Nantes | Hamburg | Helsinki

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D5.1 Integrated Evaluation Procedure

WP 5, Task 5.1

Transition of EU cities towards a new concept of Smart Life and Economy

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 731297.

Project Acronym	mySMARTLife	
Project Title	**Transition of EU cities towards a new concept of Smart Life and Economy**	
Project Duration	1st December 2016 – 30th November 2021 (60 Months)	
Deliverable	D5.1 Integrated evaluation procedure	
Diss. Level	Public	
Status		Working
		Verified by other WPs
	■	Final version
Due date	30/11/2019	
Work Package	WP5	
Lead beneficiary	CAR	
Contributing beneficiary(ies)	CER, HCU, VTT, TEC, NBK, ESA	
Task description	**Task 5.1:Integrated evaluation procedure** This task aims to develop an integrated evaluation procedure to assess the performance and success of the project activities from a holistic point of view and to replicate the project in other cities. Success is determined by the transition across the entire environmental footprint of urban areas, simultaneously promoting economic prosperity, social aims and resilience to climate change and other external disturbances. **Subtask 5.1.1: Evaluation framework**. CAR, VTT and TEC will guide the definition of the evaluation framework that will have a twofold scope in order to measure and assess the project activities at Smart City Project level (i.e. demonstration areas) and Smart City level considering the five major themes defined by CITYkeys: People, Planet, Prosperity, Governance and Propagation and considering SCIS indicators. This framework will include boundaries of the integrated evaluation and specific approaches to assess the impact of the project actions and interventions in each one of the aforementioned themes.	

Date	Ver.	Author	Comment
08/05/2017	0.0	CAR	ToC
25/05/2017	0.1	CAR	Review of the ToC and draft of contents
14/09/2017	0.2	CAR	Definition of City level indicators
30/11/2017	0.3	CAR	Intermediate Version
18/11/2018	0.4	CAR	Updated ToC and progress in evaluation frameworks, city and project indicators
25/11/2018	0.5	VTT	Review of document
30/11/2018	0.6	CAR	Second Intermediate Version
01/10/2019	0.7	CAR	Updated ToC and reporting of sections 3, 4, 5, and 6

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November 2019	0.8	CAR, CEREMA, HCU, ESADE, VTT	Description of the section 7 and Annex II
14/12/2019	1.0	CAR	Final version (deliverable submission)

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Abbreviations and Acronyms

Acronym	Description
mySMARTLife	Transition of EU cities towards a new concept of Smart Life and Economy
DoA	Description of the Action
WP	Work package
LH	Lighthouse
SCC	Smart Cities and Communities
KPI	Key Performance Indicators
SCIS	Smart Cities Information System
SDG	Sustainable Development Goal
GHG	Greenhouse gases emissions
GWP	Global Warming Potential
RES	Renewable Energy System
DHW	Domestic Hot Water
DH	District Heating
EV	Electric Vehicle
ICT	Information and Communication Technology
IoT	Internet of Things
OECD	Organization for Economic Co-operation and Development
IPMVP	International Performance Measurement and Verification Protocol
M&V	Measure and Verification
ECM's	Energy Conservative Measures
N/A	Non Available
PM	Particle matter
HC	Volatile hydrocarbons
ICE	Internal Combustion Engine

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1. Executive Summary

The aim of this deliverable is to define an evaluation procedure to assess the success of the actions implemented in the three lighthouse cities that participate in mySMARTLife project in an integrated way and at two scales: Smart City level and Smart City Project level.

For achieving this challenge, it has worked in a collaborative way among technical and city partners to determine the evaluation framework that integrates the objectives to be evaluated and their corresponding indicators. After a deep review of literature, standards and ongoing SCC projects, this deliverable collects the methods and indicators to perform a city diagnosis and to evaluate project actions implemented in the demonstrative areas. A detailed description of the indicators and the methods for their quantification is found in the document that is divided in the following chapters:

- Chapter 2 introduces the purpose and target group, the contributions of partners involved and the relation with other activities of the project.
- Chapter 3 includes a brief description of the interventions to be implemented in the 3 LH as well as the foreseen impacts.
- Chapter 4 describes the main features of mySMARTLife evaluation framework and the categories of indicators defined.
- Chapter 5 reports the process for the selection and definition of indicators and the main evaluation frameworks used, which includes CITYkeys and SCIS.
- In Chapter 6, the City Evaluation Framework is described and the application fields and city indicators are listed. Main conclusions of the city audits performed in LH and follower cities are included.
- Chapter 7 is focused in describing the scope and evaluation approach of each pillar defined in the Project Evaluation Framework.
- Chapter 8 deploys the procedure proposed to estimate the impacts of project actions at city level.
- Chapter 9 and 10 deal with the conclusions obtained and next steps, respectivelly.
- Annexes include a detailed description of the indicators at City Level and Project Level.

Last but not least, it has to mention that this report defines the evaluation approach at the current stage of actions implementation. These are subject to be modified in a possible upcoming amendment. Required updates will be included in D5.3 at M48.

2. Introduction

2.1 Purpose and target group

This deliverable is allocated within Task 5.1 and develops an integrated evaluation procedure to assess the performance and success of the actions implemented in the three lighthouse cities which participate in mySMARTLife project. The target group of the document are the partners responsible of the data collection and evaluation of the project actions but also other cities or decision makers managing smart city projects that wish to learn and use the methods and indicators described.

The Table 2.1 depicts the main contributions from participant partners in the development of this deliverable.

Table 2.1: Contribution of partners

Participant short name	Contributions
CAR	Coordination and alignment of deliverable contents Definition of the evaluation framework approach and leadership in the development of city and project evaluation frameworks Identification of city and project level indicators in all categories Contact point with partners for the selection and validation of indicators at city and project level
TEC	Identification of city and project level indicators in several categories Definition of the Governance pillar approach
ESA	Identification of city level indicators in the category of economy Definition of the approach to measure economic impacts of the actions
VTT	Identification of city and project level indicators in several categories Definition of the approach to measure impacts at city level Coordination of the work for Helsinki demo team
NBK	Identification of city and project level indicators in the category of energy-environment Coordination of the work for Nantes demo team in relation to energy pillar
CER	Identification of city and project level indicators in the category of mobility Definition of the Mobility pillar approach Coordination of the work for Nantes demo team in relation to mobility actions
NAN	Validation of indicators for the city of Nantes

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HCU	Identification of city and project level indicators in the category of Citizens and Social, respectively Definition of the approach to measure actions under a social perspective Contact point with responsible of actions in Hamburg for validation of project level indicators
HAM	Validation of indicators for the city of Hamburg

2.2 Relation to other activities in the project

The Table 2.2 compiles the main links of this deliverable to other activities developed within mySMARTLife project that should be considered along with this document for further understanding of its contents.

Table 2.2: Relation to other activities in the project

Deliverable Number	Contributions
WP1	Smart people and Smart economy concepts developed in WP1 have been considered for the definition of the approach to evaluate project actions from a social and economic point of view. Additionally, indicators and project evaluation framework defined in WP5 have been analyzed for the definition of the approach to evaluate the replication potential of interventions in WP1
D2.1/D3.1/D4.1 & D6.1/D6.2/D6.3	City audits performed in LH and follower cities utilized the city level indicators identified in D5.1
D2.18, D3.12 and D4.21	These deliverables provide the baseline of the interventions from the lighthouse cities involved in the project by making use of the project level indicators and the procedures of evaluation described in the sections 7.1 and 7.2
D5.2	D5.2 will list and analyze the data sets used in each LH city to calculate city level indicators to perform city audits. Requirements of project indicators will be described in D5.2
D5.3	The monitoring program to collect data to evaluate impacts will be based in the project indicators defined in D5.1
D5.4	Project indicators included in D5.1 will be calculated in this deliverable
D5.5	The impacts achieved in the demosites will be evaluated in this deliverable making use of the methods and indicators defined in D5.1

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3. Background and context

This section deals with the introduction of interventions implemented in mySMARTLife and their foreseen impacts that will be the basis for the development of mySMARTLife Evaluation Framework.

3.1 Description of mySMARTLife interventions

Three lighthouse cities (Nantes, Hamburg and Helsinki) have as commitment the deployment of a big set of large-scale actions/interventions and the collection of data for at least two years to demonstrate the impacts that such actions produce in the cities.

The interventions planned in the three lighthouse cities include innovative technological solutions in connection with refurbishments of buildings, usage of renewable energies, clean transport and supporting ICT solutions. On other hand, demonstrators aim the implementation of the Smart PEOPLE and Smart ECONOMY concepts for empowering the implementation of such technical solutions in these cities. Last but not least, project intends to integrate these concepts in the lighthouse cities for the definition of their Urban Transformation Strategies as well as to develop an advanced urban planning through the policy improvements and the identification of the most promising replicable actions to be included in the future city plans. As a result, around 150 actions are foreseen to be implemented in the three cities in technological and non-technological domains as it is represented in Figure 3.1.

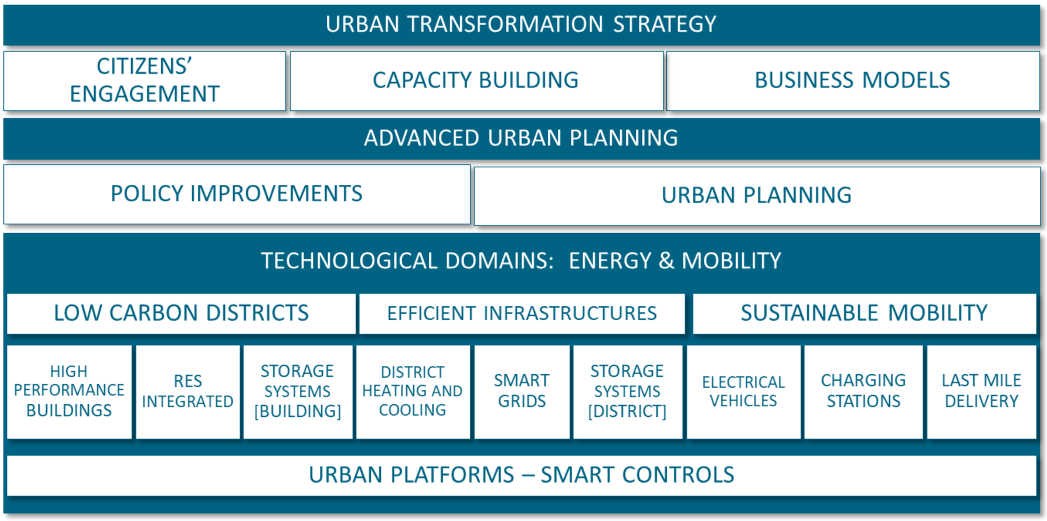

Figure 3.1: mySMARTLife Project actions

In order to give clarity and better understanding of the demonstration dimension, it is detailed the different typologies of interventions to be adopted and how these are deployed in each LH city.

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- *Building and districts* include retrofitting interventions, high performance new buildings, domotics and smart controllers, building RES integrated and building level energy storage.
- *City infrastructure* compiles smart grids, district heating and cooling, public lighting, urban scale renewable energy systems, urban thermal storage and urban electrical storage.
- *Mobility actions* consist of electrical vehicles, charging stations, demand management actions, urban freight and logistics, multimodality and intelligent transport system.
- *Non-technical actions* involve policy improvements, innovative business models, urban planning actions, citizen engagement strategies and staff exchanges initiatives.
- *Urban platform and ICT developments* incorporate urban platform deployment and Internet of Things deployment (IoT).

These actions are being implemented in each city as follows [1]:

<u>Nantes</u>

- Zone 1 consists of a new buiding area which include the following interventions:
  - New construction programme inspiration: Construction of a new building that will be connected to a high-performance district heating.
  - Existing building Pierre Landais that will be reconstructured with connection to the DH and integration of an innovative Digital Boiler concept.
  - Carbon Neutral Multimodal hub: A new multimodal concept that integrate RES, smart energy systems and soft mobility services will be demonstrated in an existing office building. This includes PV system with an electricity storage, power management and smart charging.
- Zone 2 comprises a retrofitting area with multi-owner residential buildings which will be retrofitted according to building needs and general assemblies decisions. In terms of RES, two buildings are connected to the district heating and one building integrates thermal panel. This zone is complemented with a second intervention in individual houses that will be retrofitted and include a hybrid solar thermal and PV system.
- Zone 3 includes the district-city level where all mobility actions and city infrastructures will be included: 22 new e-buses, an innovative charging technology for e-buses, around 65 charging stations, last mile initiatives, optimization of the district heating operation and smart metering and public lighting developments will be demonstrated together with the new Urban Platform developments.

[1] According to the current DoA (November 2019)

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Hamburg

These are the three zones of intervention:

- Zone 1 comprises the new construction area “Schleusengraben” whose main pillars of interventions are the new constuction of buildings above national standards, incorporating domotics and smart controls and the connection to an innovative concept of district heating with a share of renewable H2. Additionally, a new Smart adaptative lighting intervention will be implemented.
- Zone 2 is the retroftting area “Bergedorf-Süd” where an ambitious retrofitting programme will be implemented together with an innovative concept of Smart Heating Islands mainly based on Renewables. Smart controls, domotics and smart meters will be installed as well in these retrofitted buildings. A humble lampost initiative is foreseen to repurpose existing lamps.
- Mobility actions affect the whole city although they are more focused in the district of Bergedorf-Süd, comprising the so-called Zone 3. The actions foreseen are 10 electrical buses, a total 27 e-cars and 5 e-bikes for public and private fletes. Regarding charging stations, the following are foreseen: a bus charging station at depot, several fast charging stations and a set of private stations, all supplied with 100% of RES. A multimodality hub and innovative concepts like e-community fleet car sharing and logistics microhub.

Helsinki

There are three zones of interventions.

- Zone 1 comprises Merihaka and Vilhonvuori residential retrofitting zones where a large retrofitting action is taken, including renovation target of 12 buildings and 1,323 flats. Smart controls connected to the Urban Platform through IoT, smart meters in all flats. Management and optimization of the district heating and cooling will be applied as well.
- Zone 2 is related to a new construction of a high-performance residential zone in Helsinki, the so-called Kalasatama area. Nearly 4,500 flats will be part of mySMARTLife, including Smart Home solutions, smart meters in all flats, integration of RES and waste heat in the buildings, demand response actions considering the waste heat and the co-creation area Kalasatama living lab. Many on-going investments are included in this zone, like world’s largest cool reserve (38 million liter cold water storage), crowd-funded solar power plant (0.34MW Suvilahti) and world’s largest heat and cool pump (Katri Vala 90MW). The coal plant is included as well in Zone 2 and its replacement with RES is a challenge adopted by mySMARTLife.
- A third area, Zone 3 is defined for demonstration of a high-performance tertiary building comprising the Viikki Environment office Building, where the RES contribution will be maximised through better control and power management strategies.

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- Zone 4 affects the whole district (and even city) level. Several interventions (mainly mobility actions) are aimed to cover the whole area.

3.2 Identification of mySMARTLife interventions impacts

Some of the impacts due to project actions were identified at the beginning of the project and grouped in specific categories as follows:

- **Energy impacts**
  - mySMARTLife interventions assure the increase on the energy efficiency at district and city scale, maximizing the share of renewable energies and their smart integration in the energy system.
  - Project actions will also contribute to make the local energy system more secure, stable and cheaper for the citizens and public authorities.
  - Interventions will stimulate self-energy consumption and local production, reducing curtailment to the minimum.
- **Environmental impacts**
  - The investment on energy efficiency interventions with a high-share of RES-supply will contribute to decarbonize the energy system.
  - The introduction of EV as well as the replace of fossil fuel by RES to cover the energy demand of buildings will increase the local air quality due to the reduction of concentration of NO_x, particles matter (PM) and volatile hydrocarbons (HC).
- **Economic impacts**
  - The planned actions will mobilize significant public and private investments, which lead to create jobs in the short term. Additionally, the transformation of cities in smarter cities will stimulate the creation of new jobs through the establishment of newly emerging businesses.
  - The demonstration of innovative business models and finance mechanisms in the three LH cities as well as the development of enabling policies will serve to reduce financial risks and give confidence to investors. Consequently, this will encourage the creation of new market opportunities and fostering competitiveness and growth of companies.

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- **Social impacts**
  - mySMARTLife will impact on citizens through the citizen engagement, communication and dissemination strategy deployed. As a result, it is expected that citizens are aware of all benefits of project actions and face the social barriers such as the comfort distortion of the users during the execution of the activities, the resistance to change and divergence of interests.
- **Policy impacts**
  - mySMARTLife interventions will contribute to accomplish their SEAP commitments: 1 million of CO_2 by 2025 as against 2007 in Nantes, the reduction of CO_2 emissions by 50% in 2030 in Hamburg and the Carbon neutrality by 2050 as reported in Helsinki’s Climate and Mobility Plans.

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4. mySMARTLife evaluation framework

Once the impacts foreseen have been identified in previous section, this chapter describes the evaluation framework that will allow measuring the main effects of the implementation of the project actions.

4.1 Requirements of the evaluation framework

The evaluation framework has been designed taking into account that this must meet the specific requirement established in the DoA:

1) On one hand, this framework must have a twofold scope in order to measure the project activities at Smart City Project level (i.e. demonstration areas) and Smart City level.
2) Besides, it must be able to assess the performance and success of the project activities from a holistic point of view.
3) In addition, the evaluation framework must consider the five major themes defined by CITYkeys (People, Planet, Prosperity, Governance and Propagation) and SCIS indicators.

Additionally, in order to evaluate the proper impacts of the actions implemented, it was decided that the evaluation framework should be aligned with mySMARTLife project concept.

How these requirements have been transformed in features of mySMARTLife evaluation framework is described in the next sections: 4.2, 5.1,1, 5.1.2.

4.2 Approach of the evaluation framework

This section deals with the description of the mySMARTLife evaluation framework and their main features that correspond with the requirements introduced in previous subsection.

Before reporting such description, firstly is displayed the figure that summarizes the approach of the Evaluation Framework defined.

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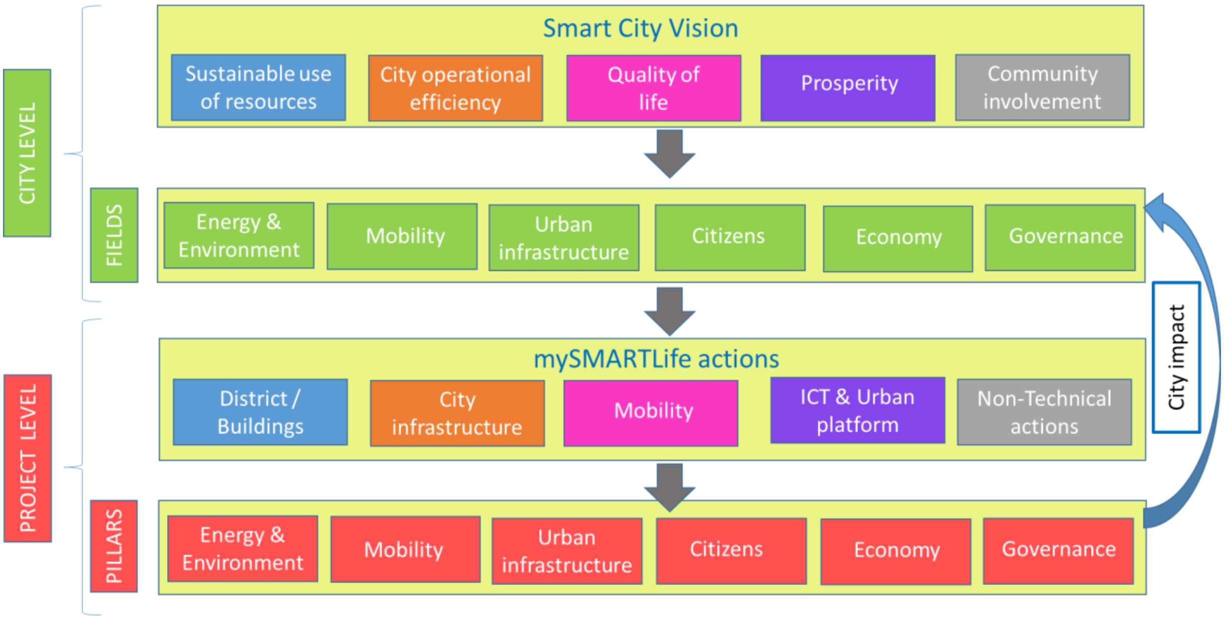

Figure 4.1: mySMARTLife Evaluation Framework

4.2.1 Twofold scope

The components and objectives that are pursued with each framework level are described below:

- City evaluation framework aims to identify the main challenges of the cities through the performance of city audits. Components identified correspond with:
  - City fields reflect the urban areas to be analysed during the city diagnosis.
  - Application fields represent specific topics that need to be analysed in each field to identify the challenges that cities must face to be smarter and more sustainable.
  - City level indicators are the tool to evaluate the different aspects of cities under the topics defined in the application fields.
- At project level, the target of the evaluation framework is to assess the effects of the project actions in the demosite.
  - Project pillars correspond with the type of impacts to be measured in the areas where project actions are implemented.
  - Project level indicators are the tool to evaluate the impacts of mySMARTLife actions in LH cities.

Additionally, both frameworks include objectives to be evaluated and stages required for the evaluation: city audits and city impacts for city evaluation framework and baseline and post-intervention evaluation for project evaluation framework.

Figure belows shows the main components of both evaluation frameworks.

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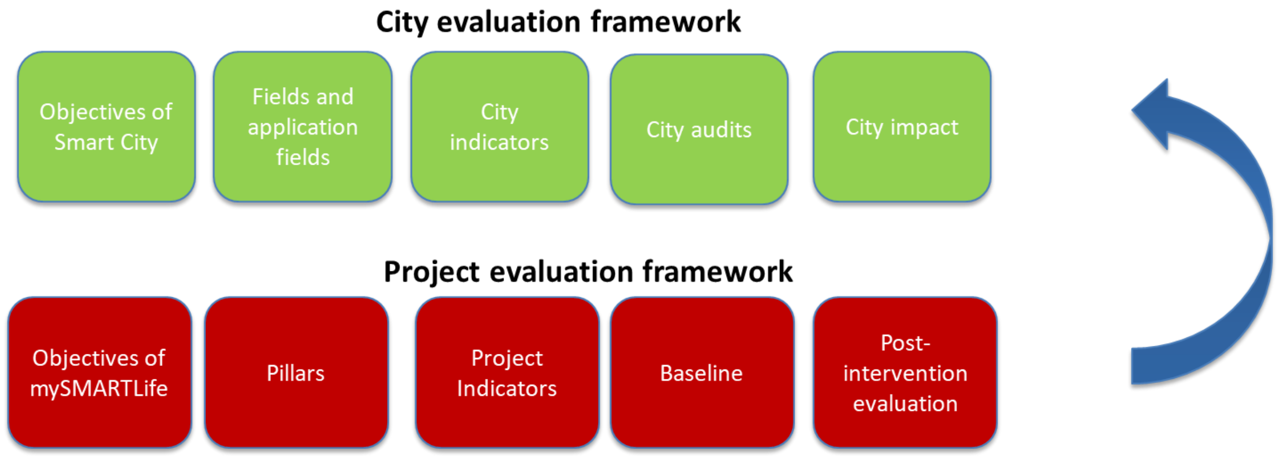

Figure 4.2: City and Project evaluation levels

Therefore, the evaluation framework is connected to the current activities of the project as follow:

- City evaluation framework is used to perform the city audits in the three LH cities and three followers cities through the use of city level indicators. As a result, the main challenges of the cities can be identified. Deliverables that are linked to this evaluation framework are: D2.1, D3.1 and D4.1 with correspond with the city audits of Nantes, Hamburg and Helsinki, respectively, and D6.1, D6.2 and D6.3 for Palencia, Bydgoszcz and Rijeka.

- Project evaluation framework will be employed to quantify the effects of the project actions in the demosite with the use of project level indicators defined.The baseline analysis of the demo areas will be required to have a reference to compare against. This initial situation will be reported in D2.18, D3.12 and D4.21 whereas the success of the project actions will be reported in D5.5 after collecting data during the post-intervention. Additionally, this deliverable will collect the impacts of these project actions at city level after the crossing city and project level indicators.

4.2.2 Holistic approach

The city and project evaluation frameworks in mySMARTLife have been oriented to have a holistic approach and make possible the evaluation of environmental, economic and social aspects. Specific categories have been created for the two level of evaluation, that in fact are the same in order to facilitate the extrapolation of the effects of the actions evaluated in demonstration areas at city level.

- Urban areas to be analysed during the city diagnosis (named as fields): energy and environment, mobility, city infrastructure (which includes ICT/Urban platform), citizens, economy and governance.

- Type of impacts to be measured in the areas where project actions are implemented (named as pillars): energy and environment, mobility, ICT/Urban platform and social, economy and governance.

Fields and pillars defined for each evaluation frameworks are included in table below.

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Table 4.1: City Field and project pillars relation

City evaluation framework *(City fields)*	Project evaluation framework *(Project pillars)*
Energy	Energy & Environment
Environment	
Mobility	Mobility
Urban infrastructure	Urban platform & ICT
Citizens	Social
Economy	Economy
Governance	Governance
City features	

4.2.3 Types of indicators

Indicators are a common tool to establish a diagnosis of starting points, to track progress towards defined goals, to benchmark and to analyses the effect of project actions and assist on the decision-making process. In a complex project such as mySMARTLife, different types of indicators have been defined according to different criteria as is described below.

- **Related to the scale of evaluation:**
  - <u>City indicators</u> to be used to perform city diagnosis.
  - <u>Project indicators</u> for measuring the impacts of projects actions in demosite area but also at city level.
- **Related to the relevance of evaluation:**
  - <u>Core indicators</u> to measure key impacts of the actions and to compare key aspects of the actions against each other.
  - <u>Complementary indicators</u> that aim to evaluate additional aspects of the project actions.

  However, the data availability can influence in the categorization of an indicator that should be core but the difficulty to collect the information makes that the indicator was proposed as complementary.

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- **According to the main data collection source:**
  - Primary indicators refer to those indicators that are directly calculated from meters to be installed in the buildings, city infrastructures or mobility actions or from other data source such as surveys.
  - Secondary indicators refer those indicators that are calculated in an indirect way from primary indicators through specific formulas.

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5. Development of mySMARTLife evaluation framework

mySMARTLife evaluation framework has been designed taking into account a set of principles: existing initiatives and cities as part of the decision process. Thus, the review of the work already performed by other initiatives was considered as a mandatory step but additionally the alignment of evaluation framework with the project concept has been considered as a further requirement. In the next lines, it will describe the process that has led to the development of the evaluation framework.

5.1 Process for the definition of the approach

5.1.1 Alignment with mySMARTLife project concept

City and project evaluation frameworks have been closely linked with the project concept and the objectives pursued by this.

In this sense, the project aims at the demonstration of an Innovative Transformation Strategy to reach a Smart City and deploy an Urban Transformation Strategy based on the frameworks that are represented in Figure 5.1. The technological framework deals with the three sectors on which the foreseen actions will be implemented: Energy, Mobility and ICT. The second framework is the non-technical one, covering the urban plans and business models, whereas innovative framework includes the terms smart people, smart economy and capacity building.

Figure 5.1: mySMARTLife Project concept

Therefore, topics to be evaluated in mySMARTLife evaluation framework at project level has a tight connection with the project concept as it can appreciate in table below.

