data.

Technical specifications of the infrastructure intervention

	For each recharging point type
Maximum power of the delivery (KW)	
Type (DC/AC)	
Voltage of the supply [Volts]	
Current of the supply [Amps]	
Recharge time (hours/KW)	
Short description	

Investment of the intervention:

For each of the concepts described in the table below, the next information will be requested; Total cost (euros), Grants (euros), Type of Business of the supplier, Registered office location, Annual revenue, Annual profit N° of employees, Cost referred to which year.

Recharging point type	
	Total cost (euros)
Total investment (excl. VAT)	
Disaggregation of the costs of the infrastructure	
	Total cost (euros)
Component 1 electric battery	
Component 2 Charger	
Component 3 Battery	
Overwrite Component 4 other (Specify)	

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9.2.5 Lighting and other ICT

Characteristics of lighting measures

Implementation period	
Date of commissioning	
Percentage of lamps substituted (%)	
Area X	
Number of lamps substituted	
Type of lamps implemented	Overwrite (specify)
Lamp electrical power consumption (W)	
Total installed power - lamps + auxiliaries (kW)	
Light efficiency - lamps + auxiliaries (lm2lux/W)	
Service life (nº of years)	
Control system implemented	Overwrite (specify)
Sensors implemented	Overwrite (specify)
Value-added services implemented	Overwrite (specify)
New daily schedule	Overwrite (specify)
Annual energy consumption calculated [kwh/year]	

ICT Smart City Platform

Short description of the interventions	
Services	Short description of the interventions
Smart mobility services	
Active citizenship	
Open-Government	
Other -Data management	
Other -Use of information generated by energy consumers	
Networks	Short description of the interventions and enumeration of the main characteristics
Mobile communications network	
Networking Sensors and capillary networks	

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Network Operating System for network control and virtualization



Investment of the lighting intervention

Total investment (excl. VAT)		
For the entire intervention		
	Costs for planning, engineering and consulting	
	Costs for approval procedure	
	Costs for custom duties and license fees	
	Costs for implementation interests	
	Contingencies	
	Other costs (specify)	

For the new public lighting implemented in the Area X

Cost of lamps	
Costs of the control system	
Cost of the integrated sensors	
Cost of other value-added services	
Installation costs	

	ICT Smart City Platform	Services	Network
Investment of the ICT intervention			
Investment	Euro	Euro	Euro
Grants	Euro	Euro	Euro

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9.3 Monitoring data

9.3.1 District energy generation and distribution infrastructures

Technical monitoring

a) In the Energy generation	
<i>if biomass is used as energy carrier in the generation</i>	
place where biomass is collected	
average distance between the collection and generation plant	[Km]
transportation type, e.g. truck, rail etc.	Overwrite (specify)
primary energy factor of the biomass used	[Kwh primary/KWh final]
Energy demand [input]	[kWh/period]
Energy carrier 1	[kWh/period]
Energy carrier 2	[kWh/period]
Energy carrier for peak load supply	[kWh/period]
Auxiliary energy used for energy generation	[kWh/period]
Energy generation [output]	
Total electricity generation	[MWh./period]
Peak load of electricity	kW
Total heating energy generation incl. peak load supply - metered on the output of the plant (= input into district heating network)	[MWhth/period]
Total heating energy production from peak load supply	[MWh./period]
b) In the energy distribution network	
Operation hours of the pump	[h/period]
average inlet and return temperature in network during operation	[°C]
auxiliary energy used of the network during operation	[MWh/Monit. period]
Subtotal amount of energy fed and extracted in the network	[MWh/Monit. period]
Subtotal energy supplied to the buildings for heating and DHW	[MWh/Monit. period]
Peak load - energy for heating and DHW extracted from network	kW
c) In the thermal storage	
Heating energy fed into the thermal storage	[MWh/Monit. period]
Heating energy extracted from the thermal storage	[MWh/Monit. period]
d) Solar Thermal	
Global solar radiation on horizontal surface	[KWh/(m2 Monit. period)]
Global solar radiation on collectors (if available)	[KWh/(m2 Monit. period)]
total thermal output of solar thermal plant	[MWh/ Monit. Period]

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Auxiliary energy (e.g. for pumps, tracking system, etc.)