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Table 5.1: mySMARTLife project concept & mySMARTLife evaluation components

mySMARTLife project concept	**City evaluation framework** ***(City fields)***	**Project evaluation framework** ***(Project pillars)***
Technological Framework	Energy	Energy & Environment
	Environment	
	Mobility	Mobility
	Urban infrastructure	Urban platform & ICT
Non-Technological Framework: *Smart people*	Citizens	Social
Non-Technological Framework: *Smart economy*	Economy	Economy
Non-Technological Framework: *Urban plans, Policy improvements, Capacity Building*	Governance	Governance
--	City features	---

5.1.2 Alignment with existing Evaluation Frameworks

mySMARTLife evaluation framework has been also aligned with existing Evaluation Frameworks and mainly with CITYkeys and SCIS.

Thus, the core categories and the list of indicators at city and project level have been selected from the initiatives described below:

- City level: CITYkeys, SCIS, Agenda for Sustainable development of the United Nations, United for Smart Sustainable Cities (U4SSC), standard ISO 37120, Eurostat City Statistics and SEAP (Sustainable Energy Action Plan).
- Project level: CITYkeys, SCIS, World Banck, OECD (Organisation for Economic Co-operation and Development) and Telefónica Foundation, among other.

Additionally, the Evaluation Frameworks defined in other SCC projects have been used as reference as SmartEnCity, REMOURBAN, Replicate and CITyFiED.

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Below these initiatives are described in detail as well as how they have supported the definition of indicators. These references have been included in the description of each indicator in the Annex I and Annex II.

5.1.2.1 CITYKEYS

CITYKeys was a project supported by the Commission to define the evaluation framework of funded demonstration projects for Smart Cities and Communities projects (SCC). The evaluation framework established is structured in five categories named as themes that correspond with potential impacts to achieve due to smart city projects. Then, each of these themes are split in subthemes to cover specific topics.

- People, planet and prosperity deal with the sustainability aimed in a smart city project in terms of social, environmental and economy.
- Propagation corresponds with the possibilities that the project is able to be up-scaled and applied in other contexts.
- Governance aims to evaluate the quality achieved in the development and implementation process.

This initiative has been one of the main references to identify fields and pillars and to take ideas on how to develop a city impact evaluation from the combination of city and project level indicators. Moreover, this framework has helped to identifity indicators of these categories for both evaluation levels: energy, mobility, ICT, economy, social and governance.

5.1.2.2 Smart Cities Information System (SCIS)

SCIS is a platform, supported by the European Commission, encouraging exchange of data, experience, know-how and collaboration on smart cities to ensure a high quality of life and a clean, energy efficient and climate friendly living environment for the citizens. This platform has developed guidelines that collect indicators to measure technical, social and economic aspects of energy related measures of SCC projects. On other hand, it has to take into account that all LH project must report the monitoring data in a tool developed by this initiative.

Thus, SCIS has been the main reference to identify city and project level indicators in categories such as energy/environment, mobility, economic and social. Moreover, guidelines developed by SCIS have been considered for the description of the assessment approach of energy/environment, economic and social.

5.1.2.3 Agenda for Sustainable development of the United Nations

The 2030 Agenda for Sustainable Development provides the goals and targets defined by all United Nations Member States in 2015 to stimulate actions in areas of critical importance for humanity and the

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planet. As a result 17 Sustainable Development Goals (SDGs) have been defined to face the main challenges of the world.

Figure 5.2: Global sustainable development goals

This initiative has been one of the main references to deploy some of the components of the evaluation framework, since mySMARTLife project has connection with the following SDG ones:

- SDG 7: Affordable and clean energy: Ensure access to affordable, reliable, sustainable and modern energy for all
- SDG 8: Decent work and economic growth: Promotion of the sustained economic growth, higher levels of productivity and technological innovation.
- SDG 11: Sustainable cities and communities: Make cities and human settlements inclusive, safe, affordable, resilient and sustainable by investment and improving urban planning and management in a way that is both participatory and inclusive
- SDG 12: Responsible consumption and production: The efficient management of the natural resources and the way the toxic waste and pollutants are disposal are important targets to achieve this goal.
- SDG 13: Climate action: Take urgent action to combat climate change and its impacts with political and technological measures.

5.1.2.4 United for Smart Sustainable Cities (U4SSC)

This is the framework developed by UNECE to provide cities with a consistent and standardised method to collect data and measure performance and progress to achieving the Sustainable Development Goals (SDGs), becoming a smarter city and becoming a more sustainable city. This initiative has been one of the references to identify city level indicators for energy, environment, economy and citizens category.

5.1.2.5 ISO for sustainable development communities (ISO 37120, ISO 37122 and ISO 37123)

ISO/TC268/WG2, which works for the standardization in the field of Sustainable Cities and Communities, has developed three standards:

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- Standard ISO 37120: Sustainable Development of Communities – Indicators for City Services and Quality of Life
- ISO 37122: Sustainable Development of Communities for Smart Cities
- ISO 37123: Sustainable Development of Communities for Resilient Cities

ISO 37120 has been used to define fields and application fields as well some indicators. ISO 37122 and ISO 37123 have not been considered since they were approved after concluded the identification of indicators.

5.1.2.6 SEAP/SECAP

The Sustainable Energy and Climate Action Plan is a key document that shows how the Covenant signatory will reach its vision and target. Indicators from SEAPs/SECAPs were considered to guarantee the availability of data since all the cities participant in the project are or will join as signatory of the Covenant of Mayors. This reference was used for energy and environment indicators at city level framework.

5.1.2.7 Others

This section compiles other significant sources that have used for the identification of indicators:

- Eurostat City Statistics: Urban Audit. Eurostat provides the European Union with statistics at European level that enable comparisons between countries and regions. Within its city statistics, the Urban Audit data collection provides information and comparable measurements on the different aspects of the quality of urban life in European cities.
- World Bank is a source of financial and technical assistance to developing countries that has developed a set of indicators to meaure a diverse number of themes such as climate change, economy, education, etc.
- Organisation for Economic Co-operation and Development (OECD) is an intergovernmental economic organization to stimalute economic progress and world trade. This inititative publishes comparative statistics that provide an overview of recent international economic development through the economic indicators defined by this entity.
- Fundación Telefónica is a foundation that belong to one of the largest telecommunications companies in the world that has developed a set of indicators to analyze the progress of infrastructures and digital services.

They have been a reference for cover some evaluation gaps from previous inititiatives (e.g. Fundacion Telefónica for ICT indicators), or to complement (e.g. World Bank, OECD for economic indicators)

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5.2 Process for the selection and definition of indicators

Given the long list of indicators derived from existing frameworks and with the aim to obtain a reduced and suitable set of indicators, a set of criteria have been considered by the partners involved in their selection. These criteria, which is based on the guidelines provided in CITYkeys, are reported below.

- RELEVANCE: Each indicator should have a significant importance for the evaluation process and a strong link to the categories of the framework where they are included.
- COMPLETENESS: Indicators should consider all aspects of the planning and implementation of smart city projects.
- AVAILABILITY: Data for the indicators should be easily available. As the inventory for gathering the data for the indicators should be kept limited in time and effort, the indicators should be based on data that either are available form partners involved in the project and can be easily compiled from public sources, meters or from interviews, maps or terrain observations.
- MEASURABILITY: The identified indicators should be capable of being measured, preferably as objectively as possible. For qualitative data, social sciences provide approaches to deal with qualitative information in a semi-quantitative way.
- RELIABILITY: The definitions of the indicators should be clear and not open for different interpretations. This holds for the definition itself and for the calculation methods behind the indicator.
- FAMILIARITY: The indicators should be easy to understand by the users.
- NON-REDUNDANCY: Indicators should not measure the same aspect of others that are included in other core category.
- INDEPENDENCE: Small changes in the measurements of an indicator should not impact in the preferences assigned to other indicators in the evaluation. This will lead to a certain extent to double counting the impact.

All these criteria have been considered as follows:

- The set of indicators that take part of mySMARTLife evaluation framework covers all the type of interventions (district, city infrastructure, mobility, ICT) and non-technical aspects (governance, citizens, finance) and expected type of impacts (environment, economy, social and technical) – COMPLETENESS.
- The set of indicators have been deeply described (See Annexes) and share to partners previously in order to identify the need of adding some clarifications – RELIABILITY and FAMILIARITY.

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- The set of indicators are mainly quantitative. However, some social and government aspects require of qualitative data – MEASURABILITY.
- The set of indicators have been defined as core and complementary in order to meet RELEVANCE but also AVAILABILITY.
- INDEPENDENCE and NON-REDUNDANCY features have also been considered in the definition of city and project indicators.

The specific steps applied that have allowed to define and validate the indicators are described below.

5.2.1 For the identification of city level indicators

1. *Identification of reference sources*

   There is a wide number of documents that analyse and provide evaluation frameworks to peform city diagnosis. In order to short the long list of existing frameworks, partners working in the design of mySMARTLife evaluation framework considered to focus mainly in CITYkeys, SCIS, ISO37120, U4SSC and SECAP. Also, list of city indicators defined and used in other SCC projects (REMOURBAN, REPLICATE and SmartEnCity) was reviewed.

2. *Selection of indicators by technical partners and cities*

   Technical partners (CAR, VTT, TEC, HCU, CEREMA and ESADE) selected the city level indicators in a collaborative way, taking into account the criteria previously described (relevance, complete, non-redundancy, etc). Each technical partner was responsible of a city category and proposed the list of indicators after the review of the bibliography selected. Then, this list was reviewed by cities in a workshop carried out during the second project meeting held in Valladolid. During this meeting, cities evaluated the relevance of the preliminary list of indicators shared and analysed the availability. Figure 5.3 represents the structure of the excel file delivered to the cities where they should score each indicator according to the relevance and availability.

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Application Field*	Indicator	Units	References	Evaluate on a scale of 1 to 10 the relevance of each indicator	Does your city currently have the information required to calculate it?
City energy profile	Final energy consumption per capita	MWh/capita	SEAP		
	Final energy consumption (Transport)	TWh/year	SEAP		
	Final energy consumption (Buildings, equipment's/facilities and Industries)	TWh/year	SEAP		
	Final energy consumption (Municipal)	TWh/year	SEAP		
	Final energy consumption (Tertiary)	TWh/year	SEAP		
	Final energy consumption (Residential)	TWh/year	SEAP		
	Final energy consumption (Public lighting)	TWh/year	SEAP		
	Final energy consumption (Industry)	TWh/year	SEAP		
	Final energy consumption (electricity)	TWh/year	SEAP		
	Final energy consumption (Heat/Cold)	TWh/year	SEAP		
	Final energy consumption (Fossil fuels)	TWh/year	SEAP		
	Final energy consumption (Renewables)	TWh/year	SEAP		
	Share of local energy production to overall final energy consumption	%	SEAP		
	Renewable electricity generated within the city	%	REPLICATE		
	Non-RES Heat/ Cold production	TWh/year	SEAP		
	RES Heat/Cold production	TWh/year	SEAP		
	Total buildings energy consumption per year	GWh/inhab.year	SEAP		
Renewable energy	Renewable energy per carrier	GWh/RES_supplier	SmartEnCity		
	Percentage of renewable energy	%	SmartEnCity		

Figure 5.3: Tool used in the selection of city indicators

In a last step, and once the cities audits was carried out at M12, the list of indicators was updated to overcome the lack of data and the non-reliable values for some categories. The final list of city level indicators is included in the Annex I and the main conclusions obtained in the final city audit can be seen in section 6.1 of the present report.

5.2.2 For the identification of project level indicators

1. *Identification of reference sources*

   Since there is not an only indicator system that can be used for mySMARTLife to assess the diverse effects produced by the interventions, different documents deployed under diverse initiatives have been consulted such as CITYkeys, SCIS and other LH projects (REMOURBAN, REPLICATE, SmartEnCity), among others.

2. *Selection of indicators by technical partners and cities*

   The same technical partners that selected the city level indicators were also in charge of the identification of the most suitable indicators to evaluate impacts due to project actions (CAR, VTT, TEC, HCU, CEREMA and ESADE). The selection of indicators was based in the identification of improvements expected with the demonstration actions and in fixing evaluation boundaries in each of the the pillars defined. On other hand, in order to assure the proper evaluation of the actions (guarantee to achieve an evaluation from a holistic point of view and avoiding redundance) and take into account the exchange of information about the actions with city partners in terms of progress,

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difficulties or requirement of ammedment, CARTIF, as WPL and project coordinator, has been in charge to define the objectives to be evaluated and identify the most suitable indicators for most of the pillars and actions. Additionaly, technical partners have contributed to the identification of the best indicators as follow:

- CAR: All and main responsible of energy and ICT pillars
- CEREMA: Mobility due to the expertise of the partner in mobility evaluation
- ESADE: Economy due to the expertise of the partner in economic issues
- HCU: Social due to the expertise of partner in social aspects
- TEC: Governance due to the relation of partner with WP1
- VTT: City impact due to its experience in CITYKEYS where two scope framework (Smart City Project level (i.e. demonstration areas) and Smart City level is defined

The indicators have been assigned to each actions/intervention and have been discussed among city and technical partners in consortium meetings and in specific telcos. Then, demo team partners have continued these discussions in monthly demo team meetings. A contact point has been selected in each demosite in order to facilitate the communication among city partners and CAR that has been the main responsible to follow up the decisions taking in each demosite.

Contact points in each demo site have been:

- Nantes: NAN with the support of NBK and CEREMA
- Hamburg: HAM with the support of HCU
- Helsinki: VTT has acted as contact point with demo team for all the indicators and actions

A preliminar list of indicators was defined at the beginning of the project, which has been updated based on the partners' proposals, difficulties found to measure some of the proposed indicators, changes in the actions due to ammedments and the publication of updated guidelines by SCIS. As a result, several iterations have been required to achieve a suitable set of indicators by each LH action/interventions but also to have a comparable framework among the three cities.

3. *Classification of indicators and definition of method to be applied for the calculation of KPIs*

The classification of core and complementary indicators was intended to be applied in all the pillars with the aim to perform a complete evaluaton but also to take into account the capability of data collection in each city. Additionally, indicators have been classified in primary and secondary to help to define the monitoring schemes.

Table below shows how has been the process of selection of actions and indicators in the energy pillar.

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Table 5.2: Tool used in the selection of energy/environmental indicators

District/Zone	Actions	Indicator	Type of indicator
Zone 1. Merihaka Retrofitting of a residential area (171 flats)	*District/Building: Retrofitting* A1: Merihaka and Vilhonvuori: retrofitting of the residential construction *District/Building: Domotics & Smart Controls* A4: Demonstration of smart home managment (heat demand response) at apartment level at Merihaka/Vilhonvuori *City infrastructure: Smart grids* A10. Data and demand response	Thermal energy consumption	Primary
		Electrical energy consumption	Primary
		Annual energy consumption	Secondary
		Reduction in annual energy consumption	Secondary

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6. mySMARTLife City evaluation framework

This section describes the evaluation framework developed in the project to make an advanced city diagnosis that allows measuring the city needs and identifying the main challenges that cities must face to become more sustainable and smartness.

As it was introduced in chapter before, this city evaluation framework consists of the following components: fields, application fields and indicators. The identification of names for the fields and application fields has been the result to apply the pillars contemplated in mySMARTLife (e.g. mobility, energy, ICT) as well as the vision that a city usually intends when takes the intention, as it happen in mySMARTLife, of developing an Urban Transformation Strategy for their transition towards a new concept of Smart Life and Economy. Additionally, the main objectives of evaluation identified in standards and literature reported in section 5.1.2 have been considered.

Table below summarizes how the Smart City Vision has been translated to the fields of the City Evaluation Framework.

Table 6.1: Smart City Vision & mySMARTLife fields

Smart and Sustainable City Vision	mySMARTLife Fields
Sustainable use of resources A better quality of life for citizens Efficient city operation	Energy Environment Mobility
Efficient city operation	Urban infrastructure
A better quality of life for citizens Community involvement	Citizens
Prosperity	Economy
Efficient city operation	Governance

Taking into account this scheme, the specific application fields and indicators defined according to the evaluation expectative for each field are included below. A detailed description of indicators that take part of the city evaluation framework is included in the Annex I of the document.

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Table 6.2: City evaluation framework: fields, application fields, indicators

Field	Application Field	Number of indicators (Application field)	Number of indicators (Field)
Main city features	Climate	1	6
	Size	1	
	Population	3	
	Land use	1	
Environment	CO_2 target	1	23
	Air Pollution	3	
	City environmental impact in climate	10	
	Noise pollution	1	
	Waste	2	
	Water resources	2	
	Land consumption	3	
	Carbon footprint	1	
Energy	City energy profile	21	33
	Renewable energies	9	
	Smart buildings	2	
	Sustainable buildings	1	
Mobility	Mobility city profile	9	22
	Sustainable transport	5	
	e-charging infrastructures	6	
	Problems due to tranport	2	
Urban infrastructure	Uses of territory	3	20
	Lighting management	1	
	Waste management	5	
	Traffic management	5	
	Communication infrastructure	3	
	Urban platform	7	
Economy	Economic performance	3	16
	Employment	2	
	Equity	5	
	Economic activity: Innovation	4	
	Economic activity: Green economy	1	
	Economic activity: Tourism	1	
Citizens	Age structure	3	16
	Education level	1	
	Accesibility of services	2	
	Channels of communication	2	
	Citizen involvement	8	
Governance	Urban planning	11	15
	Governance collaboration	2	
	Online government data	2	

The description of each pillar with the list of indicators defined is shown in the following pages.

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Environment field

This application field "Environment" consists of 8 application fields and 23 indicators and refers to the environment commitment acquired by the cities to reduce CO_2 emissions and to describe how sustainable is the use of resources and the derived impact of the human activities in the cities in the air, water and land. A good quality of citizens' life is obtained in case of low rate of emissions to the atmosphere.

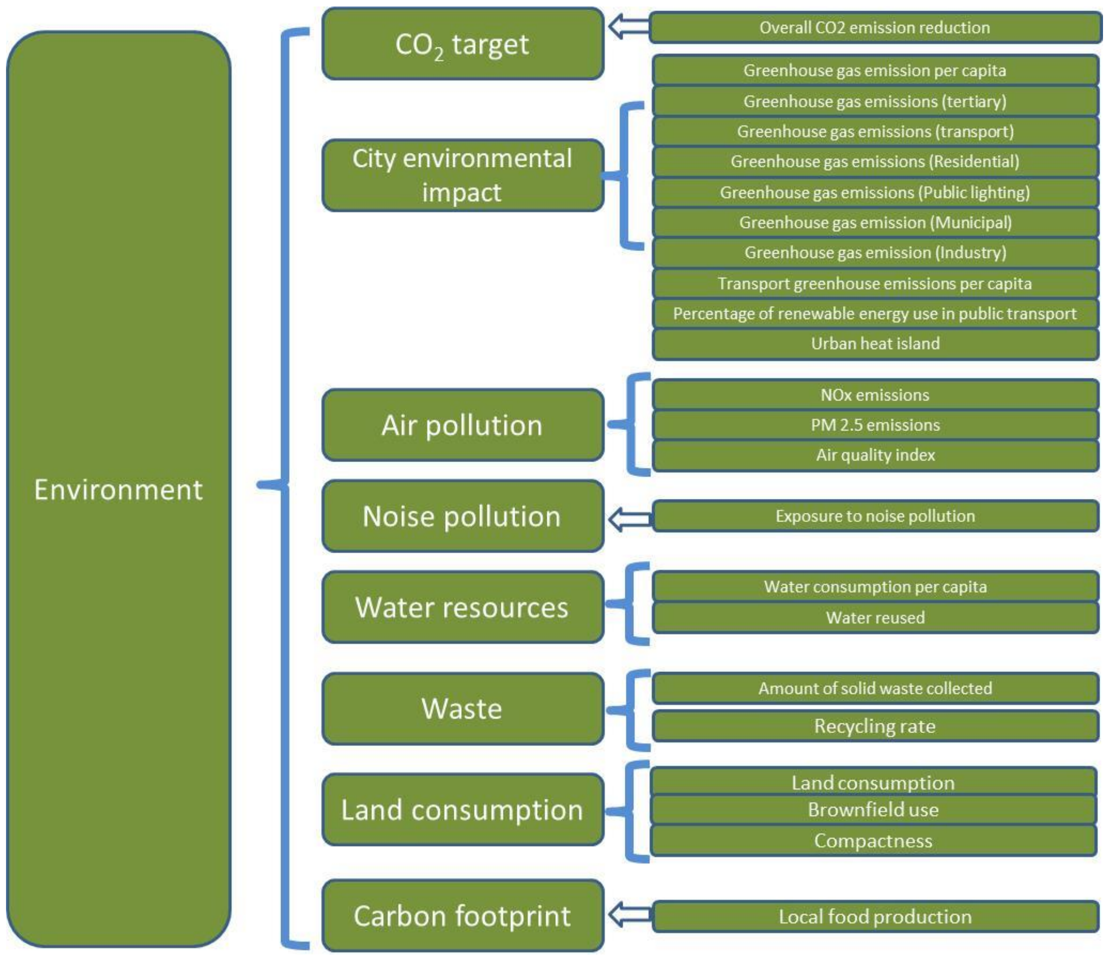

Figure 6.1: City indicators in environment field

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Energy field

Energy deals with the characterization of the energy supply of the city in terms of energy use in the main city infrastructures, the energy derived from renewable sources and the existence of smart and sustainable buildings in the city. The characterization of the city in these issues will allow to have enough data on how efficient are the city operations and the extent in the use of sustainable resources.

This application field Energy consists of 4 application fields and 33 indicators.

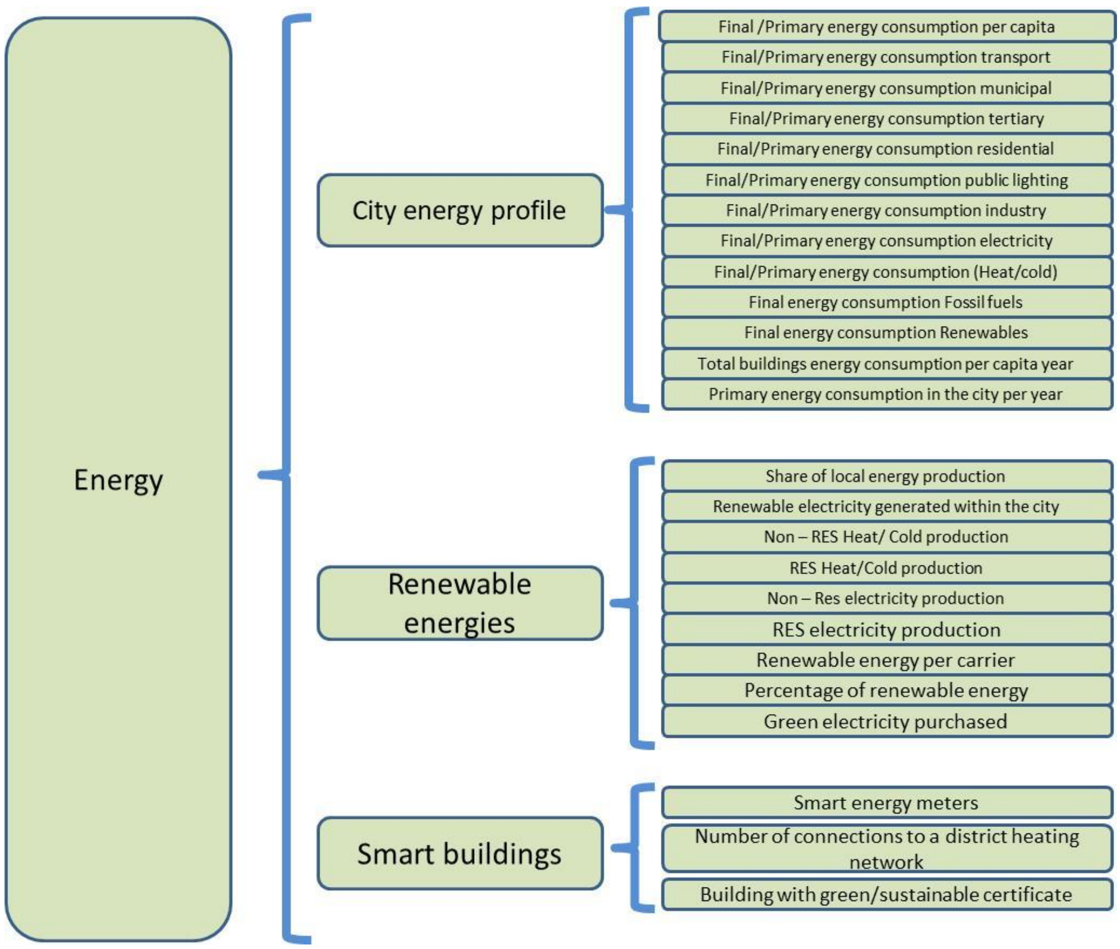

Figure 6.2: City indicators in energy field

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Mobility field

Mobility is dedicated to identify the city transport profile and know how extent is the access and use of sustainable transport measures but also the existence of problems associated to the transport in the city (i.e. congestion and traffic accidents).

This application field Mobility consists of 4 application fields and 22 indicators.

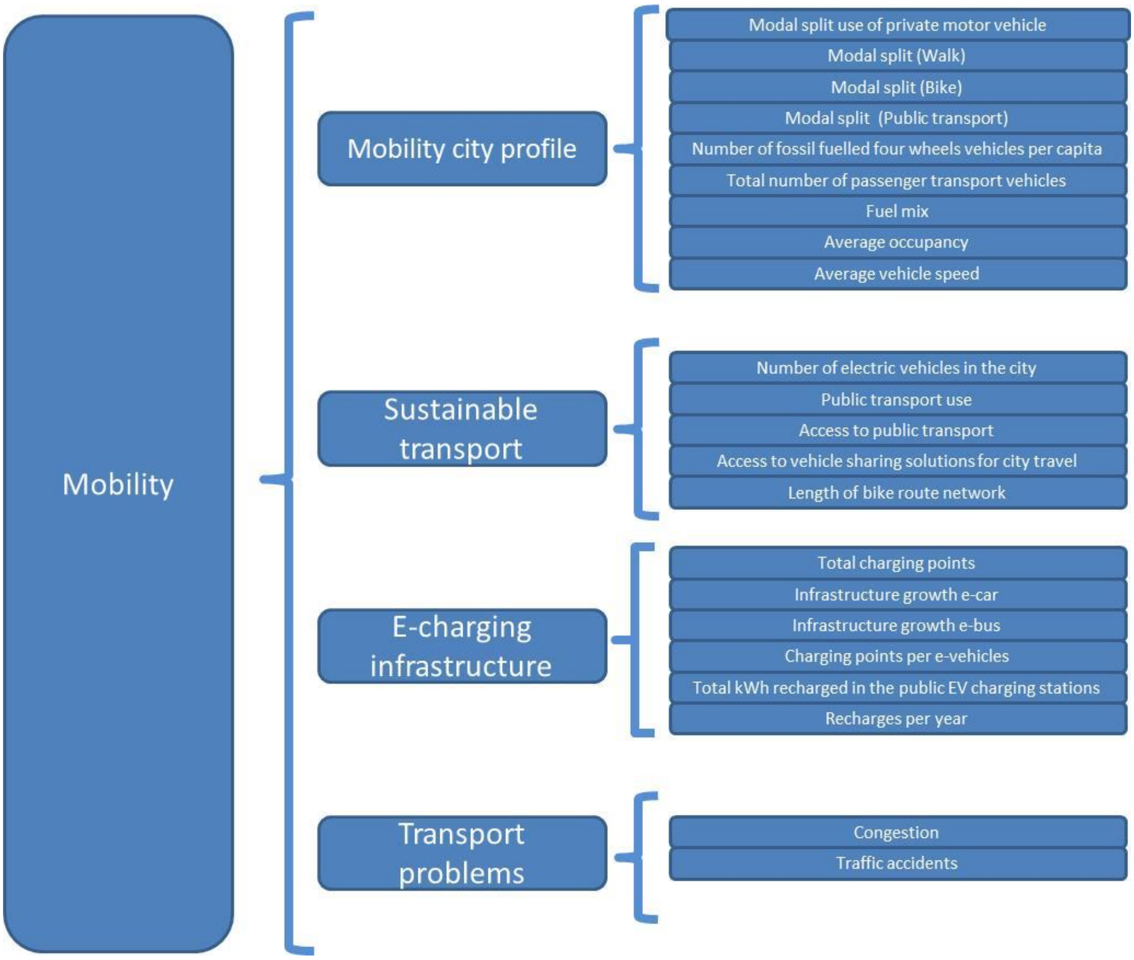

Figure 6.3: City indicators in mobility field

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Urban infrastructure field

Urban infrastructure deals to evaluate the main uses of the urban territory and to discern how is the management of the existing communication, waste, lighting and traffic urban infrastructure and the data collection from the urban territory.

This application field consists of 6 application fields and 20 indicators.

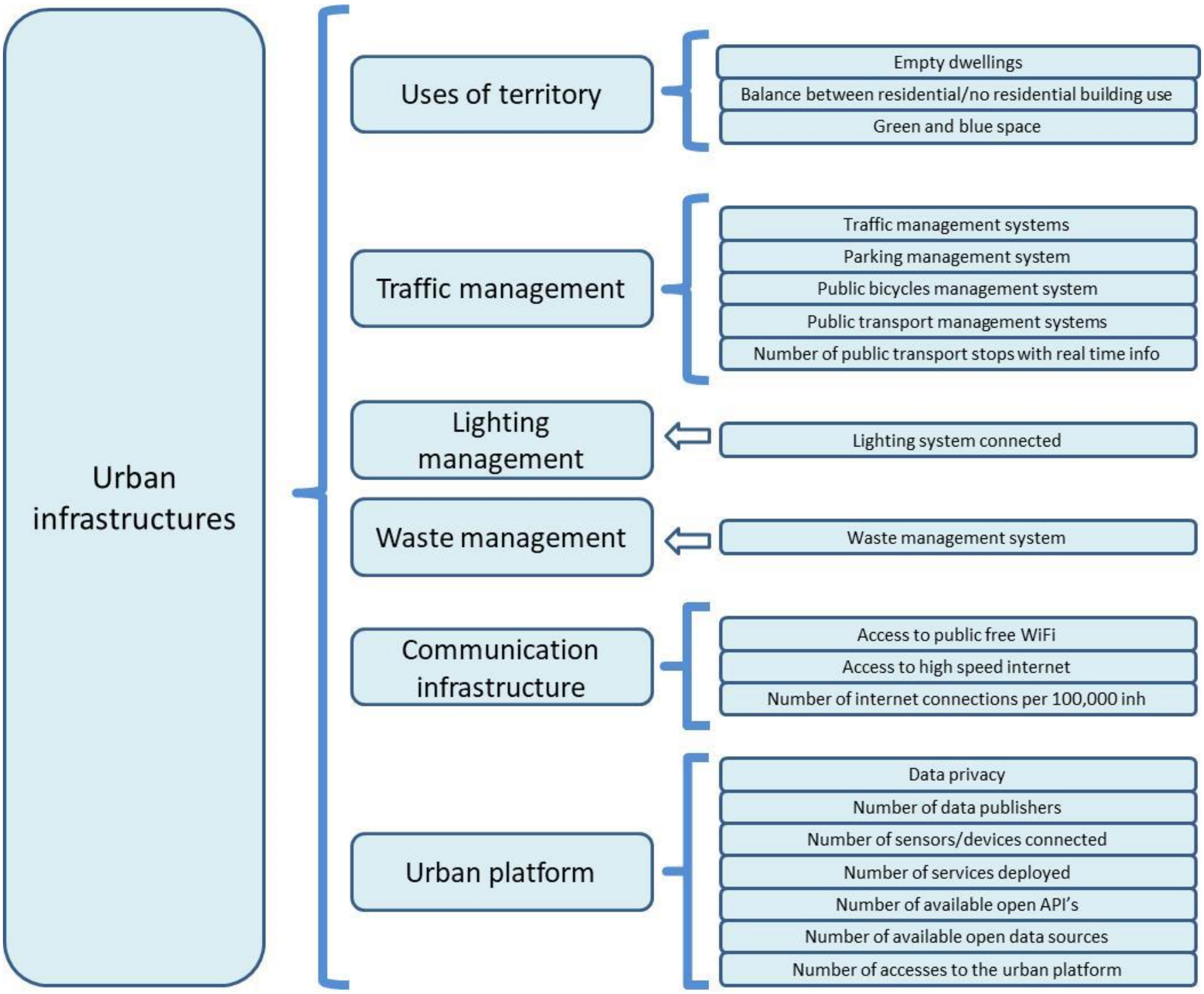

Figure 6.4: City indicators in urban infrastructure field

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Economic field

Economy field focuses on analysis how prosperous is the city, how relevant are the innovation and green activities in the economy performance of the city and how equal is the living for the citizens.

This application field consists of 6 application fields and 16 indicators.

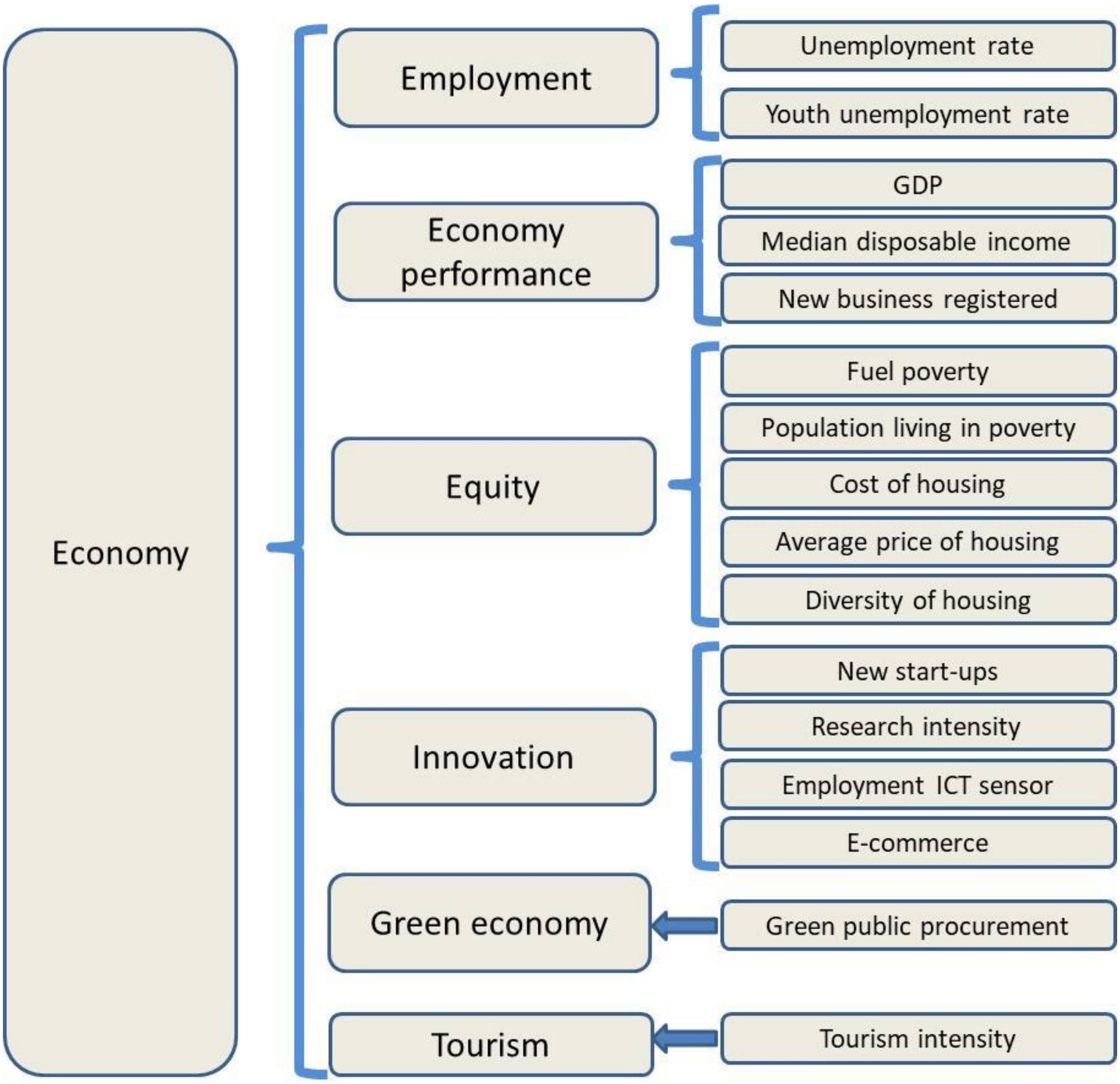

Figure 6.5: City indicators in economy field

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Citizens' field

Citizen category aims to identify the profile of the citizens that habit in the city, the accessibility of these to basic services and the existing actions and channels to inform and involve citizens in participatory process of the city.

This application field consists of 5 application fields and 16 indicators.

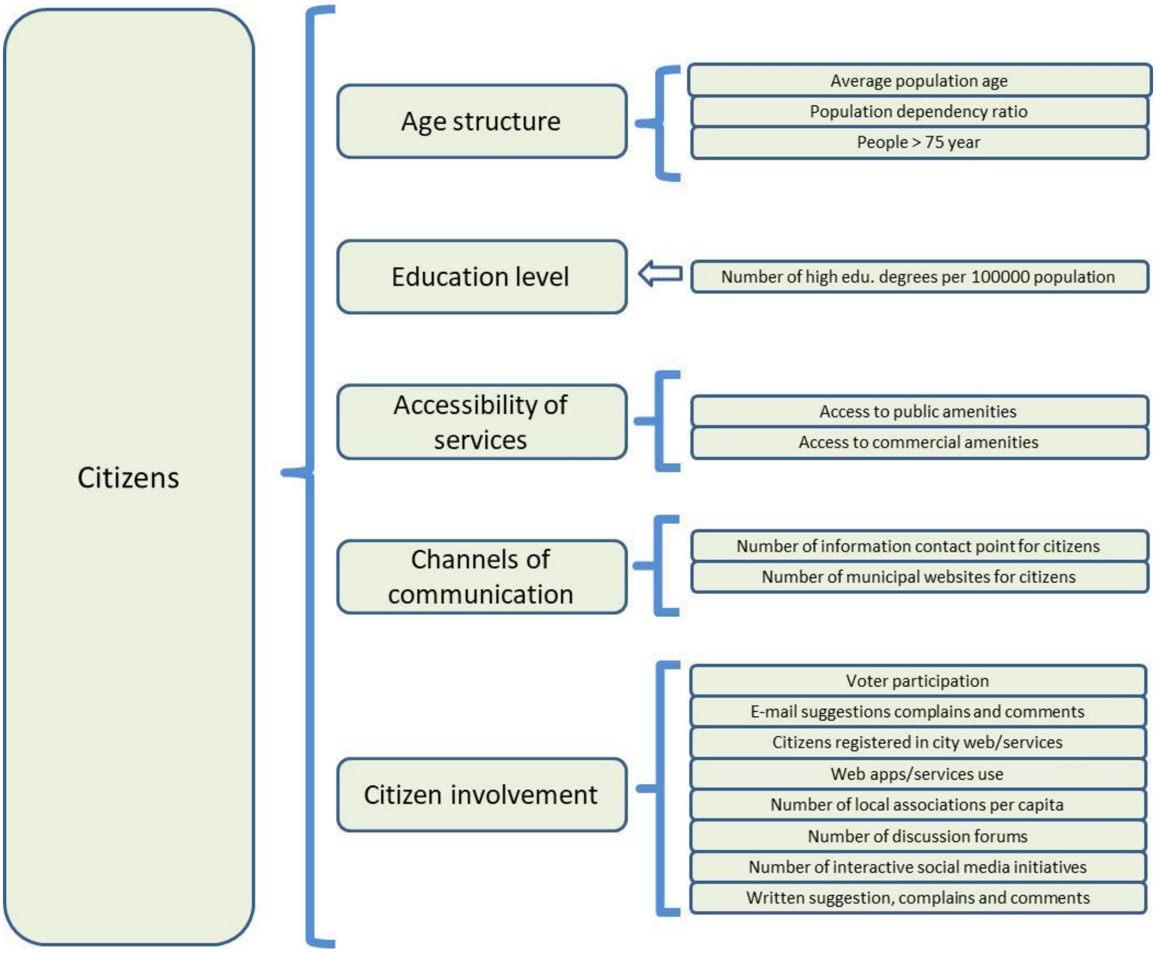

Figure 6.6: City indicators in citizens field

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Governance field

Governance includes the existing city plans, public procurements procedures and regulations for supporting the sustainable development of the city but also to describe how extent is the transparency of the municipality and how this is organizated to facilitate the implementation of integrated smart city policies.

This application field consists of 3 application fields and 15 indicators.

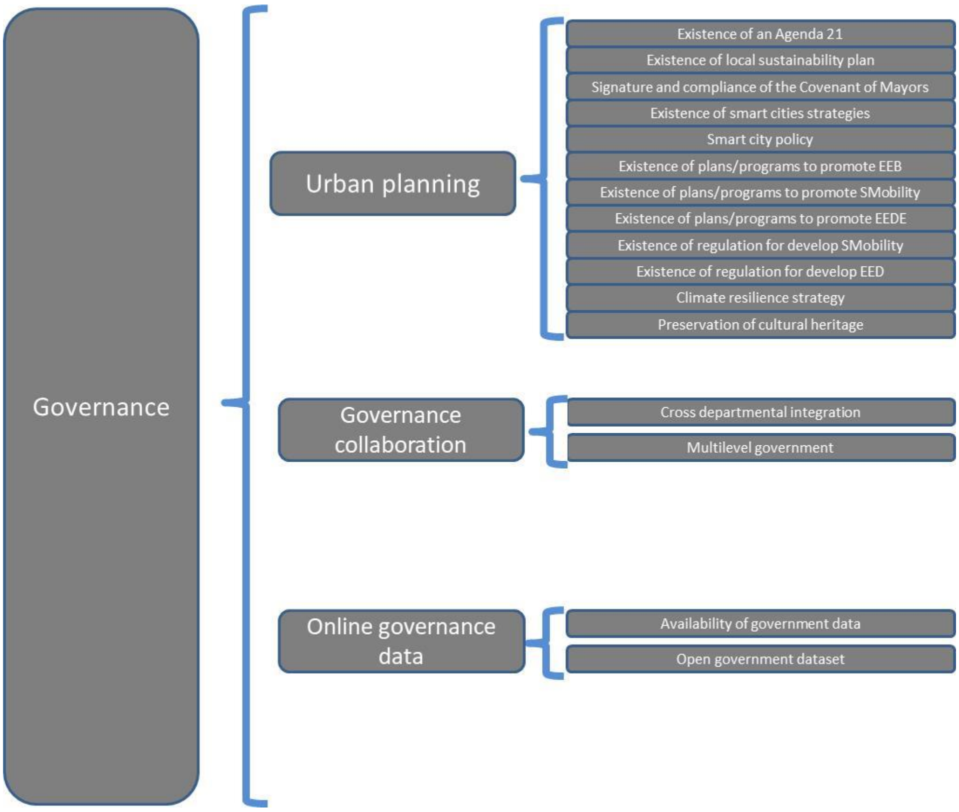

Figure 6.7: City indicators in governance field

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6.1 City audit results

This chapter is focused in the main results obtained in the city audits performed in LH cities and follower cities of the project in terms of availability of data to calculate the city level indicators proposed.

Availability of data per application field

Table below represents the different scales of data availability in the fields and application fields defined in the City Level Evaluation framework. As it can see, the lack of information affects to all the fields since no city could calculate all the indicators that take part of a same application field (with exception to main city features).

Table 6.3: Availability of city level indicators by fields

Availability	Main city features	Environment	Energy	Mobility	Urban infrastructure	Economy	Citizens	Governance
	Climate, Size, Population, Land use	CO2 target, City environmental impact, Water resources, waste, Land consumption	City energy profile, Renewable energies	Mobility city profile, e-charging infrastructures	Traffic management, Lighting management, Waste management, Urban platform	Employment, Economic performance	Age structure, Citizen involvement	Urban planning
		City environmental impact, Air pollution	City energy profile, Renewable energies	Mobility city profile, e-charging infrastructure, Sustainable Transport		Equity, Green economy	Channels of communication, Citizen involvement	Governance collaboration, Online governance data
		Water resources, Land consumption, Carbon footprint	City energy profile		Mobility city profile, Sustainable transport, e-charging infrastructure, transport problems	Equity	Accessibility of services	

Availability of data per city

This table summarizes the availability of data per field according to the possibility to measure the list of indicators provided in the LH cities and follower cities. In this case, it has to mention that for the case of follower cities the analysis includes the first list of indicators proposed whereas the analys for the LH is done with the updated list of indicators. Additionally, the analysis does not consider the reliability of data obtained but the possibility of the city to obtain the required information. This is important for avoiding

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taking a non-proper conclusion such as the availability of data is higher in follower cities analysed than in LH cities.

Table 6.4: Availability of city level indicators in cities

	Main city features	Environment	Energy	Mobility	Urban infrastructure	Economy	Citizens	Governance
Number of indicators	6	23	33	22	20	16	16	15
LH Cities	100%	48%	48%	45%	68%	50%	31%	53%
Follower cities	100%	52%	24%	13%	59%	31%	56%	86%

Taking into account previous figures, the main conclusions on the city level framework evaluation are reported below:

- The existing information at city level is scarce for most of the fields although the availability of data differs among fields, application fields and participant cities. The availability of information obtained for the 3 LH increased after updating the list of indicators but was not possible to obtain a complete evaluation of a field in a common way for the three participant cities.

  The difficulty to calculate these indicators can be explained as:

  - the required data were collected manually in most of the cases since there was not an open portal that collects this type of information
  - the required information is sometimes complex to be measured (e.g. Air index quality)
  - the non-existence of indicators in the references used to evaluate some features of the city which makes to define new indicators that can not be collected by the cities

- A significant problem detected was related to the reliability of the data obtained due to the non-familiarity of some indicators by the cities or unclear definitions that were interpreted by the cities. Also, other reason is the incomplete information in the official sources (i.e. data does not correspond with the reality where it is known the proper value).

On other hand, the work performed with the definition of indicators and data collection process has been very interesting in view to continue investigating this topic in the future. For example, a lesson learned has been the need to collect the information by variables instead to require to the cities the calculation of the final indicators. In this way, it is easier for cities to collect the information and for responsible to analyse the information collected. On other hand, working with indicators per capita is the best way to analyse the

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current situation of the city and compare the progress of the city in the time as well as with other cities. Finally, other open question to solve is the suitable number of indicators to perform an adequate city diagnosis and which could be the proper list of indicators to perform a common and complete city audit.

Finally, it has to mention that D5.2 has continued with the analysis of city level indicators calculated in order to identify the availability of data in terms of data sources (i.e. city data sets and literature used to define the indicator).

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7. mySMARTLife Project evaluation framework

This section describes the framework developed to calculate the impacts of the mySMARTLife demonstration activities implemented in the three LH cities. Specifically, this chapter includes the objectives to be evaluated and the indicators selected as well as the assessment plans and guidelines to be considered for the evaluation of the project actions.

The chapter is split in 7 subsections which correspond with each one of the pillars identified. For a better understanding of the scope of each pillar, table below summarizes the actions and main objectives to be evaluated in each case.

Table 7.1: Project evaluation overview

Pillars	Actions	Objectives of evaluation
Energy & Environment	Building/District City infrastructure	• Reduction in final and primary energy consumption • RES production • Degree of energy supplied by RES • Decrease of GHG emissions • Energy consumption provided from RES city infrastructures
Mobility	Mobility	• Reduction in GHG emissions • Energy consumed by different EV • Degree of energy supplied to EV by RES • Amount of use and usage pattern of mobility infrastructures • Change in mobility due to solutions implemented • Impact of the energy demand managment
ICT & Urban platform	Urban platform & ICT	• Improvements from the existing urban platforms • New particular ICT developments and services • ICT services' features in terms of performance • Impact in digital transformation
Economy	Building/District City infrastructure Mobility	• Cost-effectiveness of the solutions • Local economic development

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	Urban platform & ICT Non-technical: *Innovative business*	
Social	Building/District City infrastructure Mobility Urban platform & ICT Non-technical: *Citizen engagement*	• Social acceptance on project actions • Citizen involvement achieved
Governance	Non-Technical: *Urban planning, Staff exchange, Policy improvements*	• Satisfaction with urban planning methodology • Participants engaged in urban planning methodology • Satisfaction with coaching/ mentoring activity • Participants engaged in coaching and mentoring activities • Impact of the project in the strategy of the city
City impact	All	• Impacts of project actions at city level

On other hand, table below shows the evaluation approach of each pillar and the number of indicators defined.

Table 7.2: Project pillars approach

	Energy & Environment	Mobility	ICT & Urban Platform	Social	Economy	Governance
References for indicators	SCIS, CITYKEYS, BEST table	SCIS, CITYKEYS, TEST table	SCIS, CITYKEYS, Fundación Telefónica	SCIS & CITYKEYS	SCIS, CITYKEYS, Eurbanlab, OECD, Worldbank	SCIS & CITYKEYS
# of indicators	32	54	11	6	25	12
Evaluation methodology	Extension of IPMVP at district / city level	Tailored[1] (Data-driven)	Tailored[2] (Data-driven)	Surveys	Statistical & Surveys	Surveys

[1] IPCC, Covenant of Mayors and other SCC1 European projects
[2] Eurostat and other SCC1 European projects

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7.1 Energy & Environmental pillar

This pillar aims to evaluate technical and environmental impacts of the energy related measures implemented in Building/District and City infrastructures in the three LH of the project.

7.1.1 Scope

To assure that the results of the project occured at the end of the project can be evaluated properly, it is required to define firstly objectives of evaluation. They are fixed in this section 7.1.1 taking into account the general objectives of the project and objectives of the actions to implement as it is shown in table below.

Table 7.3: Objectives of mySMARTLife and LH interventions in energy and environment

mySMARTLife objective	Interventions/Actions	Project actions objectives
To achieve very efficient districts through improvements in buildings, integration of RES to energy supply and implementation of advanced energy management systems combined with innovative storage elements	**Building / District** - Retrofitting building - New building - Domotics and smart controls - Building integrated RES - Storage	• Reduce the energy demand of buildings • Decarbonisation of energy production • Reduce the environmental impacts due to energy production for covering energy demand of buildings
Setting up an advanced management of the urban energy infrastructures, integrating innovative storage technologies to increase the global performance and RES contribution	**City infrastructure** - Smart grids - Urban RES - District heating - Electrical and Thermal Storage - Public lighting	• Decarbonisation of energy production • Reduce the environmental impacts due to energy production for covering energy demand of buildings • Reduce the energy demand of public lighting and consequently the environmental impacts linked • Extend the use of current RES city infrastructures to cover energy demand of new buildings/retrofitted buildings of the project

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7.1.1.1 Actions to be evaluated

In order to define the scope of the pillar, it is required to describe properly the actions to be evaluated in the energy and environment pillar and specifically how they have been grouped in each one of the LH since they will be the objects of assessment. More information about these actions has been reported in section 3.1.

These names of the interventions will be included in the definition of project indicators in Annex 2 as well as in D5.3 (monitoring).

Table 7.4: Summary of the energy/environment project actions

LH	Name of the building/district intervention *(actions involved)*	Name of the city infrastructure intervention *(actions involved)*
Nantes	Inspiration (A1), Pierre Landais (A4, A7, A17), Oiseau des Iles (A5, A7), Individual houses (A3-A6-A12), Multi-owner buildings retrofitting (A2, A17), CIC building (A31-A8-A14-A22)	District Heating (A16), Cité des congrès (A21.a), Public buildings PV plants (A21.b), Public lighting (A18)
Hamburg	Schleusengraben- Schilfpark (A1, A13, A18), Bergedorf Süd (A2*, A14), Smart Energy Control in Smart Heating Island (Energy Campus) (A9), Smart Homes (A3)	PV in high-performance area (A19a-b), Local wind farm + decentralised storage (A17, A20), Kampweg (A5, A7), Maximization of RES production (A5, A7), Public lighting (A15, A16), District heating with renewable hydrogen (A13, A18), Smart heating island (A14)
Helsinki	Merihaka retrofitting (A1, A4, A,10), New construction Kalasatama (A2, A5, A7, A10, A13), Viikki Environment House (A3, A6, A8, A9)	Public lighting (A15), Urban RES (A16), City infrastructure (A14, A16, A19), City infrastructure (A17), City infrastructure (A11, A12, A18, A20)

7.1.1.2 Objectives to be evaluated

Taking into account the objectives that are achieved with the project actions to implement, specific objectives of evaluation have been defined.

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Table 7.5: Objectives of evaluation of energy & environmental pillar

Type of intervention	Type of action	Objective of the action	Objective of evaluation
Building & District	• Retrofitting building • New building • Domotics and smart controls • Building integrated RES • Storage	Reduce the energy demand of buildings	Reduction in final energy consumption
		Decarbonisation of energy production	Increase in the RES production Degree of energy supplied by RES Reduction in primary energy consumption
		Reduce the environmental impacts due to energy production for covering energy demand of buildings	Reduction in greenhouse gas emissions
City infrastructure	• Smart grids • Urban RES • District heating • Electrical and Thermal Storage	Extend the use of current energy city infrastructures	Energy consumption provided from energy city infrastructures
		Decarbonisation of energy production	Increase the RES production Degree of energy supplied by RES Reduction in primary energy consumption
		Reduce the environmental impacts due to energy production for covering energy demand of buildings	Reduction in greenhouse gas emissions
	• Public lighting	Reduce the energy demand of public lighting	Reduction in final energy consumption
		Reduce the environmental impacts for covering energy demand of public lighting facilities	Reduction in greenhouse gas emissions

Therefore, it can state that the objectives of evaluation for the energy and environment pillar are:

- O1: To evaluate the reduction in final energy consumption
- O2: To assess the increase in RES production
- O3: To calculate the degree of energy supplied by RES
- O4: To quantify the reduction in primary energy consumption
- O5: To calculate the reduction in greenhouse gas emissions
- O6: To measure the energy provided from existing energy city infrastructures

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7.1.1.3 Selected indicators for the assessment

According to the previous objectives and taking into account mainly SCIS and CITYKEYS, 32 indicators have been defined to assess the successful of the energy interventions/actions implemented in each lighthouse. Additionally, required information to fulfill BEST tables has been considered in the identification of indicators. The list of indicators is displayed in table below:

Table 7.6: Energy & environmental pillar indicators

Objectives of evaluation		Indicators
Technical objective	O1. Reduction in final energy consumption	E1. Thermal energy consumption E2. Electrical energy consumption E3. Public lighting energy consumption E4. Annual energy consumption E5. Reduction in annual energy consumption E6. Energy use for heating E7. Energy use for DHW E8. Energy use for lighting E9. Energy use for cooling E10. Reduction in annual heating energy use ambitious compared to national regulation for new or retrofit building E11. Reduction in annual DHW energy use ambitious compared to national regulation for new or retrofit building E12. Reduction in annual electricity energy use compared to national regulation
	O2. Increase in the RES production	E13. Total renewable thermal energy production E14. Total renewable electrical energy production E15. Total renewable energy production E16. Increase in local renewable energy production
	O3. Fraction of energetic self-supply by RES	E17. Degree of energy self - supply by RES E18. Increase of degree of energy self - supply by RES
	06. Energy provided from existing energy city infrastructures	E24. Recovery E25. Total heat supplied to the buildings connected to district heating network E26. Degree of heating supply by district heating E27. Degree of energy supply by Urban RES infrastructure

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Environmental objective	04. Reduction in primary energy consumption	E19. Primary thermal energy consumption E20. Primary electrical energy consumption E21. Total primary energy consumption E22. Reduction of total primary energy consumption E23. Total primary energy consumption related to heating delivered
	05. Reduction in greenhouse gas emissions	E28. Total greenhouse gas emissions (thermal) E29. Total greenhouse gas emissions (electrical) E30. Total greenhouse gas emissions (lighting) E31. Total greenhouse emissions E32. Reduction of total greenhouse gas emissions

These indicators are described in detail in the Annex II ”Description of project indicators”. Finally, it has to mention that specific KPIs (Key Performance Indicators) have been identified to calculate thermal and electrical issues in a separate way instead to consider an only indicator. This scheme has been proposed to facilitate the design of the monitoring program and the reporting of the impacts.