[MWh/ Monit. Period]

Economic monitoring (annual basis)

a) Revenues/Grants	Monitored data. Year 1
Electricity	
Net energy sales revenues for electricity fed into the grid (euro/year)	
Grants for electricity fed into the grid (euro/year)	
Total revenues for electricity (euro/year)	
Heating	
Net energy sales revenues for delivered heating energy (euro/year)	
Grants for delivered heating energy (euro/year)	
Total revenues for heating energy (euro/year)	
b) Costs	
Energy costs	
Net energy costs for energy carrier 1 (euro/year)	
Net energy costs for energy carrier 2 (euro/year)	
Net energy costs for peak load energy carrier (euro/year)	
Net energy costs for auxiliary energy (euro/year)	
Further Non-Energy related costs of the generation and distribution system	
Net non-energy related costs (specify) (euro/year)	
Net operation related other costs 1 (specify) (euro/year)	
Further Non-Energy related costs of the solar thermal	
Net non-energy related costs (euro/year)	
Net operation related other costs 1 (specify) (euro/year)	
Further Non-Energy related costs of thermal storage	
Replacement and substitution costs (specify) (euro/year)	
Operation related costs 1 (specify) (euro/year)	

	Type of Business of supplier	Registered office location	Annual revenue	Annual profit	N° of employees
Supplier of the energy carrier "X"					
Supplier of the energy carrier for peak load					

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Supplier of the Non-Energy related services of the generation and distribution system

Supplier of the Non-Energy related services of the other systems

Social monitoring (annual basis)

(From the point of view of owner-occupiers)

	Monitored data. Year				
	very satisfied	satisfied	neither satisfied nor dissatisfied	dissatisfied	very dissatisfied
Degree of satisfaction with the energy supply					
Degree of satisfaction with the level of information intervention/project					
Degree of satisfaction with the information received about energy topics					
Degree of satisfaction with the involvement in decision making of the project					

% of households taking part in the feedback (compared to the total households affected by the intervention)	
Actual heating consumption in households after the project	
Actual electricity consumption in households after the project	
Actual heating energy COST in households after the project	
Actual Electricity COST in households after the project	

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9.3.2 Building refurbishment

Technical monitoring

a) In the Energy generation

Meter X

energy carrier

total quantity of energy consumed in the specified period
[kwh] / period

if energy carrier is biomass, please specify:

lower heating value per specified unit

Overwrite (specify)

content of moisture

[% moisture]

density of energy carrier

[kg/m³]

Peak load - DHW

[kwh] / period

Peak load - Heating

[kwh] / period

Peak load - Electricity

[kwh] / period

b) Solar Thermal

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global solar radiation on horizontal surface [3]
[KWh/(m²period)]

global solar radiation on collectors (if available) [3]
[KWh/(m²period)]

total thermal output of solar thermal plant
[KWh/period]

auxiliary electricity (e.g. for pumps, tracking system, etc.) - specify
[KWh/period]

c) PV Electricity

Global solar radiation on horizontal surface
[KWh/(m²period)]

Global solar radiation on PV modules (if available)
[KWh/(m²_{PV}period)]

Total electricity production from PV
[KWh_{el}/period]

Auxiliary energy consumption (e.g. for tracking system) - specify
[KWh_{el}/period]

Electricity delivered to the grid
[KWh_{el}/period]

Self-consumed electricity
[KWh_{el}/period]

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Economic monitoring (annual basis)

a) Revenues/Grants	
Electricity	
Net energy sales revenues for electricity fed into the grid (euro/year)	
Grants for electricity fed into the grid (euro/year)	
Total revenues for electricity (euro/year)	
b) Costs	
Energy costs	
Net energy costs for energy carrier 1 (euro/year)	
Net energy costs for energy carrier 2 (euro/year)	
Net energy costs for energy carrier 3 (euro/year)	
Further Non-Energy related costs of the envelope measures (e.g. maintenance)	
Net non-energy related costs (specify) (euro/year)	
Net operation related other costs 1 (specify) (euro/year)	



	Type of Business of the supplier	Registered office location	Annual revenue	Annual profit	Nº of employees
Supplier of the energy carrier 1					
Supplier of the energy carrier 2					
Supplier of the energy carrier 3					
Supplier of the Non-Energy related services of the envelope measures					
Supplier of the Non-Energy related services of the energy generation systems					
Supplier of the Non-Energy related services of the solar thermal collectors					

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Supplier of the Non-Energy related services of the PV panels

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Social monitoring (annual basis)
(From the point of view of owner-occupiers)