7.1.1.3.1 Type of indicators

Indicators from energy pillar are classified in core/complementary and primary/secondary according to the relevance of the indicator and data source used, respectively.

- Core indicators refer to all indicators that must be calculated to meet the requirements of the BEST tables and SCIS platform or express significant impacts. Therefore, they should be evaluated in all the actions that they apply. On other hand, complementary indicators aim to evaluate additional aspects so that their evaluation is only recommendable.
- Primary indicators are calculated from data collected directly from monitoring whereas secondary indicators are calculated from primary indicators.

Table below collects the core indicators and specify if they are primary or secondary and therefore provides an idea about the monitoring programme to be implemented for the data collection from the project actions.

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Table 7.7: Core Energy & environmental pillar indicators by type

Indicators	Primary/Secondary Indicator
E1. Thermal energy consumption	**Primary**
E2. Electrical energy consumption	**Primary**
E3. Public lighting energy consumption	**Primary**
E4. Annual energy consumption	Secondary
E5. Reduction in annual energy consumption	Secondary
E6. Energy use for heating	**Primary**
E7. Energy use for DHW	**Primary**
E8. Energy use for lighting	**Primary**
E9. Energy use for cooling	**Primary**
E10. Reduction in annual heating energy use ambitious compared to national regulation for new or retrofit building	Secondary
E11. Reduction in annual DHW energy use ambitious compared to national regulation for new or retrofit building	Secondary
E12. Reduction in annual electricity energy use compared to national regulation	Secondary
E13. Total renewable thermal energy production	**Primary**
E14. Total renewable electrical energy production	**Primary**
E15. Total renewable energy production	**Primary**
E16. Increase in local renewable energy production	Secondary
E24. Recovery	**Primary**
E19. Primary thermal energy consumption	Secondary
E20. Primary electrical energy consumption	Secondary
E21. Total primary energy consumption	Secondary
E22. Reduction of total primary energy consumption	Secondary
E23. Total primary energy consumption related to heating delivered	Secondary

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7.1.2 Assessment plan

7.1.2.1 Existing evaluation methods

The most convenient methods found in the research desk work to determine the assessment plan to evaluate the objectives identified in this pillar are included in this subsection.

- ***International Performance Measurement and Verification Protocol (IPMVP)***

IPMVP is a best practice methodology commonly used for measuring, computing and reporting savings achieved by energy efficiency projects at end user facilities. This protocol establishes how to perform the evaluation of energy savings by comparing measured consumption before and after implementation of energy actions making suitable adjustment for changes in conditions.

Thus, the period of time prior to the implementation of energy efficient measures is selected and the energy use is measured in order to define the “baseline period” (named in the Annex II as reference period). Once these measures are applied, a suitable period of time is determined and the energy use is once again measured in order to define the “post-retrofit” performance period (named in the Annex II as reporting period). Then, the comparison of baseline period and reporting period is done following this general M&V equation:

Savings = Baseline period energy – Reporting period energy +/- Adjustments

The adjustment term shown in the previous equation should be computed from identifiable physical facts and in this case, proceed to perform an adjusted of the baseline energy.

Two types of adjustments are possible:

- Routine adjustments refers to those parameters expected to change regularly and have a measurable impact on the energy use of a system or facility such as weather, production volume, building occupancy and schedule. To define this adjustment, a variety of mathematical techniques can be used which can be as simple as a constant value (no adjustment) or as complex as several multiple parameters non-linear equations each correlating energy with one or more independent variables.

- Non-Routine adjustments consists of static factors that are not usually expected to change, such as the facility size, the design and operation of installed equipment and the type of occupants. These static factors must be monitored throughout the reporting period in order to identify some change.

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This concept M&V and the terms found in the equation are well displayed in figure below.

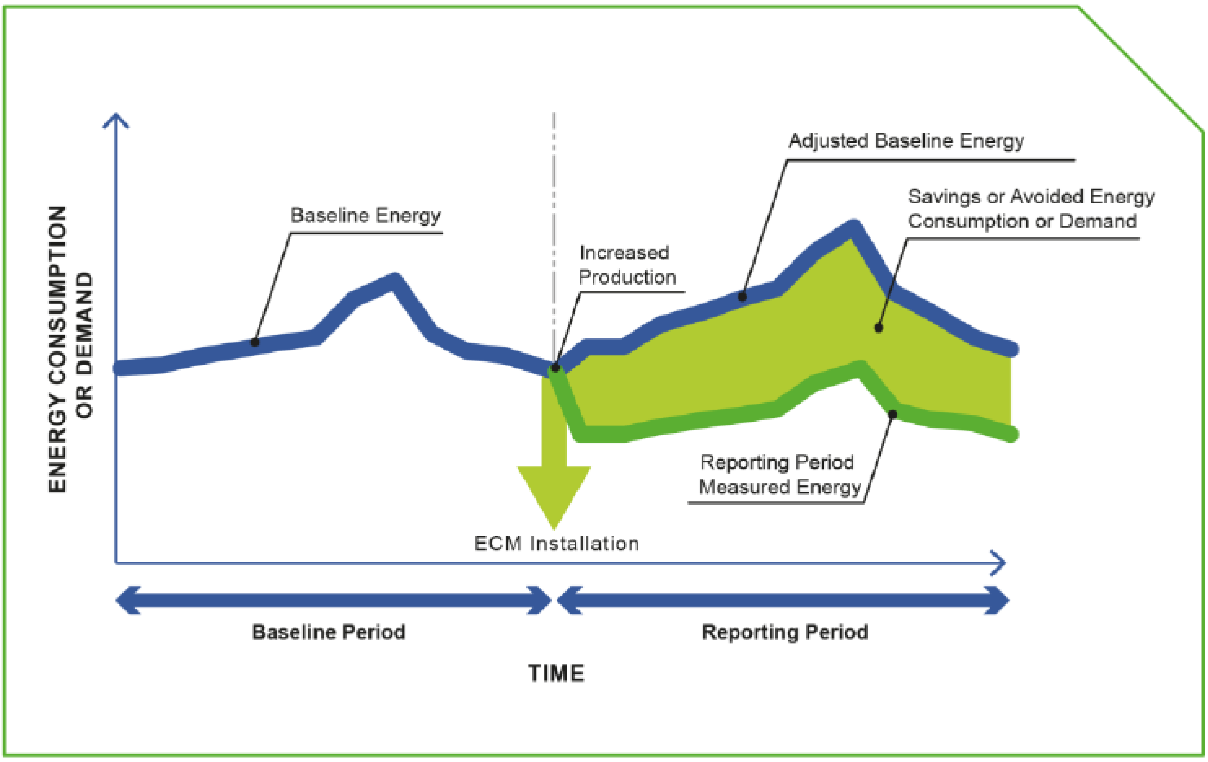

Figure 7.1: Measurement and Verification (M&V) concept

Source: EVO

IPMVP proposes four options for the determination of savings (A, B, C and D). The choice among the options involves many considerations including the location of the measurement boundary.

- Option A. Retrofit Isolation: Key Parameter Measurement
- Option B. Retrofit Isolation: All Parameter Measurement
- Option C. Whole Facility
- Option D. Calibrated Simulation

Figure Figure 7.2below shows the process to select the IPMVP option based on the full set of project conditions, analysis, budgets and professional judgment.

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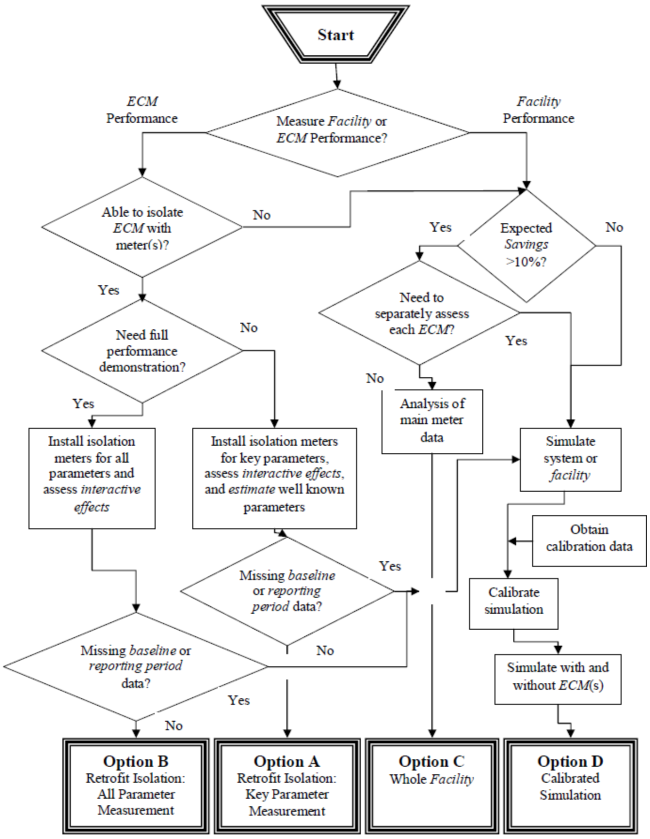

Figure 7.2: Option Selection Process in IPMVP

- ***SCIS guidelines***

This initiative has developed specific guides to help to develop indicators to measure technical aspects of energy related measures and to execute the monitoring work of EU-funded projects in the scope of Horizon 2020 such as the European funded demonstration projects for Smart Cities and Communities (SCC).

Specifically for this pillar, two documents developed by SCIS are very relevant:

- Monitoring KPI guide is focused in the energy aspects of Smart Cities and includes the description of a set of indicators and their application to the different objects of assessment and identify the data requirement and the methodology for their calculation. This document has been elaborated by SCIS following a thorough analysis of different initiatives and projects that work on the development of a Key Performance Indicator framework for Smart Cities such as ISO 37120: 2014 and CITYkeys Project.
- Technical monitoring guide provides assistance and specifies the minimum requirements and parameters for a proper monitoring and data collection process in order to enable a standardised analysis of the overall energy performance and the calculation of KPIs to be applied in retrofitting and new pojects at different agregation scale (building, cluster buildings, energy supply units,

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neighbourhood and city). Additionally, this guide provides main information about boundaries for a successful data collection.

- ***CITYkeys***

The report “Indicators for smart ciy projects and smart cities” provides a list of indicators to evaluate the impact of Smart city Project comparing before and after situations. For this pillar, indicators defined in the theme Planet and focused in measure the reduction of energy consumption, production of renewable energy and decrease the emissions to the environment are very relevant for measure the objectives identified in this pillar.

7.1.2.2 Evaluation approach

The evaluation of the technical and energy objectives defined in this pillar will be done taking as reference the technological monitoring guide from SCIS, whereas the approach to evaluate energy savings is based in Measurement and Verification (M&V) concept. Additionally, it is recommended to use IPMVP as reference for setting energy performance in buildings and city infrastructures.

To proceed to the evaluation of the scope defined in this pillar, it is required to develop the next three steps:

1. **Definition of the objects of assessment**

   The definition of the objects of assessment is a crucial step since will be the functional units on which to measure the improvement. They can be defined for a building, an energy supply unit, a set of buildings, a set of energy supply units as well at neighborhood/city scale. To picture these boundaries, it is important to identify the energy carriers used as well as the energy supply and transformation units that cover the energy demands of the demonstration area and the exported units.

   SCIS guidelines provide some description of these boundaries according to EN15603 (Energy performance of buildings. However, we have updated to include the energy generation systems as is shown in figure below.

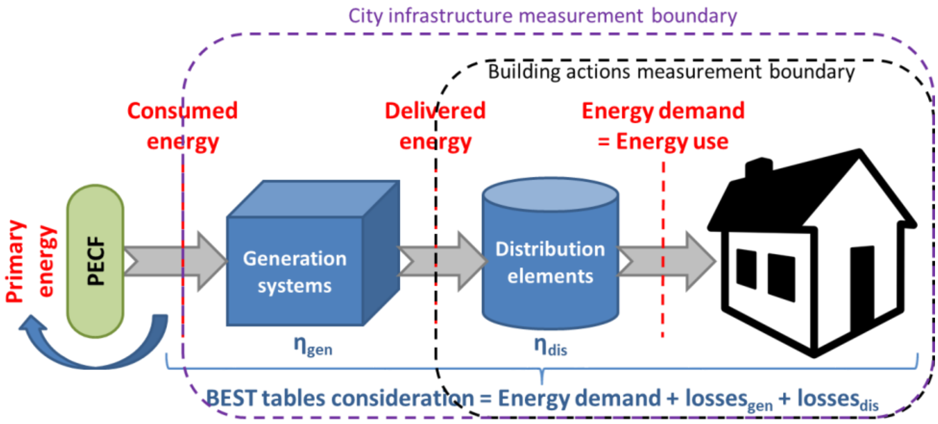

Figure 7.3: Energy assessment boundary

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For the case of IPMVP, a boundary is defined for the evaluation of savings for an entire facility or simply for a portion of it, depending upon the purposes of the reporting.

- If the purpose of reporting is to help manage only the equipment affected by the savings, a measurement boundary should be drawn around that equipment. Then all significant energy requirements of the equipment within the boundary can be determined.
- If the purpose of reporting is to help manage total facility energy performance, the meters measuring the supply of energy to the total facility can be used to assess performance and savings. The measurement boundary in this case encompasses the whole facility.
- If baseline or reporting period data are unreliable or unavailable, energy data from a calibrated simulation program can take the place of the missing data, for either part or all of the facility. The measurement boundary can be drawn accordingly.

For the case of mySMARTLife actions/interventions, indicators have been associated to actions/group of actions connected in a same geographical area or through the monitoring meters. Later, geographical boundaries must be defined specifically for each specific action or group of actions according to the evaluation purpose.

2. **<u>Definition of the baseline and post-intermediate period</u>**

This section aims to report some guidelines to apply to calculate the baseline and period after project actions implementation that have been collected from SCIS guidelines.

- ***Baseline period***

- It is needed to establish a baseline for evaluating the change and the improvement on the system due to the energy efficiency measures. Baseline is defined as an agreed set of parameter values describing the system and its ex-ante KPIs.
- A set of KPIs will be obtained as an outcome of this baseline definition, in order to be further compared with the KPIs obtained from the monitoring process of the post - intervention project. Consequently, the baseline has to gather, whenever possible, the same parameters that will be measured in the post intervention process.
- When describing the baseline, it is important to differentiate between new build projects and retrofitting projects (or new or refurbished energy systems). In both cases the baseline should be defined.
    - Projects based on existing systems: applicable in case the demonstration project is a refurbishment/retrofit/renovation, an improvement of existing technology or building, or either is a substitution of previous system for a high efficiency one. In this case, baseline

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should be based on historical data that cover a minimum duration of one year (i.e. a full operation cycle). This can be calculated from bills or through meter all energy consumption data of the system before the refurbishment or renovation works start. This includes final energy demand for heating, domestic hot water, cooling, electrical appliances, emissions, in kWh/month or kWh/km. If historical data are not available, data obtained by means of suitable modelling tools or properly justified estimations may be used.

  - Since there is no real data to compare the performance of new systems, suitable modelling tools can be used to reflect the typical scenario for one year but also minimum regulatory requirements (i.e. building technical code requirements) shall be used.

- ***Post-intervention evaluation***

- Monitoring data for post interventions is required for two years in order to demonstrate the energy performance of the implementation area. Therefore, it is important to collect all sampled data at the same time period in a consistent way.
- During the first year of monitoring, the data collection process is important for the analysis and optimization of the operating system. Aferwards it is possible to check the actual consumption against expected, calculated data and to analyse and evaluate the energy performance. In case of refurbishments it is possible to compare the data collected/metered before refurbishment against the data metered after refurbishment

  On other hand, climate factors shall be monitored by metering equipment at a proper rate (minimum once per hour or higher is advisable), unless otherwise specified. In some cases (for example, butane or diesel consumption) and other influence factors (home occupancy) data may be collected via questionnaires. These data should be collected for baseline and during the period of post-intervention evaluation.

3. **Design of assessment plan**

Specific M&V plans are required to be developed in each demosite (i.e. Nantes, Hamburg and Helsinki) in order to adapt the IPMVP protocol to each building, district or energy system. This evaluation plans should include at least the following topics:

- ECM’s (Energy Conservative Measures) deployed and expected results
- Selected IPMVP Option
- Measurement Boundary
- Baseline definition: Period, Energy and Conditions
- Reporting Period

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- Basis for Adjustment
- Energy Prices // GHG factors // Comfort range // Primary energy factors
- Meter Specifications
- Monitoring responsibilities
- Expected Accuracy
- Analysis procedure for calculation results

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7.2 Mobility pillar

The pillar aims to evaluate technical and environmental impacts of the mobility actions in the three LH of the project.

7.2.1 Scope

This section deals to introduce the potential objectives of evaluation in the mobility pillar that will be later delimited in section 7.2.1.2.

Table below summarizes the process performed to identify these objectives of evaluation from the project objectives as well as taking into account the objectives to be achieved with the implementation of mobility actions.

Table 7.8: Objectives of the project and actions in mobility

mySMARTLife objective	Interventions/Actions	Project actions objectives	Potential objectives of evaluation
To implement clean vehicles to deliver persons and goods in order to reduce the environmental impact of city transport	EV or clean vehicles - Electrical buses - e-Vehicles for public fleet (e-cars and e-bikes) - e-community fleet - Truck for city logistics EV or clean vehicles for: - Urban freight - Multimodality	Reduction of the environmental impacts of city transport due to the introduction of EV/clean vehicles that replace fossil fuel vehicles for deliver passengers or goods	Reduction in emissions *(GHG, NOx, PM)* Reduction in noise Evaluate energy consumed by these vehicles
	Charging infrastructure for e-vehicles and e-bikes		Energy delivered by charging infrastructure
To implement solutions to improve the mobility in the cities through the influence in travel mode of citizens and in the amount of travel	Electrical buses	Influence in travel mode of citizens *(change in the use of type of vehicle: from private cars towards public vehicles)*	Travel mode Amount of passengers Journey quality Safety Comfort
	e-community fleet	Influence in travel mode of citizens *(change in the use of type of vehicle: from own vehicles towards non-owned vehicles)* Influence in amount of travel *(reduction in the distances travelled, amount of trips and trips duration)*	Travel mode Amount of passengers/users Amount of travel Amount of distance travelled Amount of trips Duration
	Charging infrastructure for e-vehicles and e-bikes	Influence in travel mode of citizens travels *(from combustión fuel vehicles towards clean vehicles)*	Travel mode Amount of use and usage pattern of charging stations Journey quality Comfort
	Multimodality - Multimodal hub - Pedestrian and bikes lanes - Shared community fleet - Navigator related to EV in public transport	Influence in travel mode of citizens *(change in the use of type of vehicle: from private vehicles towards non-private vehicles)*	Travel mode Clean vehicle penetration Density of clean transport network Amount of passengers/users

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	Urban freight - Multihub for clean vehicles to deliver goods - Calls to implement delivery services with clean vehicles - Platform to manage delivery routines of companies	Influence in travel mode of deliveries travels *(from combustión fuel vehicles towards clean vehicles)*	Travel mode EV penetration rate
		Influence in the amount of travel in the delivery routines	Amount of travel Duration of delivery rounds Distance travelled Number of trips
	Intelligent transport system (ITS)	Influence in travel mode of citizens *(from fossil fuel vehicles towards electrical vehicles)*	Journey quality Comfort
To implement solutions to supply electrical vehicles with clean energy	Charging infrastructure powered with RES Solar road	Decarbonisation of energy production	Degree of energy supplied to EV by RES
Setting up an advanced management of the energy demand to optimizate the integration of RES and energy storage in the grid	Demand management	Exploit additional storage capacities that facilitate the integration of EV charging point Avoiding to exceed the grid connection capability	Impact of charging processes on the power network
		Maximizing the self-consumption of renewables	Degree of energy and RES managed
		Enable flexible charging process during optimal low-cost energy	Economic impact due to the management of the demand

For a better understanding of table above, the concepts of environmental impacts and mobility are described below and how mySMARTlife actions make improvements in both issues.

Environmental impacts due to transport

The introduction of clean vehicles in the 3 LH cities expects to improve the air quality by the reduction of NO_X and Particle Matter (PM) as well as decrease the production of Greenhouse Gases (GHG). Additionally, EVs are a suitable measure to reduce noise. Nevertheless, only GHG are aimed to be measured in mobility pillar. NO_x and PM will be considered in city impact whereas noise is out of scope due to the complexity to analyse this environmental impact.

In order to quantify the amount of emissions of GHG generated by vehicles, it is required to take into account the influenting factors that are:

- The choice of travel mode (electrical, clean or combustion fuel vehicles)
- Amount of travel (especially distance travelled)
- Vehicles characteristics (energy consumption, type of fuels consumed)
- Other external factors to the vehicle such as driving speed, driving style, road characteristics, traffic and wheater conditions.

For the case of mySMARTlife, the only factors that condition the amount of emissions is the change in the type of vehicle and the vehicle characteristics. The rest of factors will not be analysed since the interventions do not have any influence on them.

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Mobility

Mobility is defined as the capacity to move including not only the physical capacity for movement of vehicles, people or goods but also the willingness to move (Innamaa et al. 2013) and a set of aptitudes and skills necessary to move (to get one's bearings in space, to understand the functioning of means of transport ...). By extension, mobility also refers to a set of travel practices.

In general, it can be said that several different factors can influence mobilitybehaviours:

- Mobility increases when the **transport offer** increases (in terms of frequency of public transport, density of the public transport network, alternative routes or ways of transport, implementation of new mobility services…)[2]
- Mobility improves as **quality of journey** becomes better in terms of duration, price, feeling safety, comfort.
- Mobility changes are based on user preferences evolutions in terms of **travel mode** (own car, public transport, clean vehicles), **travel patterns** or on the evolution of the ways to use transport and mobility services (changes in routes, time slots…).

Actions implemented in mySMARTLife have as main goal to reduce the environmental impacts, being the improvements in mobility an additional impact of the project. However, given the complexity to measure the mobility habits evolutions, that in fact often occur after a slot of time, the impacts of implemented actions in terms of mobility behaviours will not be precisely quantified since this is out of scope of mySMARTLife timeline.

Furthermore, some of these previous factors reported above such as amount of travel and travel mode are interesting to be analysed since affect to the amount of emissions generated.

Below are described those actions from mySMARTLife that could have an impact in the travel behaviours of the citizens and in the amount of travel and consequently to impact in the emissions produced.

- Electric bus and autonomous e-buses: With the introduction of this new service, it is expected to influence in the modal shift of citizens that could start using with more frequency public and clean transport instead own vehicles. The journey quality in terms of safety and comfort will be key to influence in citizens travelling behaviour.
- e-community fleet: With this action, it intends to face a lack of parking space in the new building zones and consequently to reduce the number of own vehicles and the time required to park. Additionally, this action could reduce the amount of distance travelled and amount of trips in case these vehicles are shared by people who have same daily routines.

[2] That refers to the concept of “induced mobility”

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- Multimodality actions: With the development of multihubs and other actions that integrate public and clean transport services, it is expected an increase in the use of these clean alternatives implemented in the project in detriment of private and combustion vehicles.
- Charging infrastructures: A more number of charging points in the city intends to incentive the utilization and acquisition of e-vehicles and e-bikes.
- Urban freight and corporate cars fleets management: The measures implemented in this category have as goal to increase the number of clean vehicles used to deliver goods in the city and consequently perform more efficient deliveries in terms of travelled distances, number of trips and duration, but also to help companies to have a better management of their cars fleets.
- ITS: The installation of this solution in charging spaces to detect non-properly use of charging infrastructure aims to impulse citizens to use and acquiere e-vehicles.

7.2.1.1 Actions to be evaluated

Although the actions implemented in the LH are grouped in common category and have common goals, they are very different as described in table below.

Table 7.9: Summary of the energy/environment project actions

Type of action/LH	Nantes	Hamburg	Helsinki
EV	**A23a:** Electrical buses **A23b:** Autonomus electrical bus	**A21:** Electrical buses **A22**: e-vehicles for public fleet **A23**: e-community fleet	**A21:** Electrical buses **A22:** Truck for city logistics **A23:** Autonomus electrical bus
Charging stations and solar road	**A24:** Charging points for e-buses **A25:** Slow recharging points and fast charging points for e-vehicles in parking garages and parking slots **A25:** Clean charging points for e-bikes **A23b:** Solar road	**A24:** Charging points for e-buses **A25:** Semi-public fast charging points **A26:** Charging infrastructure for share e-community fleet **A27:** Clean energy charging stations	**A24:** Charging points for e-buses **A25:** Clean charging points for e-bikes **A26:** Electromobility charging node for e-bus, autonomous e-bus, fast charging for the city maintenance and commercial logistic fleet
Demand management	**A27:** Energy demand management linked to the renewable generation and storage capacity for on-site consumption and electric mobility of the “Carbon Neutral Multimodal Hub”	**A29:** Impact of a large scale ramp-up of EV on electricity grid **A30a:** Energy demand management to afford the implementation of new charging infrastructure **A30b:** Green integrated energy for e-buses	**A27:** Demand management for the integration of EV charging point, solar plant and energy storage **A28:** Demand management to optimize the low-cost electricity hours of the private EVs
Multimodality	**A31:** Carbon Neutral Multimodal hub (PV solar	**A32**. Pedestrian and bicycle route where Smart	**A30:** Integration of EV in multimodal public

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	power plan, solar power management, energy storage, charging stations, low carbón last kilometre delivery service)	Street lighting is implemented (A15) **A33**: e-community fleet sharing concept	transport and pedestrian navigator
Urban freigth	**A28:** Development of a call for low-carbon last-kilometre delivery services **A29*:** Platform for Green companies tools to help them to optimize their vehicle fleets management **A30:** Development of a tender call to support freight operators to develop cleaner solutions for their delivery routines	**A31:** MicroHub for several parcel service providers **A34:** Multi-modal use of available transportation methods (intermodal route planning)	
I.T.S		**A35:** Parking space detection	

7.2.1.2 Objectives to be evaluated

Taking into account previous objectives of evaluation identified, a set of these objectives has been selected to be evaluated in the mobility pillar as:

O1. To evaluate the reduction in GHG emissions

O2. To benchmark the use and energy consumption of different EV

a. Ratio by distance
b. Ratio by trips
c. Ratio by passengers

O3. To calculate the degree of energy supplied to EV by RES

O4. Amount of use and usage pattern of charging points

O5. Change in mobility due to solutions implemented

a. Change in travel mode *(EV/Clean vehicle penetration, use of clean/public transport, density of clean transport network,* willingness *of companies/municipality to introduce clean vehicles*)
b. Amount of travel *(duration, number of trips and distance travelled)*
c. Journey quality *(safety, comfort)*

O6. Impact of the energy demand management

a. Degree of energy managed
b. Degree of RES managed

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7.2.1.3 Selected indicators for the assessment

According to the previous objectives and taking into account mainly SCIS and CITYKEYS, 51 indicators have been defined to assess the successful of the mobility actions implemented in each lighthouse. Additionally, required information to fulfill TEST tables has been considered in the identification of indicators.

Following pages are dedicated to report the indicators defined, the typology of indicators and the types of actions where they are applicable. These indicators are defined in Annex II where the specific actions from each city are also specified.

<u>Indicators for O1: Reduction in greenhouse gas emissions</u>

Table 7.10: Mobility pillar indicators for Objective 1 (a)

Indicators	Actions
Annual eqCO_2 emissions saved (S)	EV (e-buses, e-cars sharing, e-vehicles for municipal fleet, clean vehicles for urban freight[3])

To calculate CO_2 saved due to the introduction of EV, it will be needed to measure some of these indicators collected in table below:

Table 7.11: Mobility pillar indicators for Objective 1 (b)

Factors	Indicators	Actions
Amount of travel	Annual distance travelled (P)	EV
Amount of energy consumed	Annual energy consumption (P)	EV
Amount of energy delivered	Annual energy delivered by each charging point (P) Annual energy delivered by charging points (S)	Charging stations

[3] It can be said that mySMARTLife funds are used to demonstrate the environmental impacts of e-vehicles that are considered in the category EV whereas the project does not intend to quantify the impacts due to the implementation of clean vehicles grouped in the category “urban freight” through monitoring equipment. Whereas impacts of vehicles from EV category will be quantified from the data collected by meters and by making use of a specific methodology described in the section 7.2.2 Assessment plan, impacts due to called clean vehicles are estimated directly in the platform created to manage the fleet of these vehicles.

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Indicators for O2: To benchmark the use and energy consumption of different EV/ clean vehicles

Table 7.12: Mobility pillar indicators for Objective 2

Factors	Indicators	Actions
Amount of use	Annual distance travelled (P) Annual number of trips (P) Annual number of passengers (P) Average number of passengers per working day (S) Average distance travelled by trip (P) Annual number of passengers.km (S) Percentage of e-buses acquired that are equipped for data collection (P)	EV/Clean vehicles
Energy consumption	Annual energy consumption (P) Annual energy consumption per annual distance travelled (S) Annual energy consumption by trip (S) Annual energy consumption per passenger.day (S) Annual energy consumption per passenger.km (S) Evolution of the energy consumption per vehicule.km or t.km Fuel consumed	

Information obtained through these indicators will help to compare efficiencies achieved by the different vehicles which will very useful for future decision processes.

Indicators for O3: Degreee of energy supplied to EV by RES

Table 7.13: Mobility pillar indicators for Objective 3

Indicators	Actions
Charging points powered by local energy sources (P) Annual energy produced by charging stations (P) Percentage of electricity supplied to charging stations by renewable energy sources compared to the total energy suplied (S)	Charging stations
Availability rate of the solar road (P) Annual energy produced by solar road (P)	Solar road

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Indicators for O4: To benchmark the use and usage pattern of charging stations

Table 7.14: Mobility pillar indicators for Objective 4

Factors	Indicators	Actions
Amount of use	Annual energy delivered by charging points (S) Total operating time for charging operations (P) Total occupancy time at charging points (P) Station uptime per year (P)	Charging stations
	Number of external charging events (P) Total charged energy from the external connection (P)	Electromobility charging node
Usage patterns	Average energy delivered per charging operation in each charging point (S) Average duration of charging operations (S) Average occupancy time at charging points (S) Percentage of the total occupancy time dedicated to recharging operations (S) Annual energy delivered by each charging point (P) Total number of charges per year in each charging station (P) Number of different users per year (P)	Charging stations
	Utilization ratio of external charging (P) Percentage of electricity charged from the external connection (S)	Electromobility charging node

These indicators will inform about the success reached with the implementation of charging stations but also to identify the need to implement specific measures according to the use of these infrastructures (i.e. increase the number of charging stations if is detected a high use or to implement specific actions to incentive the use/purchase of e-vehicles, move the location of charging statons, etc is the use has been low).

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Indicators for O5: Change in mobility due to solutions implemented

Table 7.15: Mobility pillar indicators for Objective 5

Factors	Indicators	Actions
Travel mode: Use of clean public transport	Annual number of passengers (P) Average number of passengers per working day Availability rate of e-buses (P) Percentage of e-buses acquired that are equipped for data collection (P)	EV (e-buses)
	Number of searches (P)	Multimodality: Navigator that integrates clean vehicles in public transport
Travel mode: Use of clean transport	Average number of passengers per working day (S) Annual energy delivered by charging points (S) Total operating time for charging operations (P) Total occupancy time at charging points (P) Station uptime per year (P) Number of external charging events (P) Total charged energy from the external conection (P)	Multimodality: Cycling and pedestrian lines
Travel mode: Use of clean transport	Total number of charges per year in each charging station (P) Number of different users per year (P)	Charging infrastructure for e-bikes
Travel mode: Use of clean transport	Annual number of passengers (P)	Multimodality: Cycling and pedestrian lines
Travel mode: Density of clean transport network	Length of cycling and pedestrian additional lines (P)	Multimodality: Cycling and pedestrian lines
Travel mode: Willingness of companies to introduce clean vehicles	Number of proposals submitted in response of the call for projects (P)	Urban freight: Calls for tender
Travel mode: Willingness of municipality to introduce clean vehicles	Number of HD vehicle compatible charging points installed (P)	Charging infrastructures

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Travel mode: EV/Clean vehicles penetration	Number of projects selected (P) Ratio of projects selected (S) Type of project selected (P)	Urban freight: Call for tenders
	Number of companies involved in the platform (P) Number of vehicles in the fleets of companies involved (P)	Urban freight: Platforms for management (delivery) companies
	EV penetration rate (P) Number of parcel delivery companies working in multihub (P) Deliveries operated with clean vehicles (P)	Urban freight: Microhub with delivery companies
Amount of travel	Annual distance travelled (P) Total duration of delivery rounds (P)	Urban freight: Platforms for management (delivery) companies
Journey quality: Security	Number of incidents and trafic accidents where the shuttle was involved (P)	Electrical vehicles
Journey quality: Comfort	Number of HD vehicle compatible charging points installed (P)	Electromobility charging node
	Station uptime per year (P)	Charging stations
	Occupancy (P)	ITS

With these indicators is intended to check the influence of the new mobility services (e-buses, charging infrastructure, multimodality solutions, cycling and pedestrian additional lines and ITS) in the mobility of citizens as well as the interest of companies to implement clean solutions to deliver goods. Also, is desirable to know the quality of citizens journey when they use clean vehicles/charging infrastructures as factor that can influence in the travel mode that use in their movements through the city.

Indicators for O6: Impact of energy demand management

Table 7.16: Mobility pillar indicators for Objective 6

Factors	Indicators	Actions
Degree of energy managed	Annual energy delivered by charging points (P) Number of charging sessions (P)	Demand management
Degree of RES managed	Charging points powered by local energy sources (P) Percentage of electricity supplied by renewable energy sources (S)	

O6 will be focused in analysis the growth in electric vehicle use and the integration of RES for a better understanding the implications in the power system.

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7.2.1.3.1 Type of indicators

Indicators previously defined are also classified in core/complementary according to the relevance of the indicator, taking into account in some occasions the availability of data as main criteria for the selection of the indicator. Table below collects the 21 core indicators defined and how they will support the evaluation of each objectives of evaluation.

Table 7.17: Core mobility pillar indicators

Objectives	Core indicators
O1: Reduction in greenhouse gas emissions	Annual CO_2 emissions saved Annual energy delivered by each charging point Annual energy delivered by charging points Number of vehicles in the fleets of companies involved EV penetration rate Average emissions / 100 km
O2: To benchmark the use and energy consumption of different EV	**Amount of use** Annual number of passengers/users Annual distance travelled Fuel consumed **Energy consumption** Annual energy consumption Evolution of the energy consumption per vehicule.km or t.km
O3: Degreee of energy supplied to EV by RES	Percentage of electricity supplied by renewable energy Availability rate of the solar road
O4: To benchmark the use and usage pattern of charging stations	**Amount of use** Annual energy delivered by each charging point Annual energy delivered by charging points **Usage pattern** Number of different users per year
O5: Change in mobility due to solutions implemented	**Travel mode: use of clean/public transport** Annual number of passengers/users Annual energy delivered by each charging point Annual energy delivered by charging points Number of different users per year Number of searches

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	Travel mode: EV/Clean vehicles penetration Number of vehicles in the fleets of companies involved EV penetration rate Ratio of projects selected **Travel mode: Willingness of municipality to introduce clean vehicles** Number of HD vehicle compatible charging points installed **Travel mode: Willingness of companies to introduce clean vehicles** Number of proposals submitted in response of the call for projects **Amount of travel** Annual distance travelled Total duration of delivery rounds **Journey quality** Occupancy in front of the charging points
O6: Impact of energy demand management	**Degree of energy managed** Annual energy delivered by charging points (O6: Impact of energy demand management (Degree of energy managed) **Degree of RES managed** Percentage of electricity supplied by renewable energy (degree of RES managed)

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7.2.2 Assessment plan

7.2.2.1 Evaluation approach: general context

Assessment of the CO_2 savings associated with the implementation of mobility projects is not always very easy. The evaluation process often faces difficulties in accessing precise data on mobility practices (distance and number of journeys, modes of transport used, characteristics of the vehicles used, etc.) before and after the project. It may also be complex to isolate the effects of the project itself from the effects of other implemented measures or projects.

Evaluation of mobility or transport projects, in terms of CO_2 emissions, therefore often requires the formulation of assumptions and the use of reference values obtained from previous evaluation works carried out at other scales or in other urban contexts. These data (ratio, average values, etc.) are complementary to the measurements or real data collected as part of the project monitoring and are essential to the project evaluation process.

For these reasons, assessments of CO_2 savings are often estimates, based on precise methodological processes, but nevertheless subject to a certain level of uncertainty. This is particularly true in cases where the evaluation concerns projects involving use of private vehicles (installation of charging stations for private passenger vehicles) or projects involving new mobility services (carpooling, intermodality projects, etc.).

Evaluation of the other components of mobility projects (technical characteristics of the project, levels of uses and types of uses, user audiences, etc.) is generally easier to conduct since the necessary data are often more easily available.

The following sections therefore aim to provide methodological guidelines for assessing the CO_2 savings due to different types of transport or mobility projects developed within the mySMARTLife project.

In general terms, CO_2[4] savings will be calculated by comparing emissions before and after the project implementation, using the following formula[5]:

$$eqCO_2 \text{ emissions saved} = eqCO_2 \text{ emissions before action} - eqCO_2 \text{ emissions after action}$$

However, mobility actions implemented within mySMARTLife project are very diverse, in terms of vehicles (e-buses, e-cars, e-bikes) and in terms of projects types (deployment of e-vehicles, installation of charging stations, developpement or improvment of new mobility services…). Due to this diversity actions, the data available to establish the initial situations (situation before project or baseline) are not always equivalent.

[4] Emissions are actually calculated in $eqCO_2$

[5] Same general approach is proposed by CITYkeys (D1.4 Smart city KPIs and related methodology – final)

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Thus, the methodology developed below proposes various possible alternatives, especially for estimating pre-project CO_2 emissions in order to adapt to the reality of the available data.

7.2.2.2 Methodological guidelines for calculation of $eqCO_2$ emissions savings of projects involving public vehicles (electric buses, autonomous shuttles….)

The following paragraphs apply to projects that replace old thermal public vehicles with electric public vehicles. According to the generic formula mentioned above, the $eqCO_2$ emissions savings due to implementation of new electric public vehicles can be calculated as follows:

$eqCO_2$ emissions saved = $eqCO_2$ emissions from former ICE vehicles – $eqCO_2$ emissions from new e-vehicles

(ICE: internal combustion engine)

- ***Evaluation of $eqCO_2$ emissions from former ICE vehicles can be carried out according to 2 different approaches:***

Approach 1: evaluation according to the distances travelled

$eqCO_2$ emissions = annual distance travelled (km) x emissions of vehicles per km ($geqCO_2$ / km)

While the distances travelled (e. g. annually) are generally well known by public transport operators, real vehicles emissions are not always accurately known, especially since it is preferable to use values "in real use" rather than those provided by manufacturers (sometimes underestimated). Thus, it is possible to refer to the second approach.

Approach 2: evaluation according to the energy consumptions

$eqCO_2$ emissions = annual energy consumed (MWh) x emission factor of the considered fuel (g $eqCO_2$ / MWh)

Or, when public transport operator have access to the annual energy consumptions only expressed l or kg of fuel:

$eqCO_2$ emissions = annual quantity of fuel consummed (l or kg) x emission factor of the considered fuel (g eqCO2 / l or g eqCO2 / kg)

Default emissions factors of fuels at the European level can be obtained through the combination of 3 reference sources (according to the available data at local level):

- IPCC (net calorific value of fuels, in kWh / kg)[6]

- Covenant of Mayors (CoM) (average emissions of fuels in kg $eqC0_2$ / MWh)[7]

6 https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_1_Ch1_Introduction.pdf

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- French environment agency (Ademe) (density of fuels, in kg / l)[8]

Finaly, emissions factors (per kg of fuel or per l of fuel) are provided in the table below:

Table 7.18: Default emission factors by type of fuel in Europe

	Net caloric values (kWh / kg)	Emissions kgeqCO2 / kWh for Mobile sources*	Emissions kgeqCO2 / kg	Density (kg / l)	Emissions keqCO2/ l
	Ref.: IPCC **A**	**Ref.: CoM** **B**	**Calculation** **C = A x B**	**Ref.: Ademe** **D**	**Calculation** **E = C x D**
Gasoline (95, 95E10, 98)	*12.31*	*0.323*	***3.98***	*0.755*	**3.00**
Diesel	*11.94*	*0.315*	***3.76***	*0.845*	**3.18**
Compressed natural gas for vehicles	*13.33*	*0.280*	***3.74***	-	**-**
LPG	*13.14*	*0.289*	***3.80***	*0.538*	**2.05**
Liquid Natural Gas	*13.33*	*0.280*	***3.74***	*0.654*	**2.44**

*: considering Long Cycle Assessment (= combusiton + supply chain)

Note: In the case where the project consists in deploying an electric bus on a new line (it is not a replacement of pre-existing véhicles), "pre-project" emissions must be considered as the emissions that would have resulted from the circulation of an ICE bus with a capacity equivalent to the new electric bus (and considering the same level of utilization, especially in terms of distances travelled). The emissions characterizing this baseline can be calculated by using the values from the previous tables.

- **Emissions from new e-vehicles (e-buses, autonomous shuttle…) can be estimated with the following approach**

eqCO_2 emissions = annual quantity of energy consummed (by new e-vehicles kWh) x emission factor of the electricty grid (eqCO_2 / kWh)

It is considered that annual quantity of electricity consumed by the new e-vehicles (e-buses, autonomous shuttle…) is a data provided by charging stations and that public transport operators can easily have. In addition, emissions factors of national electricity grids are provided in the table below:

[7] http://data.europa.eu/euodp/data/dataset/jrc-com-ef-comw-ef-2017

[8] http://www.bilans-ges.ademe.fr/fr/basecarbone/donnees-consulter/liste-element/categorie/34

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Table 7.19: Emission factors for electricity consumption

Cointries	Emissions tCO2 eq / MWh (in 2013)
Finland	0.206
France	0.093
Germany	0.658

(Long Cycle Assessment, including emissions from the supply chain) – Source: CoM Default Emission factors for the Member States of the UE[9]

7.2.2.3 Methodological guidelines for calculation of $eqCO_2$ emissions savings of projects involving individual e-cars (charging stations, fleets of e-cars for carsharing…)

As for public transport vehicles (e. g. buses), CO2 savings are calculated using the following formula:

$eqCO_2$ emissions saved = $eqCO_2$ emissions from former ICE vehicles – $eqCO_2$ emissions from new e-vehicles

However, as mentioned above, the assessment of CO_2 emissions associated with the implementation of new electric cars or with the deployment of charging stations for private e-cars faces data availability problems, in particular regarding the nature of travels prior to projects deployment. In other words, it is difficult to assess precisely which were former types of vehicles that new electric vehicles replace and which were the characteristics (distances) of former journeys now made with e-cars. For all these reasons, it is necessary to formulate assumptions.

- **$eqCO_2$ emissions from new e – cars**

As for public transport vehicles, emissions from new e-vehicles (e-cars) can be calculated as follow:

$eqCO_2$ emissions = annual quantity of energy consumed (kWh) x emission factor of the electricty grid ($eqCO_2$ / kWh)

It can be considered that the annual quantity of energy charged to e-vehicles can be transmitted by charging stations managers (thanks to charging station monitoring and management systems).

If the total energy consumption is not avaibale, it is possible, in an approximative way, to calculate the CO_2 emissions via the distances travelled as follows (this can apply for example on projects consisting in deployment of community fleet of e-cars or a fleet of e-cars for carsharing):

[9] Document available on line: see above

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$eqCO_2$ emissions = annual distance travelled (km) x energy consumption per km (kWh / km) x emission factor of the electricity grid ($eqCO_2$ / kWh)

However, this method of calculation requires knowing the distances traveled and the actual consumption of vehicles (in kWh / km).

If the real consumption of vehicles is not precisely known (in case for example of use of private cars that are recharged at charging stations in public access), it is possible to use the reference value of 0.18 kWh / km.

In addition, emissions factors of national electricity grids are provided in the Table 7.19.

- **CO_2 emissions from former ICE vehicles**

If no precise data are avaibale, the general idea (certainly simplifying) is to consider that journeys made with new electric vehicles (or allowed by the installation of new charging stations) replace equivalent distance journeys previously made with internal combustion engine vehicles.

Distances travelled by former ICE cars = Distances travelled by new e-cars

The annual distances travelled by new e-cars are provided by km-readers of vehicules. When this data is not available (in the case, for example, where the project consists of the installation of charging stations for private e-cars), annual distances travelled have to be estimated with the following formula:

Annual distances travelled = annual quantity of energy consumed (kWh) / energy consumption per km (kWh / km)

The annual quantity of energy consumed corresponds to the electricity charged by charging stations. By default, and if precise data is not available (for example in case of use of private cars that are recharged at charging stations in public access), energy consumption per km of e-vehicules can be estimated at 0.18 kWh / km.

It is then necessary to calculate the emissions that would have been produced by combustion vehicles if they had travelled the same distance journeys.

CO_2 emissions from former ICE vehicles = distances travelled (km) x CO_2 emission per km (g eqCO2 / km)

The emission level (in g $eqCO_2$ / km) taken into account then corresponds to the emission level of new vehicles[10] marketed in the "reference year" calculated according to the average age[11] of the vehicles fleet

[10] Historic levels of CO_2 emissions of new vehicles per country (gCO2 / km) are provided by the eurostat portal : https://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&language=fr&pcode=sdg_13_10&plugin=1

[11] European Automobile Manufacturers Association for average age of vehicles - https://www.acea.be/publications/article/acea-pocket-guide

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in the country concerned. The obtained value is then increased by 20%[12] to take into account emissions under real conditions.

Table 7.20: Default CO_2 emission factors applicable to national cars fleets

Cointry	Average age of cars fleet (in 2017)	Year of reference	Average CO_2 emissions of new cars at the reference year (g CO_2 / km)	Default emission CO_2 emissions factor to consider (emissions of new cars + 20%)
Finland	11.2	2006	179.2	215
France	9.3	2008	140.1	168
Germany	9.4	2008	164.8	198

Note: In the table below, and contrary to the values mentioned above, the emissions only concern CO_2 and not the other gases emitted during combustion. This approximation only marginally affects the final estimates because analyses show that CO_2 emissions represent about 98% of the emissions in eqCO_2 in the case of an average sort of car[13].

7.2.2.4 Methodological guidelines for calculation of eqCO_2 emissions savings of projects involving e-bikes deployment

Some of the actions of the mySMARTLife project consist in deploying fleets of electric bicycles or charging stations for electric bicycles. There are two main difficulties in assessing the CO_2 savings from these projects:

- how to characterize the initial situation (baseline): what were the characteristics of the previous trips now made by e-bikes (which mode of transport, which distances...).
- what are the actual uses of electric bicycles (distances travelled, electricity consumption, etc.): the data available here are much less numerous and complete than those relating to car use.

For these reasons, it is recommended to carry out surveys towards users of bicycles or users of the services that have been set up, paying particular attention to asking:

- current situation: what are the distances covered by electric bicycles? what is the capacity of the battery? what is the frequency of charging or the range observed?

[12] Expert estimation value

[13] See « base carbone – bilan GES » (Carbon data base – GHG audits) from Ademe (French Agency for Energy and Environment) – emissions from middle power individual cars

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- previous situation: which mode of transport was used in the past for trips now made by electric bicycle (public transport, private car, walking...)

Given the diversity of possible responses, it is difficult at this stage to provide more details on the methological guidelines to be followed to estimate the CO_2 savings associated with these measures. However, some elements and orders of magnitude can be mentioned for possible use, in addition to figures and default values mentioned in the tables above:

- consumption of e-bikes changes according to different criteria, such as speed, bicycle conditions (tire pressure), topography, power of electric-assistance... Considering a battery of 400 Wh and an autonomous 70 km, the average consumption can be estimated at 0.0057 kWh / km. This is 30 times less than the average consumption of e-cars (0.18 kWh / km).
- some surveys towards e-bikes users show that e-bikes replace trips previously made by public transport or on foot more than by private cars.

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7.3 ICT and Urban Platform pillar

This pillar is focused in evaluating the impacts of the ICT actions in the Urban Platform in the three lighthouse cities of the project.

7.3.1 Scope

Under mySMARTLife project, one of the innovations/improvements is related to the urban platform and ICT services associated. As being part of the project actions, they should be evaluated with the objective of extracting a set of conclusions. That is why this pillar aims to establish a common framework for the cities at time of assessing the urban platform actions and their impact in terms of digitalisation processes.

On the other hand, the design of specific evaluation method under this pillar has been performed in order to ensure that the project objectives for the ICT solutions are achieved. Mainly, openness in the form of open Data and open APIs, as well as interoperability, are the criteria to be focused on. Based on qualitative and objective indicators, this methodology aims to obtain the level of improvement that mySMARTLife has reached for lighthouse cities digitalisation processes. Thus, table below summarises the objective of the project, the objectives of the evaluation and the set of related interventions.

Table 7.21: Objectives and interventions of ICT/Urban platform

mySMARTLife objective	Interventions/Actions	Objectives to be evaluated
Increase the quality and services of urban platform focussing in privacy, security, replicability, reusability and interoperability	Urban platform IoT data integration ICT developments (new services)	• To evaluate the improvements from the exiting urban platform • To evaluate the new ICT developments and services carried out under mySMARTLife umbrella and integrated into the existing or newly deployed smart urban platform • To assess the ICT services features, in terms of performance, replicability, interoperability, accessibility, privacy, security • To assess the impact in the digital transformation and digital agenda

In order to measure these improvements and extract the corresponding conclusions, a set of indicators is defined. They are related to ICT specific objectives that the ICT assessment plan is proposing, which will be detailed below.

It should be noted that interoperability is highlighted as one of the ICT requirements for the urban platforms development. However, it is out of scope of this deliverable and the evaluation framework within

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WP5. The reason is because there is a dedicated deliverable (D2.17) where the interoperability is specifically assessed. Hence, in order to avoid duplication, this feature is neglected here (see D2.17 for further details).

7.3.1.1 Actions to be evaluated

As stated before, ICTs are one of the main enablers for Smart Cities through the deployment of communication infrastructures to support city services and, thus, contribute to the urban transformation (i.e. from the digitalization point of view). In this way, mySMARTLife deals with the improvement of the urban platforms with a twofold purpose: 1) provide services to the citizens and 2) integrate data and information in a harmonized way (i.e. digitalisation). Under this perspective, the application of digital technologies becomes pivotal to ensure the urban transformation strategy and, hence, their performance via different pillars needs to be evaluated.

Before the definition of the assessment method, it is important to recall the interventions that are being taken into consideration within the mySMARTLife project. Table below summarises the project actions for the three lighthouse cities related to ICTs.

Table 7.22: Summary of the ICT project actions

Action number	Nantes action	Action number	Hamburg action	Action number	Helsinki action
42	Urban platform, openAPIs	**56**	New architecture: Field Component Gateways, Field Component Platforms, Smart Middleware and Access	**44**	Helsinki Urban platform improvements with building-level open energy data on energy savings potentials
43	Solar cadaster	**54**	Integration of DTAG (T-Systems, AG) Smart City ecosystem	**45**	Implementation of "mySMARTLife features" into the Public Transport Navigator App
44	Smart data on mobility	**55**	Open APIs developments	**46**	Implementation of "Carbon-Ego" App (before Carbon-Neutral Me)
45	Energy data lab initiative	**56**	Open Data developments	**47**	Lighthouse IoT repository up-take and integration of sensor sources to the repository
46	Decision making tool	**57**	Monitoring services	**48**	Up-take of new sensoring infrastructure in the smart districts to support actions
47	Energy data monitoring of public buildings	**58**	Improve decision making on urban services		
		59	Mobile Access Management		

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From the previous table, different categories of actions may be distinguished:

- Improvements in the existing urban platforms through new concepts of openness and interoperability, implemented via open APIs and open data.
- Integration of data gathering processes from the deployed monitoring equipment across the cities. The IoT sensor devices are deployed in relation to the technical project actions within the project pillars: mainly energy and mobility are providing real-time data. Through the use of these data, other digital features are possible, such as implementing added value services, calculating indicators and supporting decision-making processes. In conclusion, this category is essential for the digitalisation as data collection is the initial stage in any digital plan.
- Development of new added value services whose focus is on the citizens and city decision-makers. These services are deployed on top of the urban platform.

7.3.1.2 Objectives to be evaluated

Keeping in mind the actions and categories of them, a set of objectives may be established in terms of impact of the urban platform related developments. Four goals are then identified to evaluate the ICT actions strategies:

- O1: To evaluate the improvements from the existing urban platforms.
- O2: To evaluate the new particular ICT developments and services carried out under the mySMARTLife umbrella and integrated into the existing smart urban platforms.
- O3: To assess the ICT services' features, in terms of performance, such as response time, scalability and extensibility.
- O4: To assess the impact that the urban platform has over the urban transformation, mainly in terms of digitalisation.