	Monitored data. Year 1				
	very satisfied	satisfied	neither satisfied nor dissatisfied	dissatisfied	very dissatisfied
Degree of satisfaction with the envelope refurbishment					
Degree of satisfaction with the energy supply					
Degree of satisfaction with the level of information about the energy supply system					
Degree of satisfaction with the information received about energy refurbishment topics					
Degree of satisfaction with the involvement in decision-making of the project					
Citizens directly involved in the feedback					
% of households taking part in the feedback (compared to the total households affected by the intervention)					

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9.3.3 Electric vehicles fleet

Technical monitoring

(For each electric vehicle type)

Electricity consumption [KWhe/period]	
Traveled distance [Km]	
Number of trips	
Average charging time of the period [hour]	
Number of charging in the period	
State of Health (SOH) of the battery at the end of the period	
Average occupancy	
Accuracy of timekeeping (Number and percentage of services on time) [%]	

Economic monitoring (annual basis)

(For each electric vehicle type)

a) Revenues/Grants

Total operating revenues (euro/year)	
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b) Costs

Operating costs (related to energy consumption) (euro/year)	
Non-energy related operating costs (euro/year)	
Maintenance costs (labour) (euro/year)	
Maintenance costs (components) (euro/year)	

For each related company

Type of Business of the supplier	
Registered office location	
Annual revenue	
Annual profit	
N° of employees	

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Social monitoring (annual basis)

	Level of satisfaction
Perception of driving comfort	
Perception of comfort in the charging of the battery	
Noise perception	
Acceptance level	
Perception of security	
Quality of service	
Degree of satisfaction with the level of information intervention/project	
Degree of satisfaction with the information received about energy topics	
Degree of satisfaction with the involvement in decision - making of the project	
	Value
Citizens directly involved	
Injuries and deaths caused by transport accidents	

The level of satisfaction of the indicators defined in the table above is measured through a likert scale as follows: Number of "very satisfied" responses, Number of "satisfied" responses, Number of "neither satisfied nor dissatisfied" responses, Number of "dissatisfied" responses, Number of "very dissatisfied" responses and finally the average evaluation.

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9.3.4 Transport Infrastructure

Technical monitoring

(For each recharging point type)

Average daily energy availability [KWhe]	
Cumulated energy supply in the period [KWhe]	
Average time of the charging [hours]	
Number of charges	

Economic monitoring (annual basis)

(For each recharging point type)

a) Revenues/Grants

Total operating revenues (euro/year)	
b) Costs	
Operating costs (related to energy consumption) (euro/year)	
Non-energy related operating costs (euro/year)	
Maintenance costs (labour) (euro/year)	
Maintenance costs (components) (euro/year)	
	For each related company
Type of Business of the supplier	
Registered office location	
Annual revenue	
Annual profit	
N° of employees	

Social monitoring (annual basis)

	Level of satisfaction
Perception of comfort in the charging of the battery	
Acceptance level	
Perception of security	
Degree of satisfaction with the level of information intervention/project	
Degree of satisfaction with the information received about energy topics	
Degree of satisfaction with the involvement in decision - making of the project	

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Citizens directly involved



9.3.5 Lighting and other ICT

Technical monitoring

a) In the lighting system		
Real daily schedule		Area X
	summer month	
	winter month	
	spring month	
	Autumn month	
Number of black spots after the lighting implementation and area (m2)		
Number of lights substituted (damaged-not planned) lamps during the year [nº] - per 1000 lamps		
Total annual electricity consumption [kwh/year]		

b) Energy consumption per lighted area	
Area X	
Total electricity consumption	[KWh/period]
Lighting electricity consumption	[KWh/period]
Control system electricity consumption	[KWh/period]
Others	[KWh/period]

c) ICT technical monitoring			
Services	Number of final users involved	Number of Apps developed	Number of downloads of developed Apps
Smart mobility services			
Active citizenship			
Open-Government			
Other -Data management			
Other -Use of information generated by energy consumers			

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Networks			
Mobile communications network			
Networking Sensors and capillary networks			
Network Operating System for network control and virtualization			

Economic monitoring (annual basis)

a) Revenues/Grants of lighting interventions	Monitored data. Year 1
Total annual electricity cost [euro/year]	
Total fixed costs electricity - power contracting (eur/a)	
Total revenues for electricity saved (euro/year)	
b) Cost of lighting interventions	
Further Non-Energy related costs of the lighting measures (e.g. substitution)	
Non-energy related costs: maintenance (components) (euro/year)	
Non-energy related costs: Maintenance (labour) (euro/year)	

	ICT Smart City Platform	Services	Network
c) Grants and Operational costs of the ICT intervention			
Grants	[euro/year]	[euro/year]	[euro/year]
Energy Use Costs	[euro/year]	[euro/year]	[euro/year]
Operating revenues (<i>if applicable</i>)	[euro/year]	[euro/year]	[euro/year]
Operation and Maintenance costs	[euro/year]	[euro/year]	[euro/year]



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	Type of Business of supplier	Registered office location	Annual revenue	Annual profit	Nº of employees
Supplier 1 of the Non-Energy related services of the lighting measures					
Supplier 2 of the Non-Energy related services of the lighting measures					

Social monitoring (annual basis)

	Monitored data. Year 1				
	very satisfied	satisfied	neither satisfied nor dissatisfied	dissatisfied	very dissatisfied
Degree of satisfaction with the lighting intervention in area 1					
Degree of satisfaction with the lighting intervention in area 2					
Degree of satisfaction with the lighting intervention in area 3					
Degree of satisfaction with the black spots removal					
Degree of satisfaction with the level of information intervention/project					
Degree of satisfaction with the information received about lighting system topics					
Degree of satisfaction with the involvement in decision-making of the project					
Degree of satisfaction with the ICT Services					

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<p>Degree of satisfaction with the ICT Networks</p>	
<p>Citizens directly involved in the surveys</p>	

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10. Annex II: KPI Templates

10.1 TECHNICAL KEY PERFORMANCE INDICATORS

Total final energy generation – Heat & electricity separately [kWh/year]

Description

Output energy flow of final energy (heat and electricity expressed separately) produced by energy supply units per year [kWh/year]

Source

Concerto.

Expected Data Source

Monitoring.

Considered to relate with city level indicators

No.

Total final energy consumption – Heat & electricity separately [KWh/year]

Description

Input energy flow of final energy (thermal energy and electricity expressed separately) needed to cover energy demand per year [kWh/year].

Source

Concerto.

Expected Data Source

Monitoring.

Considered to relate with city level indicators

Yes. (Annual final energy consumption). Indirect calculation.

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Total fuel consumption – per energy carrier [KWh/year]

Description

Input flow of energy carrier (expressed per type of fuel) to energy generation units per year [kWh/year]

Source

Concerto.

Expected Data Source

Monitoring.

Considered to relate with city level indicators

Yes. (Annual final energy consumption). Direct calculation.

Renewable Energy Production – Heat & electricity separately [KWh/year]

Description

Output of final energy (heat and electricity expressed separately) flow produced by renewable systems per year [kWh/year]. This KPI can be expressed by type of Renewable Energy Source (RES).

Source

Concerto.

Expected Data Source

Monitoring.

Considered to relate with city level indicators

Yes. (Renewable electricity generated within the city and Renewable heat generated within the city). Direct calculation.

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Degree of energetic self-supply by RES – Heat & electricity separately [%]

Description

The degree of energetic self-supply by RES (Renewable Energy Source) is defined as ratio of “Renewable Energy Production KPI” and the “Total final energy consumption KPI” expressed in percentage. This ratio must be expressed separately for thermal energy and electricity production.

Source

Concerto.

Expected Data Source

KPIs.

Considered to relate with city level indicators

Yes. (Renewable electricity generated within the city and Renewable heat generated within the city). Indirect calculation.

Degree of energetic self-supply by CHP – Heat & electricity separately [%]

Description

The degree of energetic self-supply by CHP (Cogeneration Heating Plant) is defined as ratio of cogeneration energy production and the “Total final energy consumption KPI” expressed in percentage. This ratio must be expressed separately for thermal energy and electricity production.

Source

Concerto.

Expected Data Source

Monitoring and KPI.

Considered to relate with city level indicators

Only in the case that the CHP works with renewable energies. (Renewable electricity generated within the city and Renewable heat generated within the city). Indirect calculation.

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Number of buildings connected to the DH [n°]

Description

The number of buildings connected to the district heating (DH) will be obtained from the intervention characterisation in each case study.

Source

Replicate.

Expected Data Source

Intervention characterisation.

Considered to relate with city level indicators

Yes. (Number of connections to a district heating network). Direct calculations.

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Total heat supplied to the buildings connected to the district heating network [kWh/year]

Description

Thermal energy flow produced and distributed by the district heating employed to cover building heating and DHW (Domestic Hot Water) demand per year [kWh/year].

Source

Replicate.

Expected Data Source

Monitoring.

Considered to relate with city level indicators

No.