To clarify the scope of the aforementioned objectives, it is important to remark that O1 looks for how the urban platforms are adapted to the openness concept (i.e. open APIs and open Data), as well as the capabilities of digitalization by integrating new data-sets. In other words, how the extensions of the urban platform concepts are adjusted to the Open Specifications Framework defined within D2.16. This objective is completely aligned with the actions 42 in Nantes, 56 in Hamburg and 44 in Helsinki.

Furthermore, O2 focuses on the new services for the citizens and/or city decision-makers, such as the Solar Cadaster service in Nantes or Carbon Ego app in Helsinki. This schema is depicted in Figure below where the south part is dedicated to the O1 and the north side is O2.

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Figure 7.4: Urban platform concept vs services

In the case of O3 and O4, these are more transversal to the urban platform and ICT implementations. In this way, O3 takes everything as a whole to evaluate the performance, i.e. software metrics. For instance, response time is one of the most used indicators, which provides a value about the time that one user should wait from the request to the response when browsing in any app or service. There are other metrics to measure performance parameters when talking about software solutions, which are included in the indicator list.

Last but not least, O4 determines the impact of the urban platforms in the urban transformation strategy. That is to say, how the urban platforms affect the digitalisation processes and digital agendas of the cities. Complementary, it is remarkable to say this is more related to the city impact (i.e. city level indicators) as the effect is for the whole city.

7.3.1.3 Selected indicators for the assessment

Until now, the actions to be evaluated and the objectives to be achieved have been described, but it is also important to determine how they are being contrasted. For that end, a set of indicators are defined. These are depicted in Table below where the evaluation category (to be explained later), the project actions and its objective are related to such an indicator. The details of the indicator definition are included within Annex 2.

Table 7.23: ICT pillar indicators

ID	Indicator	Type of indicator	Evaluation category	Objective
ICT-1	Data privacy	Core	Urban development	O1: Urban platform O2: Services O3: Performance
ICT-2	Number of data publishers	Core	Urban development and Management	O1: Urban platform O2: Services
ICT-3	Number of sensors	Core	Urban development and	O1: Urban platform

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	integrated		Management	O2: Services O4: Digital tranformation
ICT-4	Number of services deployed	Core	Society	O1: Urban platform O2: Services O4: Digital tranformation
ICT-5	Number of available Open APIs	Core	Urban development, Management and Society	O1: Urban platform O2: Services
ICT-6	Number of available Open Data sets	Core	Urban development, Management and Society	O1: Urban platform O2: Services O4: Digital tranformation
ICT-7	Number of accesses to the urban platform	Complementary	Society	O1: Urban platform O2: Services
ICT-8	Response time	Complementary	Urban development	O3: Performance
ICT-9	Scalability	Complementary	Urban development	O3: Performance
ICT-10	Storage capacity	Complementary	Urban development	O3: Performance
ICT-11	Availability	Complementary	Urban development	O3: Performance

7.3.2 Assessment plan

7.3.2.1 Existing evaluation methods

One of the major concerns at time of evaluating the ICT tools is the lack of a common framework or procedure. Nevertheless, there exist several software metrics, as well as some initiatives that are very useful for mySMARTLife project. In this sense, a minimum set of software metrics (both direct (speed, cost, etc.) and indirect measures (quality, functionality, reliability, efficiency, maintainability, etc.)) to be measured (including their measurement methods) have to be established. Besides that, the desirable range of values for each measure/metric should be defined depending on the characteristics of the specific software, the place on which it will be used, etc.

Having said that, it is important to remark the two main references being used within mySMARTLife. On one hand, SCIS defines a general performance set of indicators for ICT technologies. They provide two oreder effects, but mainly focused on the impacts in GHG emissions and enviromental load reduction due to the deployment of ICT solutions. Therefore, their objective lies in the impact in the energy performance, like power in the grid, flexibility, energy costs or RES maximisation. Then, it fails in the application for Smart Cities Urban Platforms, generally speaking.

On the other hand, CITYKEYS does not provide a specific framework for ICT evaluation, but the ICTs are considered within its three main pillars: People, Planet and Prosperity. Nevertheless, within them, there

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exist some indicators that generally evaluate the ICTs, like cybersecurity or data privacy. Nevertheles, these are based on likert scale without a quantifiable value (i.e. subjective assessment). Moreover, some other indicators are split into domains (like education), being not applicable here.

Finally, under the Eurostat[14], statistical office of the European Union, has published a set of indicators related to ICT tools, as illustrated into Figure below, where diverse areas of interest are covered where the ICT tools have impact.

1. Economic development	4. Public Health	7. Management of natural resources
2. Poverty and social exclusion	5. Climate change and energy	8. Transport
3. Ageing society	6. Production and consumption patterns	9. Good governance
		10. Global Partnership

Tab. 3.2 Eurostat renewed EU sustainable development indicators
(Gothenburg 2001, renewed June 2006, revised by the end of 2007)

Figure 7.5: Eurostat related indicators

The way Eurostat establishes the evaluation is through the digital agenda scoreboard for measuring the progress of digitalization and ways of success under the aforementioned pillars. That is to say, how the ICT tools are contributing to digitalization and urban transformation. The scoreboard defines a large number of assets, being most of them out of the scope of the mySMARTLife context. This framework is supported by multiple indicators, such as presented on the article “Appropriate Evaluation Methods for ICT Initiatives”[15].

Apart from Eurostats, mySMARTLife has followed other initiatives, such as the published by Fundación Telefónica[16], under a dossier about how to evaluate the development of a Smart City. Additionally, the Organization for Economic Co-operation and Development (OECD) collects 15 ICT indicators that are drawn from various publications and databases produced by the OECD’s Directorate for Science, Technology and Innovation[17].

Last but not least, it is important to highlight that mySMARTLife takes these definitions into consideration, although, in some cases, they are slightly varied to adapt them to the specific requirements of the project.

7.3.2.2 Evaluation approach

With the aforementioned initiatives in mind, next step is to define the evaluation approach of the project. As stated, mySMARTLife follows these procedures with the aim of evaluating the objectives that have been defined according to the project actions. In this way, the list of indicators shown before is compiled

[14] http://ec.europa.eu/eurostat/web/sdi/indicators

[15] Appropriate Evaluation Methods for ICT Initiatives B. Shadrach and Ron Summers. Loughborough University, UK. http://www.iimahd.ernet.in/egov/ifip/apr2002/article1.htm

[16] https://telos.fundaciontelefonica.com/seccion=1268&idioma=es_ES&id=2016102617400002&activo=6.do#

[17] http://www.oecd.org/internet/broadband/oecdkeyictindicators.htm

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from the aforementioned initiatives. The ultimate goal is anyway to evaluate how the digitalization process and urban platform development have impact in the city; therefore, two levels are necessary: project actions evaluation and city impacts. In both cases, the indicators are the same as an urban platform does not only apply at project level, but also the rest of the city takes advantage of these developments.

In terms of analysing the impact, it is required to establish the situation before the project (which is similar to the baseline concept of energy protocols like IPMVP). Then, after the project, the improvements may be easily contrasted. Here, it is where the two levels should be split. On one hand, the objectives O1 and O2 directly refer to the project actions (i.e. improvements of the urban platform and services). On the other hand, O3 and O4 are more global, being the impact at urban scale.

The procedure is very simple. While, for instance, energy requires continuous monitoring for determining the performance compared to the climate conditions and the evolution of energy consumption, ICTs remain "static" if no changes are produced. Therefore, there is no need for constantly monitoring. The way to evaluate is to compare two statuses, or commonly named snapshots. In the ICT world, the snapshot concept is used to "save" the current status of a system. Then, by comparing two snapshots, whenever taken, improvements may be assessed. Within mySMARTLife, these are the situations before the project and after the implementation of the ICTs, although multiple snapshots would allow the comparison in the time scale (but this is out of scope of the project). In short, the schema is the one depicted in Figure below.

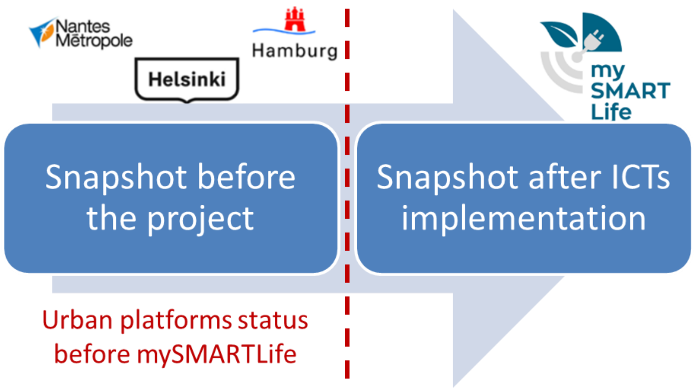

Figure 7.6: ICTs evaluation methodology summary

Finally, there is an additional aspect to be considered in the assessment plan. Before, it was mentioned the categorisation of the urban platform actions in terms of (1) improvements of the urban platform, (2) integration of monitoring data and (3) added value services. These categories are mapped into different focus groups that are part of the evaluation procedure, which were already included into the indicators table. However, these terms are more technical. Below, these focus groups and their meaning.

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- Urban development, where the improvements and performance of the urban platforms apply to a more environmentally friendly ecosystem where digitalisation tools take part. In this sense, ICTs play an important role in the urban development.
- Management, which, in the ICT context, means the management of the technical assets. That is to say, monitoring equipment integrated into the urban platforms, such as new data-sets, variables, users, etc.
- Society, being one of the major focuses of one urban platform. It refers the services deployment, whose direct beneficiaries are people (citizens, city planners, decision-makers…), who make use of the functionalities to improve the society.

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7.4 Economy pillar

The pillar aims to evaluate the economy impacts of the actions implemented in the three LH of the project.

7.4.1 Scope

7.4.1.1 Objectives to be evaluated

In order to determine the objectives of evaluation in this pillar, firstly it is introduced the relevant objectives that mySMARTLife aims under the economic perspective; which are collected in table below.

Table 7.24: Economic objectives of mySMARTLife

mySMARTLife objective	Interventions/Actions
Implement a set of actions in the three LH that will be accompanied by sound business models and a planned financial scheme based on public and private funds	Building / District City infrastructure & Mobility Urban Platform & Non Technical Actions
Implement a set of actions in the three LH that help to reduce the energy bills due to energy and maintenance cost savings	Building / District City infrastructure & Mobility
To deploy a good set of very innovative business models to demostrate that both technical and financial risk are low enough for large investments with the aim to encourage private investment	Non Technical actions: Innovative business models
Increase employment opportunities and improve the local economy of urban areas through the implementation of innovative actions in cities	Building / District City infrastructure & Mobility Urban Platform & Non Technical Actions

Additionally, mySMARTLife actions intend to improve efficiency in the use of energy and change the current energy sources by decarbonising the energy supplies and increasing the share of renewables which suppose an improvement of the air quality of the city as well a reduduction of CO_2 emissions to the atmosphere to face to the big environmental problem of Climate Change. Consequently, this benefit on the environment and health of citizens has to be taking into account when a holistic evaluation is performed as mySMARTLife does.

Taking into account previous ideas, the economic evaluation of project actions is focused toward the measure of the next two main objectives:

- O1: To measure the cost effectiveness of the project actions
- O2: To measure the economic impact of the actions in the city

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Finally, it has to remartk that this economic evaluation can help to identify proper and new business models, finantial schemes, directs costs and economic savings as well as direct impacts in economy, environment and societal areas for the city but also to guide the city policies and urban planning agendas that are defined in pro of the economic progress of cities. Therefore, this pillar is crucial to bring about smart and sustainable policy actions.

7.4.1.2 Actions and target groups to focus the evaluation

All type of project actions are potential actions to be measured by the two principle objectives of the evaluation. Obviously, would be desiderable to evaluate all actions in each field - building, city infrastructure, mobility, urban platform and non technical actions -, but we believe that the efforts, attending the classical triple restriction of projects - cost, scope and time - should focus on concrete criteria that will allow the evaluation a major impact. To this regard, technical partners and cities have been working to identify and describe the actions to be evaluated in the economic pillar. However, it was finally decided that were the cities the responsible to select the actions according to their own criteria following the guidelines provided in CITYkeys - mentioned in section 5 - such as relevance, completeness, availability, measurability, reliability, familiarity, non-redundacy and independence. Furthermore, although the task could be complicated, we also believe that an important criteria to add is comparision. These criteria will allow us try to identify and explain similarities and differences among cities and actions despite the discrepancies between cities and actions. The selection of the most suitable actions takes time and is required to continue working in this issue during the next months. Final actions selected will be reported in D5.4 by M48: Data collection and KPI.

On other hand, the evaluation will be focused towards the identification of benefits of concrete target groups such as municipality, citizens, SME and large companies. Such selection is linked to the research and analysis carried out in WP1, precisely with D1.6. Key aspects of City's Business Models; D1.7. Ecosystems for big players in the urban field; D1.8. Ecosystems for boosting SMEs at local level; and D.1.9. Business models innovation.

Thus, for O1 (cost-effectiveness): the target groups identified are municipality and SMEs whereas for O2 (economic impact), the target groups to focus the analysis are large companies and citizens. The reason to select these target groups follows general criteria and it is not exclusive (e.g. large companies can obviously be involved in the first objective).

For the first objective, the cost-effectiveness, Municipality and SMEs have been selected because they are who carry most of the actions, either as owners, implementers or developers. Obviously, there are some actions that are carried out by large companies or residents, but its presence is less in comparision with other targets. For the second objective, the economic impact, we have selected large companies and citizens because large companies represent big players who can pusch hard in the scale-up of interventions and citizens are who clearly receive the impact of actions from an economic, environment and societal aspects. Regarding citizens, all actions focus on citizens in general, but district and building actions target owners and residents as well, and mobility actions target also EV owners.

Table below collects the potential target group to focus the evaluation according to the type of action and objective of evaluation.

Table 7.25: Target groups identified for economic evaluation

Type of action	Objective of evaluation	Target group
District/Buildings	Cost-effectiveness	Impact on the municipality
		Impact on SME
	Economic impact at city level	Impact on large companies
		Impact on citizens and residents
Mobility	Cost-effectiveness	Impact on the municipality
		Impact on SME
	Economic impact at city level	Impact on large companies
		Impact on citizens (users) and EV owners
City infrastructures	Cost-effectiveness	Impact on the municipality
		Impact on SME
	Economic impact at city level	Impact on large companies
		Impact on citizens
Urban Platform	Cost-effectiveness	Impact on the municipality
		Impact on SME
	Economic impact at city level	Impact on large companies
		Impact on citizens
NTA	Cost-effectiveness	Impact on the municipality
		Impact on SME
	Economic impact at city level	Impact on large companies
		Impact on citizens

7.4.1.3 Selected indicators for the assessment

In order to identify the most suitable indicators, each main objective of evaluation has been split in dimensions. For the case of the first objective, cost-efectiveness, three main dimensions have been defined: the cost of the action, the revenues from the action and the return of investment. For the first case, the objective is to quantify the cost of the action for the implementation and operation and principle

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sources of cost. For the second case, the objective is to identify and quantify income generated by the action. Obviously, this will not apply to all actions because many of them do not present incomes. And for the third case, the objective is to evaluate the return of the investment through different type of indicators such as the NPV, IRR, PP and ROI. For the case of the second objective, economic impact, the objective presents two dimensions: the economic impact and the social impact.

As a result, 24 economic indicators have been defined. Table below shows these indicators as well as the dimensions and indicators defined in each objective of evaluation.

Table 7.26: Economic pillar indicators

Objective of evalation	Dimensions	Indicator
Objective 1 Cost-effectiveness of the intervention	Cost of the action	Cost of project
		Cost of the project not covered by the municipality
		Public funds covered by the municipality
		Cost covered by funds (public or private)
		Opex cost of the project
		Cost of project by m^2
	Revenues from the action	Income
	Return of the investment - profitability	Net Present Value (NPV)
		Internal Rate of Return (IRR)
		Payback
		Return On Investment (ROI)
		Cost of housing (market price)
		Energy consumption reduction cost
		Variation in operation cost (opex cost)
Objective 2 Economic impact of the actions	Economic impact	Expenditure in local economy
		Number of job created
		Impact in business unit
		Number of SME introducing innovations to the market
		Number of large companies introducing innovations to the market
	Social impact	Change in fuel poverty
		Type of job creation (employee qualification required)
	Enviromental impact	CO_2 reduction cost efficiency

These indicators have been defined from CITYKEYS and SCIS as other documents developed by World Bank, OECD, ISCED, EASME, etc. The details of these indicators are included within ANNEX 2 “Description of the project indicators”.

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Two types of indicators have being defined in this pillar: those regarding their relevance and those regarding their availability. This classification precedes the core and complementary tipology which will be introduced in further steps according to the selection performaded by city partners. Nonetheless, we considered that those types of indicators considered relevant, strictly apply to core indicators which relies on project actions scopes and could be easily measured. Furthermore, these indicators cataloged under this category, are crucial for policy makers and investors stakeholders to set up an agenda of investments and prioritize investment portafolios. On the other site, those types of indicators considered available highly depend on complementary information and data to the projects. To this regard, its calculation depends on the capacity of cities to obtain these data.

To sump up, it is important to highlight that the selection and consequently the classification of indicators depends on cities. ESA and technical partners have proposed a first classification based on objective parameters that are often used to evaluate possible investments. In this sense, the priority or categorization in terms of importance compete to partners from cities and specific policy agendas. There could be indicators considered under the availability type that clearly could be of higher importance. To this end, we must mention, as concluded in analysis from D1.6. Key aspects of City's Business Models, that benefits of the actions are greater than the cost of producing them. The interventions cannot be just analysed in moneratity terms, and for this reason the environmental and social benefits must be incorpored in policy decisions.

7.4.2 Assessment plan

7.4.2.1 Existing evaluation methods

According to SCIS recommendations and ESA proposal on business models framework - CANVAS -, it is convenient to evaluate the convenience of investment according to the triple bottom line concept. This means that business models should be composed by budget costs and revenues streams as usual, but also by environmental costs and benefits and socials risks and benefits. This approach is crucial for cities and valid for those actions whose ownership is the Municipallity. To this end, it is about the concept of public value for public bodies as well as should be for the private sector. Under the umbrella of the project, it is supposed that all stakeholders, no matter its tipology, work for a value that addresses citizens and stakeholders concerns, as it could be environmental protection, security and safety matters, social inclusion, energy poverty, equity, quality of life, etc.

From an evaluation point of view, the impact of actions must rely in this holistic approach to demonstrate that benefits clearly overcome costs. From the economic pillar, we work under the hiphotesis that recovey paybacks for investors, no matters its typology, and could be clearly reduced by benefits from all pillars. Obviously, this situation requires the involvement of all stakeholders and the sharing of risks. This fact is what really can lead to scale-up and replicate new business models and finantial schemes.

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7.4.2.2 Evaluation approach

The evaluation approach is basically obtained from primary resources and based on quantitative data. Nonetheless, some indicators obey to subjective evaluations.

Regarding the first objective, cost-effectiveness, the first dimesion - cost of the action – applies for every action. This is a primary source based on quantitative data that the owner of the action must provide. The objective is to quantify the cost of every action as well as to identify the ownership and percentatge covered by different types of cost (public, private, subsidies, etc.). This will allow identifying the total cost as well as the sources of financing. Furthermore, it is proposed to calculate the cost to manage, operate and maintain the actions. This is the sum of total cost to performance the intervention during the project lifetime. For the case of the district and building actions, the project will calculated also the total cost by m^2 to implement the specific actions.

The first objective has a second dimension, income. This indicator, as a primary source based on quantitative data, will reflect income generated by actions. This is the sum of incomes received during the lifetime project because of the implementation of the action. In this sense, we must take into account that many interventions do not generate an income, but many of them generate important savings such retrofitting and mobility actions that impact in the return of the investment.

In this regard, the first object has a third dimesion that clearly reflects this situation exposed above, the return of investment (profitability). To this regard we have proposed classical indicators that investors, no matter its typology, evaluate as criteria to decided wheter or not to implement an action. These indicators are the NPV, IRR, Payback and ROI. Furthermore, we have introduced the variation in opex cost as an important indicator per se as it is crucial for procurement an new business models based on services, as well as energy consumption reduction cost that it is an important saving for the return of the investment. Finally, we believe interesting to evaluate the cost of housing (market price) due to retroffiting because could imply an increase of the value in the case of the residential retroffiting and an incentive for owners.

Regarding the second objective, economic impact of the actions, the first dimesion - economic impact - applies also for all actions although not all will present data for each indicator. For exemple, not all action are a source of job or imply innovations. Regarding the indicators presented, we try to evaluate the contributions of actions to local economy (expenditure), job creation, impact in business units from partners and number of innovations. The second objective has a second dimension, social impact. There are two indicators, a specific one related to residential retrofitting, fuel poverty, and a general one related to the type of job creation. Finally the second objective present a third dimesion, the environmental impact. The proposed indicator regards to the CO_2 reduction cost efficiency.

It is important to remark that these indicators depends on availability and some of them depends on information and data provided by end users such as the case of the change in fuel poverty.

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Despite the aligment between objectives and action, the evaluation approach of interventions aims to group actions under a same type of intervention regarding districts and buildings, mobility, city infrastructures or urban platform. In this regard, as depicted from the DoA, residential retrofitting is a clear example of this situation for every LH. For example, Nantes Métropole retrofitting of individual houses (action 3) involves other actions such as smart thermostats (action 6) and hybrid and PV systems (action 12). In this sense, the evaluation of actions related and interdependent between them could bring a higher impact in the evaluation although we can loss specificity of concrete and smaller actions.

Having said this, the evaluation approach will be tailored according to the actions selected by LH. To this end, it is important to mention, as introduced above, that some dimensions and related indicators could no be quantified in the evaluation and thus will will no be evaluated because of its absense. An example of this situation are revenues from actions. Many actions, such as NTA, do not imply revenues.

The data collection process will be based on structured questionaries giving priority to the first objective, which really collects internal data controlled by the owners of the actions and present key indicators for the selection of investment for scale-ups and replications. Nonetheless, the second objective – economic, social and nviromental impacts - although depends on availability, will be required to merge and combine the information and data collected from indicators in the first objective.

The vast majority of questions refer to numeric variables based on calculations from primary resources directly involved in the actions. Also, there are a few questions based on linkert scales that implies subjective evaluations. The process of collection will be at the end of the implementation. Furthermore, some questions are related to variations and comparisions between t_0 and t_1, for example the energy consumtion reduction cost, variation in opex cost or change in full poverty. In this sense, the data will be obtained for the situation previous to the intervention and after the implementation. The ideal time for such collection between t_0 and t_1 will be on year.

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7.5 Social pillar

The pillar aims to evaluate the social impacts related to the actions implemented in the three LH cities of the project. Whereas scope section describes the objectives to be evaluated after an analysis of the project objectives, assessment plan section introduces the evaluation methods for being used.

7.5.1 Scope

7.5.1.1 Objectives to be evaluated

Through the activities developed in the project in WP1 (Urban Transformation Strategy) and WP8 (Dissemination and Communication), mySMARTLife project intends to achieve specific social objectives in LH cities as part of the strategy to promote the concept of Smart People:

- Fostering citizen engagement in the integrated planning process and in the implementation and deployment of urban initiatives
- Raising social awareness in citizens on sustainable concepts and promoting a change in the consumer behaviour

Furthermore, through the implementation of non-technical project actions in the three LH cities, mySMARTLife aims to accomplish the following objectives under the social perspective:

- Make citizens aware of the benefits of energy efficiency and RES projects
- Facilitate the execution of energy efficiency and RES projects
- Empowering citizens by involving them in the decision-making process

Additionally to these activites, the implementation of demonstrative actions contribute to improve citizens quality of life, promoting change in the consumer behaviour of citizens from lighthouses cities and in special from the citizens affected by the actions, increase the awareness on the benefits of energy efficiency and RES projects and consequently the acceptance on this type of solutions. This acceptance can refer to a positive opinion of the citizens (e.g. people are favourable to investments that can providing better services, produce environmental benefits, etc) or the acceptance on a solution when this affects directly on people' life (e.g. retrofitting of building, use of vehicle working with electricity, etc).

Therefore, it can state that there are two types of actions deployed in the LH cities:

- Project actions implemented in building/district, city infrastructure actions, mobility actions or ICT & urban platform, which directly or indirectly affect citizens in their living environment and consequently citizens develop a satisfaction/non-satisfaction on the solutions implemented.
- Deployed activities (presencial activities or apps) focused in providing information and engage citizens in the execution of projects on energy efficiency and RES and in the decision-making

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process with the aim to increase social acceptance on above project actions and assure their future implementation in the cities.

Consequently, the following objectives of evaluation are proposed to focus the social evaluation of the project.

- O1: Social acceptance related to the technical project actions implemented by evaluating the level of satisfaction and factors that influence in the perception of the target group (i.e. users or citizens affected).
- O2: Assess the range of the target people reached in citizen involvement activities.

Table below displays these social objectives identified for mySMARTLife due to these technical and non-technical actions involved and the proposed objective of evaluation.

Table 7.27: Social objectives of mySMARTLife

mySMARTLife objective	Project actions	Objective of evaluation
• Make citizens aware of the benefits of energy efficiency and RES projects • Facilitate the execution of energy efficiency and RES projects	**Nantes:** *Policy improvement:* Solar Cadaster (A43) *ICT & Urban Platform:* Smart data on mobility (A44) *Citizen engagement:* Support to citizen project of Renewables (A38), Engagement Portal for citizens (A39) **Hamburg:** *Citizen engagement:* A community on the move (A47), Citizens' participation to promote investments (A48) **Helsinki:** *ICT & Urban Platform*: Implementation of "Carbon-Neutral Me" App (A46) *Citizen engagement:* Real-time "Large scale" visualization of the district energy performance (A41)	O2: Taget people reached
• Empowerment of citizens by involvement in the decision-making process	**Helsinki** *Citizen engagement:* Kalasatama Living Lab (A39), Implementing Energy Advisor (A40)	O2: Taget people reached

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• Improving citizens quality of life *(Improved comfort and well-being of its inhabitants (e.g. reduced energy bills)* • Promoting change in the consumer behaviour • Increasing the satisfaction/social acceptance of the project actions implemented	**All cities:** Bulding & District, City infrastructure, Mobility, ICT and Urban Platform	O1: Social acceptance
• Make citizens aware of the benefits of energy efficiency and RES projects	Social campaigns to disseminate the project to overcome the social opposition to the action	O2: Taget people reached

Additionally, specific dimensions to be evaluated have been identified in each objective and will be the main objects of evaluation.

Table 7.28: Dimensions for social evaluation

O1: Social acceptance on project actions	O2: Target people reached in citizen involvement activities
• Satisfaction with the solution from a technical point of view *(e.g. perceived adequateness, perceived benefit (e.g. comfort), perceived usefulness, perceived ease of use, aesthetical solution satisfaction)* • Satisfaction with the solution from an economic point of view *(e.g. cost, risk, benefit)* • Behaviour of change *(e.g. energy consumption behaviour, willingness to invest in energy savings measures or pay more for RES or service, recommend the project to others)* • Influence factors *(e.g. divergence of interest, resistance to change, perception on amount of information received, perception on involvement in decision-making, interviewed profile)*	• Number of target people reached • Range of people reached from diverse social backgrouds

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7.5.1.2 Actions to be evaluated and target groups to focus the evaluation

All project actions described in the introduction of this pillar are potential actions to be measured by the two objectives of the evaluation. However, the project efforts should be used to evaluate those actions that each city considers more relevant or are capable to collect information. Therefore it will be the own partners of the city who decide the actions to be evaluated under this approach according to the possibilities of data collection.

On other hand, two criteria should be considered for such selection for the social acceptance evaluation:

- The most suitable actions are those that are visible for citizens and thus have an effect on their perception.
- It should be interesting that the same type of actions are selected by the three cities in order to identify and explain similarities and differences among different contexts.

Finally, the different target groups on which the social acceptance evaluation could be focused are described below.

Table 7.29: Target groups for social acceptance evaluation

Type of project actions	Project actions	Target group to focus the evaluation
Building & District	Public buildings Private buildings	• Property owners/tenants of new-built or retrofitted houses • Citizens in the neighbourhood
City infrastructure	District Heating Urban RES Public lighting	• Citizens
Mobility	Public/ private vehicles Public/Private charging stations Urban freight, Multimodality, ITS actions	• Passengers/users from public vehicles • Public vehicles drivers • Users from private vehicle • Manager of the company that buys/operate the vehicles
ICT & Urban Platform	ICT solutions	• Users of ICT solutions

7.5.1.3 Selected indicators for the assessment

The two objectives of the social evaluation will each include different indicators. Indicators identified in O1 were selected from the Social Monitoring Guide from SCIS whereas indicators from O2 come from the basis of the indicator sets of CITYKEYS.

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The first objective, the evaluation of the social acceptance, comprises a total of three indicators, which are intended to make statements about the satisfaction of the affected public with the implemented actions. They are related to the dimensions defined for social evaluation.

Table 7.30: Social pillar indicators (social acceptance)

ID	Indicator	Dimensions
S1	Degree of satisfaction *(%, 5 point Likert scale)*	Technical solution satisfaction Economic solution satisfaction
S2	Social factors *(%, 5 point Likert scale)*	Influence factors
S3	Active/pro active citizen's behaviour *(%, 5 point Likert scale)*	Behaviour of change

For the second objective, two indicators have been defined. On the one hand, the first indicator "number of people reached", refers to the estimated total number of people that could be reached within the citizen involvement activities. On the other hand, the second indicator "range of people from diverse social backgrounds" aims to reveal the degree of diversity and inclusiveness regarding people reached in those activities.

Table 7.31: Social pillar indicators (citizens involvement)

ID	Indicator
S4	Number of people reached
S5	Range of people from diverse social backgrouds reached

Concerning the type of indicators (core/complementary), for the case of O1 (social acceptance), the three indicators are relevant for the evaluation whereas for the case of O2 (citizen involvement), it has established that the typology of indicators for S5 and S6 are core and complementary, respectively. However, it has to mention that the relevance of the indicators could be changed with the type of action to be measured.

7.5.1.4 Social acceptance concept

Social acceptance of technological innovations has been a popular research subject since the 1980s and has gained great importance in the last decades, especially the research on acceptance of renewable energy technologies (GAEDE & ROWLANDS, 2018). Studies on social acceptance are generally induced by social opposition and resistance against the expansion of technological innovations, especially of

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renewable energy technologies and corresponding infrastructure and the question how a greater level of public acceptance can be achieved. A wide spread social acceptance is crucial for the successful implementation and operation of renewable energy technologies (EKINS, 2004). So far, there are different popular approaches, concepts and definitions in this field.

DEVINE-WRIGHT (2008) distinguishes three different scales of implementation of renewable energy technologies considering different impacts on the local economy, community and public attitudes:

- micro (at single building or household level)
- meso (at the local, community or town level)
- macro (at the large scale ‘power station’ level)(DEVINGE-WRIGHT, 2008: 7)”.

WUESTENHAGEN et al. (2007) propose a concept breaking social acceptance into the three dimensions: socio-political acceptance, community acceptance, and market acceptance. By considering three dimensions as well as respective sub-dimensions the proposed model is very differentiated and might cover the complexity of social acceptance.

Figure 7.7: The triangle of social acceptance of renewable energy innovation

Reference: *Wuestenhagen et al. 2007*

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7.5.2 Assessment plan

7.5.2.1 Existing evaluation methods

Surveys is the most common method conducted to evaluate social acceptance, existing different methodological ways and approaches in which data for the evaluation of social perception can be gathered:

- A **questionnaire** (online tool, mail, or paper) represents common method for collecting information and attitudes. Even though a questionnaire is a relatively easy approach for gathering large amounts of data, it has also to consider disadvantages, such low return rates, littly flexibility and no control if question are understood in the intended way.
- **Individual interviews** are a suitable approach if questions are only targeted at a few selected key persons. An interview offers the possibility to gather in-deth information with a qualitative character, being an appropriate tool to discover the motivations and attitudes of the interviewees. They are suitable when it is not easy to involve a high number of people in questionnaires or if it is hard to arrange a focus group interview for practical reasons. This type of procedure usually takes about one hour and requires the experience and training of an expert.
- **Focus groups** is a special kind of interview. With this approach, the discussions are in small groups, consisting of different stakeholders which are guided by an expert. In this way, a large amount of qualitative data and different opinions can be gathered. Its development requires the management of an expert in the field and takes about half a day.

From a temporal perspective, the evaluation of social acceptance can be analysed differently. On the one hand, in a longitudinal study, data can be collected over a longer period of time and the development over time can be depicted. This is particularly useful for investigations in which changes are to be expected in a certain period of time. On the other hand, a cross-sectional study can be used to evaluate social acceptance in a certain momentary.

7.5.2.2 Evaluation approach

The approach and methodologies chosen for the social acceptance evaluation of project actions (Objective 1) is based in many respects on the social monitoring guide of the SCIS project. Thus, as the mySMARTLife actions will already be implemented when the evaluation starts, the analysis will not cover the process of implementation but rather a current state. Beside a cross-sectional one time data collection, data could also be gathered in form of a longitude study if seen as suitable. In order to get a valuable opinion of the citizens perspective, it is important that data is collected after citizens have known/used the respective implemented action for a while.

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The way in which data will be collected (interviews, questionnaires or online survey) must be determined for each case depending on the number of people of the target group, the availability of direct contact and the specific social group. The data collection tool will consist of closed questions (yes/no) as well as by questions to be answered with the Likert Scale and open questions. Dimensions identified in the description of the social pillar should be considered to have a common evaluation approach among the three cities but topics to be asked can be adapted to the specific cirquestences. Therefore, this tool will be tailored designed according to the object to be assessed and the target audience, taking as reference a template to be designed firstly. For the process of evaluation, the collected data will be entered into an excel file and analysed by quantitative statistical methods. Social acceptance will be reported in a scale 1-5 for each one of the dimensions evaluated. It is further recommended to report conclusions on social acceptance in relation to the influence factors and behaviour of change.

With regard to the Objective 2 (citizen involvement activities), the evaluation will be focused in measuring the social impacts of project in terms of people reached and to identify, as far as possible, the diverse social backgrounds. Specific conclusions should be reported with the aim to measure the success of the actions implemented.

According to the actions objectives, the evaluation of the success of the actions should be addressed towards the progress in:

- How extent the execution of energy efficiency and RES projects have been facilitated: Nantes (A38, A39, A43, A44), Hamburg (A47, A48), Helsinki (A41, A46)
- How extent the information on energy uses have been achieved by citizens: Nantes (A39, A44), Hamburg (A47), Helsinki (A41, A46)
- How extent the citizens have been involved in the execution of energy efficiency and RES projects (A43)
- How extent the citizens have been empowered by involvement them in the decision-making process: Helsinki (A39, A40)

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7.6 Governance pillar

7.6.1 Scope

7.6.1.1 Actions to be evaluated

This pillar is focused in evaluating the success of the implementation of the next non-technical actions: capacity building activities developed in the project as part of staff exchange activities, policy improvements actions and urban planning. All these actions are shown in table below as they are categorized in the project.

Table 7.32: Summary of the non-technnical actions related to Governance

Type of action/LH	Nantes	Hamburg	Helsinki
Staff Exchange	**A40:** City mentoring strategy **A41: C**ity coaching strategy	**A51:** City mentoring strategy **A52:** City coaching strategy	**A42:** City mentoring strategy **A43:** City coaching strategy
Policy improvement	**A32:** Single window / desk for energy retrofitting	**A37:** Development of structural and economic policies **A38:** Policy implementation **A39:** Evaluation of institutional framework conditions	
Urban planning	**A34:** Advanced urban planning **A37**: Replication plan	**A43:** Advanced urban planning **A46**: Replication plan	**A35:** Advanced urban planning **A38**: Replication plan

7.6.1.2 Objectives to be evaluated

The relevant objectives that mySMARTLife aims with the implementation of previously mentioned NTA have been defined as requisite to determine the objectives of evaluation of the pillar. Thus, the identified objectives of evaluation and the project objectives that take part of Governance pillar are shown in table below.

Table 7.33: Objectives and interventions of governance pillar

mySMARTLife objective	Interventions/Actions	Objectives to be evaluated
Strengthening the scaling up and replication of Smart solutions in participant cities (LH, followers and networks)	NTA: Urban planning	• O1: Satisfaction with urban planning methodology • O2: Participants engaged in urban planning methodology
	NTA: Mentoring and coaching actions	• O3: Satisfaction with coaching/ mentoring activity • O4: Participants engaged in coaching and

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		mentoring activities
Development of new policies and instruments for smart city development	NTA: Policy improvements	• O5: Impact of the project in the strategy of the city

7.6.1.3 Selected indicators for the assessment

In order to evaluate the actions according to the established objectives, six indicators have been defined considering mainly SCIS and CITYKEYS bibliography sources. The table below shows the indicators defined and the types of actions and objectives of evaluation where they are applicable.

Table 7.34: Governance pillar indicators

ID	Indicators	Action category	Objective
Go-1	Perception of satisfaction with urban planning methodology	Urban planning	O1
Go-2	Targeted people reached in urban planning methodology	Urban planning	O2
Go-3	Perception of satisfaction with coaching / mentoring activity	Staff exchange	O3
Go-4	People reached in urban coaching/mentoring activities	Staff exchange	O4
Go-5	New rules / regulations due to the project	Policy improvement	O5
Go-6	Change in rules and regulations	Policy improvement	O5
Go-7	Change in public procurement	Policy improvement	O5

These indicators have not been classified in core or complementary since will depend firstly if they are applicable (e.g. any action in Helsinki is linked to Go-7) as well as the capacity of each city to evaluate each of them.

The details of these indicators are included within ANNEX 2 “Description of the project indicators”.

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7.6.2 Assessment plan

7.6.2.1 Existing evaluation methods

There is no common framework for quantifying indicators related to non-technical actions implemented. However, there are different European initiatives that are useful to know how to measure this type of actions.

This section summarizes the methods found in the bibliographic analysis and that are used as a basis for establishing the evaluation plan of the objectives identified in this pillar.

- SCIS guidelines: Policy and Finance Monitoring Guide.

Since projects are strongly affected by the local regulatory environment and local planning, SCIS has developed this specific guide "Policy and finance monitoring guide". The assessment method described is a tailored questionnaire for projects involving mainly energy efficiency in buildings. This should be filled by the project developers who are asked to provide information on the impacts of the project, barriers and success factors.

- *CITYkeys*

The report “Indicators for smart city projects and smart cities” includes indicators to measure success factors of project actions as prerequisite to replicate/upscale project actions as well as indicators to evaluate the involvement of local government or stakeholders in the advanced urban transformation strategy.

7.6.2.2 Evaluation approach

The evaluation of the objectives defined in this pillar will be done taking as reference the previous initiatives. Thus, the method to measure the indicators proposed in this pillar will be Likert scale questionnaires where the answers obtained will be analysed through statistical tecniques. By this method of measurement, the indicators provide qualitive measures that will be rated on a five-point Likert scale.

The Likert scale is a measurement tool that, unlike yes/no questions, allows us to measure attitudes and know the degree of conformity of the respondent with any statement that we propose. It is especially useful to use it in situations in which we want the person to nuance their opinion. In this sense, the response categories will help us to capture the intensity of the respondent's feelings towards that statement.

A more detailed description of the objectives to be evaluated and the data collection process for each objective of evaluation is detailed below.

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For O1: Satisfaction with urban planning methodology

- Justification: It is important that the urban planning methodology developed within smart city projects supports to the cities in the definition of specific transition models addressing the main city challenges and which are replicable. In this case, it will be evaluated the satisfaction of the methodology developed in the project "Urban Transformation Strategy" for the development of the long term advanced urban planning of the cities.
- Data collection process: The data collection will be done at the end of the project when the urban planning methodology have been already developed and applied. A questionnaire will be designed and distributed among the target audience defined by the city partners (e.g. partners working in the application of the urban planning methodology, stakeholders, policy makers, citizens, etc) so that they can complete it.

For O2: Participants engaged in urban planning methodology

- Justification: It is important that the urban planning methodology developed in the project is well known for the key responsible of the design of the strategy of the city, the main relevant stakeholders in the city and for the citizenship in general. For this reason, it is interesting to know the number of policy makers, stakeholders or citizens that have heard of this methodology or have been engaged.
- Data collection process: The data collection can be done during whole duration of the project and it will be the own city which decides the target audience that takes part of the analysis.

For O3 (Satisfaction with mentoring / coaching activity) and O4 (Participants engaged in coaching and mentoring activities)

- Justification: In the smart city projects, is necessary to guarantee the knowledge transfer between cities allowing them gain experience in order to lead, spread and learn better the solutions, strengthening the scaling up, market deployment and their accompanying business models. Within the mySMARTLife project´s framework different mentoring/coaching sessions are carried out to reach these objectives. The complete information about mentoring/coaching activities is reported within Deliverable 1.11.
- Data collection process: In order to allow the assessment, the data collection will be obtained from the participants of the mentoring/coaching activities during the own realization of such activities.

For O5: Impact of the project in the strategy of the city

- Justification: The implementation of urban actions developed in the smart cities projects is often hampered by existing regulatory frameworks and systems, because such existing rules and regulations are not updated to include the innovation implementations. In this context, the change

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in local rules has an important signalling function which can inspire a new interpretation of the rules in other locations, paving the way for replication of the urban innovation or for similar innovations. Additionally, the public procurement also can be an important driver for innovation actions as procurement procedures are often very precise in detailing all requirements of a project, so a new public procurement procedure, could be more effective for getting the optimal solution.

- Data collection process: The data needed will be derived from desk research and/or through interviews with responsible of actions, the legislative department and/or the department for public procurement within local administration. The data collection will be done at the end of the project once the project actions have finished.

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8. City impact of mySMARTlife project actions

This section deals with the estimation of the overall impact generated in the cities as a result of the implementation of project actions in demoareas.

8.1.1 Scope

The scope is defined by the impacts to quantify and the indicators defined to measure the total effects of project actions in the energy, transport and ICT sector and scaling up at city level with the use of city level indicators evaluated in the city audits performed at the beginning of the project. The purpose of such evaluation is to promote and extend the execution of this type of actions carried out in the project among the stakeholders, making decisions agents and citizens as well as to show to which extent the most important city policy goals have been reached or are within reach.

To identify the impacts to be evaluated at city level, it has merged the main impacts due to the project actions defined in each pillar of the project evaluation framework. Additionally, other potential impacts to be evaluated have been identified.

Table below collects the potential impacts that could be evaluated at city level.

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Table 8.1: mySMARTLife impacts at city level

Type of impact	Impacts	Responsible actions	Project evaluation pillar
Impacts in the environment	Reduction in final energy consumption	• Building / District • City infrastructure • EV and other clean vehicles	• Energy & Environment • Mobility
	Reduction in primary energy consumption	• Building / District • City infrastructure	• Energy & Environment
	Reduction in GHG	• Building / District • City infrastructure • Clean vehicles	• Energy & Environment • Mobility
	Reduction in NO_X and PM 2.5 emissions	• EV and other clean vehicles	• None
	Increase in RES production	• Building / District • City infrastructure • Charging stations • Solar road	• Energy & Environment • Mobility
	Electromobility penetration rate	• EV • Charging stations	• Mobility
Impacts in the economy	Number of jobs created	• All	• Economic
Impacts in the citizens	Number of citizens reached	• All	• Social

Once defined the impacts, a set of indicators has been proposed as well as the formula to calculate them. However, given that the values required evaluating the impacts come from city audits performed that are not comparable among the 3 LH due to the different availability of data, these formulas will be tailored developed by each city. Additionally to complete the scope of the evaluation, it is required to know in advance the actions that will be selected to be evaluated under economic and social approach.

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Table 8.2: mySMARTLife city impacts indicators

Type of impact	Impacts indicators	Formula
Impacts in the environment	Reduction in final energy consumption at city level	City level final energy consumption - Aggregated final energy consumption reductions
	Reduction in primary energy consumption at city level	City level primary energy consumption - Aggregated primary energy consumption reductions
	Reduction of total greenhouse gas emissions at city level	GHG (city audit) – Agregated GHG
	Reduction in NO_X and PM 2.5 emissions	NO_X/PM2.5 (city audit) – NO_x/PM2.5 post-intervention
	Increase in RES production at city level	City level RES - aggregation of values from RES production indicators from all actions
	Number of new e-vehicles	Total e-vehicles in the city - Sum of new e-vehicles *The information should be reported in number and by type of vehicle*
	Number of new charging stations	Total charding stations in the city - Sum of new charging stations. *The information should be reported in number, power and by type (type of vehicle, fast/slow)*
Impacts in the economy	Number of jobs created	Sum of new mySMARTLife related new jobs and its contribution to job creation at city level
Impacts in the citizens	Number of citizens reached	Sum of citizens reached due to project actions

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8.1.2 Assessment plan

8.1.2.1 Existing evaluation methods

SCIS and CITYKEYS focused the evaluation of project actions at city level. Whereas in SCIS, the same indicators are proposed for the different objects of assessment (building, energy supply units, neighbourhood, city), CITYKEYS evaluation framework includes city and project level indicators and establish a relation among these type of indicators which idea is followed by mySMARTLife. Moreover, CITYKEYS provides indicators to support the evaluation of the scalability and replicability potential of SCC solutions.

8.1.2.2 Evaluation approach

Direct impacts will be evaluated by the aggregation of the effects of project actions by the combination of project indicators and corresponding city indicators. Additionally, cities will identify the main goals of city policies and urban planning to evaluate how extend they have been met due to mySMARTLife project actions. Candidate urban planning should be SEAPs/SECAP and SUMP as well as those target policies included as action in the category policy improvements of the project. Thus, actions related to SECAP (*A35 for Nantes, A44 for Hamburg and A36 for Helsinki*), regarding Sustainable Urban Mobility plans (*A36 for Nantes, A45 for Hamburg and A37 for Helsinki)* and related to Policy improvements (*A31 and A32*) could be evaluated under this approach. For the case of Helsinki, the city is interested in knowing to which extent mySMARTLife project contributes towards achieving policy goals such as the key strategic city goal to be carbon neutral by 2035, the RES strategy to find clean energy solutions as replacement for Hanasaari B Coal Plant Decommissioning (A31) and the Smart District-Level Energy RENEISSANCE Strategy (A32) where is studied how contribute to the scalability and replicability of mySMARTLife energy solutions.

The exact selection of demo actions to be included in the assessment in each city and the indicators used for assessing the impact of the project on city level will be further specified at later stages of the project based on the indicator data for project and city indicators.

Last but not least, the scalability and replicability will be at least qualitatively assessed for selected mySMARTLife solutions in WP1 in D1.15.

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9. Conclusions

This report describes the methodological approach and the overall framework for the evaluation of the impacts of mySMARTLife actions in the three LH cities of mySMARTLife project as well as for the performance of city audits of the participant cities.

For the definition of the evaluation approach, an exhaustive list of existing literature, standards and previous SCC projects has been reviewed, taking as main sources the outcomes from CITYkeys project and SCIS. Additionally mySMARTLife concept (Smart People and Smart Economy) and main project pillars (energy, mobility, ICT) have been considered.

As a result, a holistic and twofold scope framework has been designed with the purpose to analyse the benefits of the project actions as well as for evaluating the needs or challenges that a city has to face to be smarter and more sustainable. Additionally, the framework allows monitoring the progress of the city towards smart city goals.

Whereas the assessment of city audits is based in a list of **151 city level indicators** selected, the quantification of project impacts is supported with **128 project level indicators**. Exactly, the assessment indicators defined in this report are split in the following categories:

- City level indicators: 56 energy & environment indicators, 22 mobility indicators, 20 urban infrastructure indicators, 16 economic indicators, 16 citizens indicators and 15 governance indicators.
- Project level indicators: 32 energy & environment indicators, 51 mobility indicators, 11 urban platform & ICT indicators, 22 economic indicators, 5 social indicators and 7 governance indicators.

For the definition of the project evaluation framework, it has followed the following steps: identification of project and project actions objectives, definition of objectives of evaluation and selection of the set of indicators accordingly. Moreover, the project level indicators have been assigned to the project actions implemented in the LH cities according to their applicability, data availabity and relevance.

To evaluate the effectiveness and impacts of mySMARTLife interventions, a pre- and post- intervention comparison will be performed. Therefore, when this is applicable, the indicators defined in this report will be calculated at the following stages and deliverables:

- Calculation of baseline values (D2.18, D3.13, D4.21) before interventions in the three cities.
- Data collection and KPI calculation (D5.4) and impact assessment (D5.5) after the interventions where the effects in the demoarea will be reported but also at city level after calculating the joint

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effects of the actions and estimate the city impact by means of high level indicators that merge project and city level indicators.

Apart of having designed a common evaluation framework for the three LH cities participating in mySMARTLife, further conclusions can be taking after the review of literature and the already use of city level indicators in the realization of city audits.

- CITYkeys indicators and SCIS guides have been used to define the evaluation approach of mySMARTLife project but further existing literature and standards on smart city assessment were required to make possible the evaluation of objectives proposed in mySMARTLife evaluation framework. Additionally, the review of current SCC project evaluation frameworks has been of great help since all these projects face to similar objectives of evaluation.
- An exhaustive work has been performed to identify the most suitable city level indicators. However, some indicators have been added by the partners working in the project to cover the evaluation of some issues. Additionally, it has not been possible to find a set of common indicators to evaluate all the application fields identified in the city level evaluation framework due to the difficulty found by the cities to calculate many of the indicators proposed. The fact of collecting information manually from database in the official sources, the complexity of some required indicators, the non-familiarity of the indicators by the cities and the non-existence of indicators in the literature for measuring some aspects of the city have been identified as the main reasons that explain the lack of information at city level.

Consequently, and taking into both previous statements, mySMARTLife evaluation framework can complement to existing assessment frameworks on smart cities projects. Last but not least, the evaluation procedure can be used beyond mySMARTLife participant cities in order to evaluate the impacts of similar innovative solutions.

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10. Next steps

The present deliverable becomes the main input for remaining WP5 deliverables related to data sets (D5.2), monitoring program (D5.3), data collection (D5.4) and final performance evaluation (D5.5).

On other hand, since the evaluation procedure is complex due to the holistic procedure of assessment defined, it is very convenient to remark how is intended to perform the data collection and evaluation process for each pillar.

- Indicators from energy and mobility pillar will be unpacked in variables in T5.3 in order to design the monitoring program; this is to define the data to be collected, frequency to measure and meters to be installed in buildings, city infrastructure and mobility actions. Two years of monitoring will be established to validate the data obtained from meters that will be stored in urban platform. To fulfill this requirement, it will be established in T5.4 a comprehensive procedure that allows a proper supervision and analysis of data collected. Additionally, indicators and guidelines reported in present document will be the basis to evaluate the baseline and final impacts for energy and mobility pillars that will be reported in D2.18 and D3.13, D4.21 (baseline) and D5.5 (post-intervention).
- Indicators from ICT pillar will be calculated taking into account the own information of the urban platform. Both baseline and post-intervention statues will be included in D5.5 using the snapshot.
- Indicators from social, economic and goveranance will require the development of surveys that will be designed in the D5.4. This deliverable will also provide the requirement of the data collection process and include the calculation of selected indicators whose main conclusions will be reported in D5.5. On other hand, economic pillar will require values from the situation before the implementation of project, whereas indicators from social and goverance do not need this stage.

Finally, it is also required to clarify the two process of evaluation along the project that will make use of indicators defined in the current report: impact assessment of the actions and the calculation of BEST/TEST tables. Latest includes the use of a subset of indicators defined.

Figure below displays how final energy and CO_2 savings achieved and measured with the data monitoring equipement installed in buildings/city infrastructures will be compared with the data estimated in BEST tables in relation to the national regulation or current practices. Thus, this figure shows the evaluation impact following IPMVP protocol and calculation of BEST tables. On other hand, CO_2 savings related to mobility will be compared with data estimated in TEST tables.

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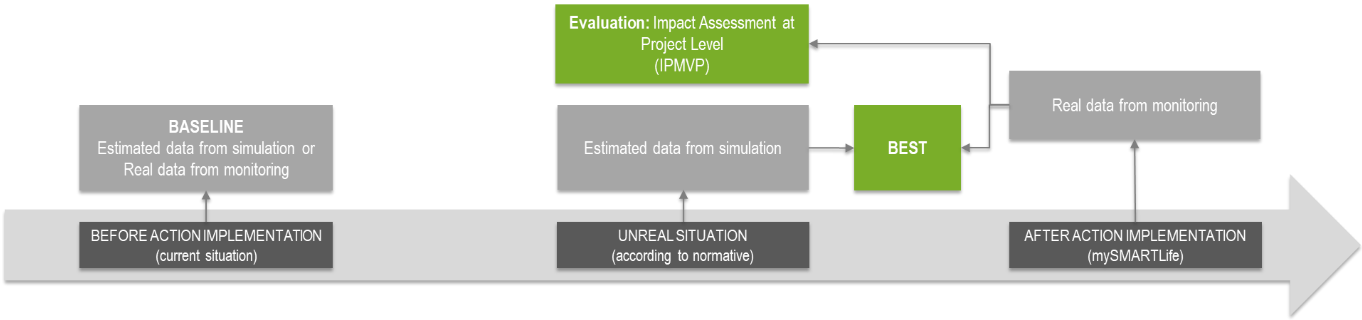

Figure 10.1: BEST tables in mySMARTLife evaluation

Last but not least, impacts evaluated in WP5 can have some connection with results obtained in D1.15 where the most promising interventions to be replicated from each LH will be identified through the application of a priorization method based on impacts evaluation.