Degree of heating supply by DH [%]

Description

The degree of heating supply DH (District Heating) is defined as ratio of "Total heat supplied to the buildings connected to the district heating network KPI" and the "Total final energy consumption – heating KPI" expressed in percentage.

Source

Replicate.

Expected Data Source

KPI.

Considered to relate with city level indicators

No.

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Final energy demand of the buildings [KWh/year.m2]

Description

The final energy demand of buildings calculated based on the thermal resistance of the building envelope and use hypothesis considering the climate conditions. This KPI will be expressed per year and square meter of Heated Floor Area (HFA).

Source

Replicate.

Expected Data Source

Baseline and interventions assumptions.

Considered to relate with city level indicators

No.

Number of refurbished buildings [n°]

Description

The number of refurbished buildings will be obtained from the intervention characterisation in each case study.

Source

Replicate.

Expected Data Source

Intervention characterisation.

Considered to relate with city level indicators

Yes. (Refurbished buildings improving energy efficiency). Direct calculations.

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Number of electric vehicles acquired [n°]

Description

The number of electric vehicles acquired will be obtained from the intervention characterisation in each case study.

Source

Replicate.

Expected Data Source

Intervention characterisation.

Considered to relate with city level indicators

Yes. (Number of electric vehicles in the city and Percentage of EV per sector).
Direct calculations

Number of EV recharging points [n°]

Description

The number of electric vehicles (EV) recharging points installed will be obtained from the intervention characterisation in each case study.

Source

Replicate.

Expected Data Source

Intervention characterisation.

Considered to relate with city level indicators

Yes. (Number of electric charging stations for EV). Direct calculations.



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Number of trips [n°/year]

Description

The number of trips will be monitored for the new electric vehicles acquired and will be expressed per year.

Source

Replicate.

Expected Data Source

Monitoring.

Considered to relate with city level indicators

Yes. (Number of annual PT trips per capita). Direct calculations.

Travelled distance by electric vehicles [Km/year]

Description

This indicator will be monitored for the new electric vehicles acquired and will be expressed per year.

Source

Replicate.

Expected Data Source

Monitoring.

Considered to relate with city level indicators

No.

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Number of final users involved – Services and Networks separately [n°/year]

Description

The number of final users involved will be quantified for each service (smart mobility, active citizenship, open-government, other-data management and other use of information generated by energy consumers) and for each network (mobile communications, networking Sensors and capillary and network Operating System for network control and virtualization) contained into the Smart City Platform. This indicator will be expressed per year.

Source

Replicate.

Expected Data Source

Monitoring.

Considered to relate with city level indicators

Yes. (Number of users of digital services). Direct calculations.

Number of Apps developed – Services and Networks separately [n°/year]

Description

The number of apps developed will be quantified for each service (smart mobility, active citizenship, open-government, other-data management and other use of information generated by energy consumers) and for each network (mobile communications, networking Sensors and capillary and network Operating System for network control and virtualization) contained into the Smart City Platform. This indicator will be expressed per year.

Source

Replicate.

Expected Data Source

Monitoring.

Considered to relate with city level indicators

No.

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Number of downloads of developed Apps [n°/year]

Description

The number of downloads of developed apps will be quantified for each service (smart mobility, active citizenship, open-government, other-data management and other use of information generated by energy consumers) and for each network (mobile communications, networking Sensors and capillary and network Operating System for network control and virtualization) contained into the Smart City Platform. This indicator will be expressed per year.

Source

Replicate.

Expected Data Source

Monitoring.

Considered to relate with city level indicators

No.

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10.2 ENVIRONMENTAL KEY PERFORMANCE INDICATORS

Total primary energy consumption related to heating and electricity consumption [MJ/year]

Description

The primary energy consumption will be calculated multiplying the primary energy conversion factors of each energy carrier by the “Total fuel consumption KPI – per energy carrier”. Furthermore, we will multiply the primary energy conversion factor of the Power Grid Mix by the electricity consumed from the grid. These two data will be added to calculate the “Total primary energy consumption KPI” expressed in MJ per year. It is important to note, that each country will have different conversion factors for the Power Grid.

Source

Replicate.

Expected Data Source

Monitoring and KPI. Bibliography.

Considered to relate with city level indicators

Yes. (Annual final energy consumption). Indirect relation.

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Total greenhouse gas emissions related to heating and electricity consumption [Kg CO₂ eq./year]

Description

The greenhouse gas emissions will be calculated multiplying the GWP (Global Warming Potential) factors of each energy carrier by the “Total fuel consumption KPI – per energy carrier”. The GWP will differ depending on the energy generation system, so specific correction factors will be implemented into the calculation. Furthermore, we will multiply the GWP factor of the Power Grid Mix by the electricity consumed from the grid. These two data will be added to calculate the “Total greenhouse gas emissions KPI” expressed in kg CO₂ equivalent per year. It is important to note, that each country will have different conversion factors for the Power Grid.

Source

Replicate.

Expected Data Source

Monitoring and KPI. Bibliography.

Considered to relate with city level indicators

Yes. (Carbon Dioxide emissions). Direct calculations.

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10.3 ECONOMIC KEY PERFORMANCE INDICATORS

Total investment per intervention. Excl. VAT [€]

Description

The total investment is defined as cumulated payments until the start of the initial operation/use of the implemented intervention.

Source

Concerto

Expected Data Source

The corresponding supplier.

Considered to relate with city level indicators

Yes. (Expenditures by the municipality to the transition towards smart city).
Direct calculations.

Total municipal grants per intervention [€]

Description

Grants are non-repayable funds that a grant maker, such as the municipality provides to a recipient, for implementing the interventions. In order to receive a grant, an applicant must submit a proposal or an application to the potential funder. This could be either on the applicant's own initiative or in response to a request for proposal from the funder.

Source

Concerto

Expected Data Source

The corresponding supplier or the municipality.

Considered to relate with city level indicators

Yes. (Incentives for final users for low carbon measures). Direct calculation.

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Local cost ratio per intervention (related to total costs) [%]

Description

The relation between the local shares (within the city boundaries) of the “Total investment per intervention KPI” compared to its “Total investment per intervention KPI”. This KPI will be calculated per intervention and expressed in percentage.

Source

Replicate.

Expected Data Source

The corresponding supplier and KPI.

Considered to relate with city level indicators

Not directly. Intermediate data for the impact assessment methodologies. (Gross domestic product)

Energy production cost – Heat & electricity separately [€/KWh]

Description

The energy production costs are defined as sum of discounted total annual costs less sum of discounted total annual revenues except annual energy-sales revenues. The costs are related to the production of thermal energy and electricity by the energy generation systems under study. This KPI will be calculated separately for thermal energy production and electricity and will be expressed as euro per Kwh.

Source

Concerto.

Expected Data Source

Monitoring.

Considered to relate with city level indicators

Not directly. Intermediate data for the impact assessment methodologies.

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Energy bill – Heat & electricity separately [€ /KWh]

Description

Costs related to the final energy consumption of households and other end users. This KPI will be calculated as euro per Kwh.

Source

Replicate.

Expected Data Source

Monitoring.

Considered to relate with city level indicators

Not directly. Intermediate data for the impact assessment methodologies. (Gross domestic product)

Total energy cost per year [€ / year]

Description

The total energy cost is related to the “Energy bill KPI” and the “Total final energy consumption KPI” cost. This KPI will be calculated for the interventions under study and per year.

Source

Concerto.

Expected Data Source

Monitoring and KPI.

Considered to relate with city level indicators

Not directly. Intermediate data for the impact assessment methodologies. (Gross domestic product)

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Payback Period per intervention [n° years]

Description

The payback period, expressed in number of years, 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.

Source

Concerto.

Expected Data Source

Monitoring.

Considered to relate with city level indicators

Not directly. Intermediate data for the impact assessment methodologies. (Gross domestic product)

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10.4 SOCIAL KEY PERFORMANCE INDICATORS

Direct total and local jobs created [n° jobs / year]

Description

The amount of jobs created directly in the city due to the deployment of interventions. Jobs created or maintained due to the investments carried out in the companies of the cities. This KPI will be expressed as number of jobs per year.

Source

Replicate.

Expected Data Source

The corresponding supplier and monitoring.

Considered to relate with city level indicators

Yes. (City's employment rate and Gross domestic product). Impact assessment method.

Number of citizens involved in the study [n°]

Description

This KPI will quantify the number of citizens involved in the study related to the degree of satisfaction assessment.

Source

Replicate.

Expected Data Source

Monitoring.

Considered to relate with city level indicators

No

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Degree of satisfaction per intervention [level]

Description

The degree of satisfaction will be related to the citizens involved in the interviews. The satisfaction will be monitored for the following topics: decision making process, intervention implementation, intervention operation and final energy supply. The level of satisfaction will be defined for each case study before the monitoring process starts.

Source

Replicate.

Expected Data Source

Monitoring.

Considered to relate with city level indicators

No.