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Annex I: City level indicators

The purpose of this Annex is to present a detailed description of the indicators at City Level which help to the involved partners in the the search of the required information to perform the city diagnosis of cities involved in mySMARTLife project as well as other cities. Thus, next pages compile the list of city indicators completely defined, where for every indicator a factsheet is filled, including the following information:

Template for the city level indicator description

Feature	Description
Indicator Name	Name of the indicator
Field	Category according to Evaluation Framework defined in the main text of the document
Application field	Application field according to Evaluation Framework defined in the main text of the document
Description	Definition of the indicator
Source	Reference document or project on which the indicator is based
Calculation	Calculation formula to obtain the indicator
Unit	Indicator unit of measurement
Justification	Include the reason why is required to calculate the indicator
Data source(s)	Possible data sources where needed data should be gathered
Reference period	Period considered to calculate the indicator
Additional notes	Comments or additional considerations about the indicator

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Main city features

C1	Climate Koppen-Geiger classification
Field	Main city features
Application field	Climate
Indicator summary	
Description	Each climate type is represented by letter symbols
Source	REPLICATE
Calculation	The Köppen climate classification scheme divides climates into five main groups (A, B, C, D, E) and subtypes. Each particular climate type is represented by a two- to four-letter symbol.
Unit	
Justification	The energy needs of a city will be according to its type of climate
Indicator requirements	
Data source(s)	See classification scheme in: http://koeppen-geiger.vu-wien.ac.at/pdf/kottek_et_al_2006_A4.pdf
Reference period	
Additional notes	

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C2	Size
Field	Main city features
Application field	Size
Indicator summary	
Description	Land area of the city
Source	
Calculation	
Unit	Km^2
Justification	Main feature of the city
Indicator requirements	
Data source(s)	Data should be gathered from city statistics
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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C3	Population
Field	Main city features
Application field	Population
Indicator summary	
Description	Total number of persons inhabiting a city at a given time
Source	Replicate
Calculation	
Unit	Inhabitants (inh)
Justification	Main feature of the city
Indicator requirements	
Data source(s)	Data should be gathered from city statistics
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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C4	Type of city
Field	Main city features
Application field	Population
Indicator summary	
Description	Typology of the city under study in these categories: metropolitan, urban and suburban
Source	SmartEnCity
Calculation	
Unit	
Justification	It is important to classify the cities in order to summarize its main features. In this case, it has decided to highlight the size of the cities
Indicator requirements	
Data source(s)	Data should be gathered from municipality or from statistic database
Reference period	
Additional notes	- Metropolitan areas are urban areas with more than 500,000 inhabitants - Urban area is a functional economic unit characterised by densely inhabited ‘cities’ with more than 50,000 inhabitants and ‘commuting zones’ whose labour market is highly integrated with nearby cities - Suburban areas correspond with a residential district located on the outskirts of a city and with a population less than 50,000 inhabitants

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C5	Population density
Field	Main city features
Application field	Population
Indicator summary	
Description	Population per unit area in the city
Source	CITYkeys
Calculation	Total number of persons inhabiting a city / Land area of the city
Unit	Inh/Km^2
Justification	Population density is an indicator usually associated with several aspects of sustainable urban development, such as the efficient operation of urban infrastructures, the share of green transport modes, street life, and soil sealing. - Efficient urban infrastructures: The higher the population density is, the easier it is to operate the public transport. But also water, communication and energy infrastructures at low cost. - There is strong statistical evidence for a positive correlation between population density and the share of green transport modes public transport, walking and biking. - A higher urban population is sometimes associated with lively urban streets. - A high population density reduces the footprint of urban development and prevents the development of farm land and natural areas.
Indicator requirements	
Data source(s)	Data should be gathered from city statistics
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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C6	Land use
Field	Main city features
Application field	Land use
Indicator summary	
Description	Number of existing buildings in the city in relation to its surface
Source	SmartEnCity
Calculation	Nº Buildings/Total city surface
Unit	nº buildings/Km^2
Justification	Measure of urban areas density
Indicator requirements	
Data source(s)	Data should be gathered from municipality or from statistical data source
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	The term "building" used by this indicator refers to single structures that are suitable for continuous human occupancy which includes residential, commercial, cultural and institutional buildings.

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Environment

Env 1	Overall CO_2 emission reduction target
Field	Main city features
Application field	CO_2 target
Indicator summary	
Description	The objective of reduction of CO_2 in the cities according to its SEAP
Source	SEAP
Calculation	Self-defined
Unit	%
Justification	This value shows the commitment assumed by the city to protect the environment
Indicator requirements	
Data source(s)	Data should be gathered from the SEAP of the city
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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Env 2	Greenhouse gas emissions per capita
Field	Environment
Application field	City environmental impact in climate
Indicator summary	
Description	CO_2 emissions in tonnes per capita per year
Source	CITYkeys,SEAP
Calculation	The CO_2 emissions shall be measured as the total amount of direct CO_2 emissions in tonnes (equivalent carbon dioxide units) generated over a calendar year by all activities within the city, including indirect emissions outside city boundaries (numerator) divided by the current city population (denominator)
Unit	Tonnes CO_2/inhabitant
Justification	Greenhouse gases (GHGs) are gases in the atmosphere that absorb infrared radiation that would otherwise escape to space; thereby contributing to rising surface temperatures. CO_2 accounts for a major share of GHGs emissions in urban areas The main sources for CO_2 emissions are combustion processes related to energy generation and transport. Tons of CO_2 emissions per capita can therefore considered a useful indicator to assess the contribution of urban development on climate change.
Indicator requirements	
Data source	The CO_2-emissions can be calculated from the energy consumption figures of indicator 'annual final energy consumption', using conversion factors for various forms of energy. Other sources for information on CO_2 emissions can be Sustainable Energy Action Plans (SEAPs), Local Greenhouse Gas Inventories, The municipal statistical department
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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Env 3	Greenhouse gas emissions *(Tertiary)*
Field	Environment
Application field	City environmental impact in climate
Indicator summary	
Description	CO_2 emissions of tertiary sector
Source	SEAP
Calculation	The CO_2 emissions shall be measured as the total amount of direct CO_2 emissions in tonnes (equivalent carbon dioxide units) generated over a calendar year by tertiary sector within the city.
Unit	Mtonnes CO_2
Justification	Greenhouse gases (GHGs) are gases in the atmosphere that absorb infrared radiation that would otherwise escape to space; thereby contributing to rising surface temperatures. CO_2 accounts for a major share of GHGs emissions in urban areas The main sources for CO_2 emissions are combustion processes related to energy generation and transport. Tons of CO_2 emissions can therefore considered a useful indicator to assess the contribution of urban development on climate change.
Indicator requirements	
Data source	The CO_2-emissions can be calculated from the energy consumption figures of indicator 'annual final energy consumption', using conversion factors for various forms of energy. Other sources for information on CO_2 emissions can be Sustainable Energy Action Plans (SEAPs), Local Greenhouse Gas Inventories, The municipal statistical department
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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E4	Greenhouse gas emissions *(Transport)*
Field	Environment
Application field	City environmental impact in climate
Indicator summary	
Description	CO_2 emissions of transport sector
Source	SEAP
Calculation	The CO_2 emissions shall be measured as the total amount of direct CO_2 emissions in tonnes (equivalent carbon dioxide units) generated over a calendar year by transport sector within the city.
Unit	Mtonnes CO_2
Justification	Greenhouse gases (GHGs) are gases in the atmosphere that absorb infrared radiation that would otherwise escape to space; thereby contributing to rising surface temperatures. CO_2 accounts for a major share of GHGs emissions in urban areas. The main sources for CO_2 emissions are combustion processes related to energy generation and transport. Tons of CO_2 emissions can therefore considered a useful indicator to assess the contribution of urban development on climate change.
Indicator requirements	
Data source	The CO_2-emissions can be calculated from the energy consumption figures of indicator 'annual final transport energy consumption', using conversion factors for various forms of energy. Other sources for information on CO_2 emissions can be Sustainable Energy Action Plans (SEAPs), Local Greenhouse Gas Inventories, The municipal statistical department
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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Env 5	Greenhouse gas emissions *(Residential)*
Field	Environment
Application field	City environmental impact in climate
Indicator summary	
Description	CO_2 emissions of residential sector
Source	SEAP
Calculation	The CO_2 emissions shall be measured as the total amount of direct CO_2 emissions in tonnes (equivalent carbon dioxide units) generated over a calendar year by residential sector within the city.
Unit	Mtonnes CO_2
Justification	Greenhouse gases (GHGs) are gases in the atmosphere that absorb infrared radiation that would otherwise escape to space; thereby contributing to rising surface temperatures. CO_2 accounts for a major share of GHGs emissions in urban areas. The main sources for CO_2 emissions are combustion processes related to energy generation and transport. Tons of CO_2 emissions can therefore considered a useful indicator to assess the contribution of urban development on climate change.
Indicator requirements	
Data source	The CO_2-emissions can be calculated from the energy consumption figures of indicator ‘annual final residential energy consumption’, using conversion factors for various forms of energy. Other sources for information on CO_2 emissions can be Sustainable Energy Action Plans (SEAPs), Local Greenhouse Gas Inventories, The municipal statistical department
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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Env 6	Greenhouse gas emissions *(Public lighting)*
Field	Environment
Application field	City environmental impact in climate
Indicator summary	
Description	CO_2 emissions of public lighting sector
Source	SEAP
Calculation	The CO_2 emissions shall be measured as the total amount of direct CO_2 emissions in tonnes (equivalent carbon dioxide units) generated over a calendar year by public lighting within the city.
Unit	Mtonnes CO_2
Justification	Greenhouse gases (GHGs) are gases in the atmosphere that absorb infrared radiation that would otherwise escape to space; thereby contributing to rising surface temperatures. CO_2 accounts for a major share of GHGs emissions in urban areas. The main sources for CO_2 emissions are combustion processes related to energy generation and transport. Tons of CO_2 emissions can therefore considered a useful indicator to assess the contribution of urban development on climate change.
Indicator requirements	
Data source	The CO_2-emissions can be calculated from the energy consumption figures of indicator ‘annual final public lighting energy consumption’, using conversion factors for various forms of energy. Other sources for information on CO_2 emissions can be Sustainable Energy Action Plans (SEAPs), Local Greenhouse Gas Inventories, The municipal statistical department
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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Env 7	**Greenhouse gas emissions *(Municipal)***
Field	Environment
Application field	City environmental impact in climate
Indicator summary	
Description	CO_2 emissions of municipal sector
Source	SEAP
Calculation	The CO_2 emissions shall be measured as the total amount of direct CO_2 emissions in tonnes (equivalent carbon dioxide units) generated over a calendar year by municipal within the city.
Unit	Mtonnes CO_2
Justification	Greenhouse gases (GHGs) are gases in the atmosphere that absorb infrared radiation that would otherwise escape to space; thereby contributing to rising surface temperatures. CO_2 accounts for a major share of GHGs emissions in urban areas. The main sources for CO_2 emissions are combustion processes related to energy generation and transport. Tons of CO_2 emissions can therefore considered a useful indicator to assess the contribution of urban development on climate change.
Indicator requirements	
Data source	The CO_2-emissions can be calculated from the energy consumption figures of indicator ‘annual final municipal energy consumption’, using conversion factors for various forms of energy. Other sources for information on CO_2 emissions can be Sustainable Energy Action Plans (SEAPs), Local Greenhouse Gas Inventories, The municipal statistical department,Energy utility
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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Env 8	Greenhouse gas emissions *(Industry)*
Field	Environment
Application field	City environmental impact in climate
Indicator summary	
Description	CO_2 emissions of industrial sector
Source	SEAP
Calculation	The CO_2 emissions shall be measured as the total amount of direct CO_2 emissions in tonnes (equivalent carbon dioxide units) generated over a calendar year by industrial sector within the city.
Unit	Mtonnes CO_2
Justification	Greenhouse gases (GHGs) are gases in the atmosphere that absorb infrared radiation that would otherwise escape to space; thereby contributing to rising surface temperatures. CO_2 accounts for a major share of GHGs emissions in urban areas. The main sources for CO_2 emissions are combustion processes related to energy generation and transport. Tons of CO_2 emissions can therefore considered a useful indicator to assess the contribution of urban development on climate change.
Indicator requirements	
Data source	The CO_2-emissions can be calculated from the energy consumption figures of indicator 'annual final industriy energy consumption', using conversion factors for various forms of energy. Other sources for information on CO_2 emissions can be Sustainable Energy Action Plans (SEAPs), Local Greenhouse Gas Inventories, The municipal statistical department, energy utility.
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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Env 9	Transports greenhouse gas emissions per capita
Field	Environment
Application field	City environmental impact in climate
Indicator summary	
Description	Measure of the total greenhouse gas emissions per capita due to public and private transport
Source	SEAP
Calculation	The CO_2 emissions shall be measured as the total amount of direct CO_2 emissions in tonnes (equivalent carbon dioxide units) generated over a calendar year by transport sector within the city, (numerator) divided by the current city population (denominator)
Unit	tonnes CO_2/inhabitant
Justification	Greenhouse gases (GHGs) are gases in the atmosphere that absorb infrared radiation that would otherwise escape to space; thereby contributing to rising surface temperatures. CO_2 accounts for a major share of GHGs emissions in urban areas. The main sources for CO_2 emissions are combustion processes related to energy generation and transport. Tons of CO_2 emissions can therefore considered a useful indicator to assess the contribution of urban development on climate change.
Indicator requirements	
Data source	The CO_2-emissions can be calculated from the energy consumption figures of indicator 'annual final transport energy consumption', using conversion factors for various forms of energy. Other sources for information on CO_2 emissions can be Sustainable Energy Action Plans (SEAPs), Local Greenhouse Gas Inventories, The municipal statistical department, energy utility.
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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Env 10	Percentage of renewable energy use in public transport
Field	Environment
Application field	City environmental impact in climate
Indicator summary	
Description	Measure of renewable energy used in public transport
Source	
Calculation	Indicator is calculated as the total amount of energy used in public transport that come from RES sources (numerator) divided by the total energy consumed in public transport (denominator) and multiplied by 100
Unit	%
Justification	Measure of use of the renewable energy in public transport.
Indicator requirements	
Data source	
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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Env 11	Urban heat island
Field	Environment
Application field	City environmental impact in climate
Indicator summary	
Description	Maximum hourly difference in air temperature within the city compared to the contry side during the summer months
Source	CITYkeys
Calculation	Whether there is one or several measurement stations in the built environment, compare the air temperature measurements of these stations with a station outside the city which functions as a reference station, and look for the largest temperature difference (hourly average) during the summer months.
Unit	ºC UHImaz
Justification	The UHI effect is caused by the absorption of sunlight by (stony) materials, the lack of evaporation and the emission of heat caused by human activities. Urban areas in Europe and worldwide are increasingly experiencing the pressures arising from climate change and are projected to face aggravated climate-related impacts in the future
Indicator requirements	
Data source	Operators of weather stations within the city and outside (eg. Meteorological institute, research organisations, weather amateurs)
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	Whether there is one or several measurement stations in the built environment, compare the air temperature measurements of these stations with a station outside the city which functions as a reference station, and look for the largest temperature difference (hourly average) during the summer months

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Env 12	NO_x emissions
Field	Environment
Application field	Air pollution
Indicator summary	
Description	Annual nitrogen oxide emissions (NO and NO_2) per capita
Source	CITYkeys
Calculation	Indicator is calculated as the total amount of NO_2 emission generated in a city during a year (numerator) divided by the total population in the city (denominator)
Unit	g/inhabitant
Justification	Nitrogen oxides (NO and NO2) are major air pollutants, which can have significant impacts on human health and the environment. NO contributes to ozone layer depletion and, when exposed to oxygen, can transform into NO_2. NO_2 contributes to the formation of photochemical smog and at raised levels can increase the likelihood of respiratory problems. NO_2 chemically transforms into nitric acid and contributes to acid rain. Nitrogen dioxide is part of the exhaust gases of motor vehicles, but also emanates from other combustion processes, related e.g to domestic heating and industrial processes.
Indicator requirements	
Data source	Environmental department/service; City emission registration. Hourly average concentrations are measured by monitoring equipment and reported to Air Quality monitoring authority (i.e.,City Environment Office, National Environment Office, etc.).
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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Env 13	PM 2.5 emissions
Field	Environment
Application field	Air pollution
Indicator summary	
Description	Annual particulate matter emissions (PM 2,5) per capita
Source	CITYkeys
Calculation	Indicator is calculated as the total amount of PM2.5 emsission generated in a city during a year (numerator) divided by the total population in the city (denominator)
Unit	g/inhabitant
Justification	Measurements of fine particles PM2.5 and PM10 serve as indicators of air quality, being PM2.5 more dangerous for the health of persons. Fine particulate matter can cause major health problems in cities. The range of health effects is broad, but are predominantly to the respiratory and cardiovascular systems. Chronic exposure leads to a number of health risks. On average, traffic is the biggest source of air pollution, responsible for one quarter of particulate matter in the air.
Indicator requirements	
Data source	Concentrations are measured by monitoring equipment and reported to Air Quality monitoring authority (i.e., City Environment Office, National Environment Office, etc.).
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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Env 14	Air quality index
Field	Environment
Application field	Air pollution
Indicator summary	
Description	Air quality is expressed in the concentration of major air pollutants. At this moment from a human health perspective most important are particulates (PM10, PM2,5), NO_2 (as indicator of traffic related air pollution) and ozone (important for summer smog). Different indexes are found in a European initiative to make possible the comparison among cities (http://www.airqualitynow.eu/index.php): roadside index, background index and city index.
Source	CITYkeys
Calculation	http://www.airqualitynow.eu/index.php The overall city index is the average of the sub-indices for NO2, PM10 (both year average and the number of days >=50 µg/m3 sub-index) and ozone for the city background index. For the traffic year average index the averages of the sub-indices for NO2 and PM10 (both) are being used. The other pollutants (including PM2.5) are used in the presentation of the city index if data are available, but do not enter the calculation of the city average index. They are treated as additional pollutants like in the hourly and daily indices. The main reason is that not every city is monitoring this full range of pollutants.
Unit	Index
Justification	For the EU, the CiteAir project has defined hourly, daily and yearly indices to express in one figure air quality. (http://www.airqualitynow.eu/index.php). For this indicator we use the year average air quality index. It is a distance to target indicator that provides a relative measure of the annual average air quality in relation to the European limit values (annual air quality standards and objectives from EU directives). If the index is higher than 1: for one or more pollutants the limit values are not met. If the index is below 1: on average the limit values are met.

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Indicator requirements	
Data source	Concentrations are measured by monitoring equipment and reported to Air Quality monitoring authority (i.e., City Environment Office, National Environment Office, etc.).
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	Many cities use a local or national variant of an air quality index, which can replace this indicator (but loosing EU comparability).

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Env 15	Exposure to noise pollution
Field	Environment
Application field	Noise pollution
Indicator summary	
Description	Share of the population affected by noise >55 dB(a) at night time
Source	CITYkeys, U4SCC
Calculation	Noise pollution shall be calculated by mapping the noise level at night (Ln) likely to cause annoyance as given in ISO 1996-2:1987, identifying the areas of the city where Ln is greater than 55 dB(A) and estimating the population of those areas as a percentage of the total city population. The result shall be expressed as the percentage of the population affected by noise pollution.
Unit	% of people
Justification	Prolonged exposure to noise can lead to significant health effects, both physical and mental
Indicator requirements	
Data source	Average concentrations are measured by monitoring equipment and reported to Air Quality monitoring authority (i.e., City Environment Office, National Environment Office, etc.)
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	Noise pollution shall be calculated by mapping the noise level at night (Ln) likely to cause annoyance as given in ISO 1996-2:1987, identifying the areas of the city where Ln is greater than 55 dB(A) and estimating the population of those areas as a percentage of the total city population.

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Env 16	Water consumption per capita
Field	Environment
Application field	Water resources
Indicator summary	
Description	Total water consumption per capita per day
Source	CITYkeys, U4SCC
Calculation	City's total water consumption / total population
Unit	l/inhabitant/day
Justification	The main driver for water consumption indicator is the increased concern of water scarcity and decreased water quality.
Indicator requirements	
Data source	This information should be obtained from the main water supply companies, which maintain record on water supplied, delivered, consumed and ultimately paid by the end-users. The urban audit database also contains information on the 'Total use of water'. This information should be obtained from the main water supply companies, which maintain record on water supplied, delivered, consumed and ultimately paid by the end-users. The urban audit database also contains information on the 'Total use of water'.
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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Env 17	Water re-used (rain/grey water)
Field	Environment
Application field	Water resources
Indicator summary	
Description	Percentage of houses equipped to reuse grey and rain water
Source	CITYkeys
Calculation	[(houses with grey and rain water reuse capability)/(total number of houses)] x 100
Unit	% of house
Justification	Grey water and rainwater use may be an important aid to significantly decrease the domestic water consumption. The published literatures indicate that the typical volume of grey water varies from 90 to 120 l/p/d depending on lifestyles, living standards and other issues.
Indicator requirements	
Data source	Records of building permission authorities or surveys among households
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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Env 18	Amount of solid waste collected
Field	Environment
Application field	Waste
Indicator summary	
Description	The amount of municipal solid waste generated per capita annually
Source	CITYkeys
Calculation	Annual amount of genererated municipal solid waste/total population
Unit	Tonnes/inhabitant
Justification	The proper discharge, transportation and treatment of solid waste is one of the most important components of life in a city and one of the first areas in which governments and institutions should focus.
Indicator requirements	
Data source	Environmental department, department responsible for waste collection. The urban audit database contains information on ‘municipal waste generated (domestic and commercial)’.
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	The municipal solid refers to households and commercial waste. The definition shall exclude: - waste from municipal sewage network and treatment; - municipal construction and demolition waste

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Env 19	**Recycling rate**
Field	Environment
Application field	Waste
Indicator summary	
Description	Percentage of city's solid waste that is recycled
Source	CITYkeys
Calculation	[(total amount of the city's solid waste that is recycled in tonnes) / (total amount of solid waste produced in the city in tonnes)] x100
Unit	% tonnes
Justification	Many cities generate more solid waste than they can dispose of. Even when municipal budgets are adequate for collection, the safe disposal of collected waste often remains a problem. Diverting recyclable materials from the waste stream is one strategy for addressing this municipal issue. Higher levels of municipal waste contribute to greater environmental problems and therefore levels of collection, and also methods of disposal, of municipal solid waste are an important component of municipal environmental management. Solid waste systems contribute in many ways to public health, the local economy, the environment, and the social understanding and education about the latter. A proper solid waste system can foster recycling practices that maximize the life cycle of landfills and create recycling microeconomies; and it provides alternative sources of energy that help reduce the consumption of electricity and/or petroleum based fuels
Indicator requirements	
Data source	This information should be obtained from municipal bodies, public services and major private contractors dealing with solid waste collection and disposal. Data may be obtained from specific studies carried out on solid waste for specific projects.
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	Hazardous waste that is produced in the city and is recycled shall be reported separately.

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Env 20	Land consumption
Field	Environment
Application field	Land consumption
Indicator summary	
Description	Proportion of city land occupied by permanent structures
Source	SmartEnCity
Calculation	[Total built surface/Total city surface] x100
Unit	%
Justification	This describes the saturation of land use
Indicator requirements	
Data source(s)	Data should be gathered from municipality or from statistical data source
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	This indicator covers buildings for tertiary sector but also factories that are in urban areas

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Env 21	Brownfield use
Field	Environment
Application field	Land consumption
Indicator summary	
Description	Share of brownfield are that has been redeveloped in the past period as percentage of total brownfield area
Source	CITYkeys
Calculation	(Brownfield area redeveloped in the last year/total brownfield area in the city) x 100
Unit	% of km^2
Justification	Many brownfields are contaminated as a result of previous industrial or commercial uses. The European Environment Agency (EEA) has estimated that there are as many as three million brownfield sites across Europe, often located and well connected within urban boundaries and as such offering a competitive alternative to greenfield investments. Brownfield remediation and regeneration represents a valuable opportunity, not only to prevent the loss of pristine countryside and reduce ground sealing, but also to enhance urban spaces and remediate the sometimes contaminated soils.
Indicator requirements	
Data source	City statistics
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	Brownfield is a term used in urban planning to describe “land which is or was occupied by a permanent structure, including the curtilage of the developed land and any associated fixed surface infrastructure.

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Env 22	Compactness
Field	Environment
Application field	Land consumption
Indicator summary	
Description	It is the relation between the usable space of the buildings and the urban space
Source	REMOURBAN
Calculation	Σ Building volume/ Σ Urban area
Unit	meters
Justification	This indicator expresses the idea of urban proximity, increasing the contact and interchange possibilities. It also optimises the management of one of the most important natural resources, land. Despite this, an excessive level of compactness is not necessarily beneficial so the provision of public areas for pedestrians, green spaces, squares and sidewalks should be also considered to evaluate urban space.
Indicator requirements	
Data source	From city statistics. From the raw digital cadastral data, extract the parcels that do not correspond to buildings (still not included in the urban consolidated area, technical and communications infrastructure, parks and green zones…). For each building, estimate the usable space (volume) multiplying the number of floors of each polygon by an agreed constant that represents the height per floor (for example, 3 meters). Finally, calculate the sum of the whole building volume and the whole urban area that are necessary to apply the formula.
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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Env 23	Local food production
Field	Environment
Application field	Carbon footprint
Indicator summary	
Description	Share of food consumption produced within a radius of 100 km
Source	CITYkeys
Calculation	(Food produced in 100 km radius / Total food demand within city) x 100
Unit	% of tonnes
Justification	Local food production increases self-reliant and resilient food networks, enhances local economies by connecting food producers and food consumers in the same geographic region. It can reduce the carbon footprint of the urban areas by reducing energy demand of transport, stimulate the local economy, and improve citizen participation and social cohesion in the city, and stimulate the local economy
Indicator requirements	
Data source	*Food production:* Crop statistics and animal populations at NUTS2 level (Eurostat, 2015) *Food consumption:* The yearly intake in Europe was 770 kg per person in 2000 (EEA,2005). The food demand can then be calculated by multiplying the number of citizens with 770 kg.
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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Energy

Ene 1	**Final Energy Consumption per capita**
Field	Energy
Application field	City energy profile
Indicator summary	
Description	The final energy consumption is the energy actually consumed by the end user (municipal, tertiary sector, residential sector, public lighting, industry, transport)
Source	SEAP, SCIS, CITYkeys
Calculation	Total final energy consumption (residential, tertiary, etc) divided by city population and multiplied by 100
Unit	MWh/inhabitant
Justification	Reducing the energy consumption also reduces greenhouse gas emissions and the ecological footprint, which contribute to combating climate change and achieve a low carbon economy
Indicator requirements	
Data source	Data should be gathered from city's statistics
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	This indicator shall assess the final energy consumption of the city taking into account all forms of energy (e.g. electricity, gas, heat/cold, fuels) and for all functions (transport, buildings, ICT, industry, etc.). This in contrast with primary energy use, the energy forms found in nature (e.g. coal, oil and gas) which have to be converted (with subsequent losses) to useable forms of energy, a more common indicator for evaluating energy consumption. When moving towards a renewable energy system, however, measuring the primary energy consumption loses its value. A reduction in primary energy consumption, for example by increasing the production of renewable energy, does not directly lead to a reduction in final energy consumption.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 731297.

Ene 2	Final Energy Consumption *(Transport)*
Field	Energy
Application field	City energy profile
Indicator summary	
Description	Annual final energy consumption of transport of all types
Source	SEAP, SCIS, CITYKeys
Calculation	Total final transport energy consumption per year
Unit	TWh
Justification	Contibution of the city transport activity into climate change and air quality
Indicator requirements	
Data source	Data should be gathered from city's statistics
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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Ene 3	Final Energy Consumption *(Municipal)*
Field	Energy
Application field	City energy profile
Indicator summary	
Description	Annual final energy consumption of buildings and municipality facilities
Source	SEAP
Calculation	Total final energy consumption by municipal facilities per year
Unit	TWh
Justification	This indicator aims to have a reference on how extent the municipality can have control for implementing proper measures that help to reduce the amount of energy consumed in the city
Indicator requirements	
Data source	Data should be gathered from city's statistics
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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Ene 4	Final Energy Consumption *(Tertiary)*
Field	Energy
Application field	City energy profile
Indicator summary	
Description	Annual final energy consumption of tertiary sector of the city
Source	SEAP, SCIS
Calculation	Total final energy consumption by tertiary sector per year
Unit	TWh
Justification	Contibution of the city tertiary activity into climate change and air quality
Indicator requirements	
Data source	Data should be gathered from city's statistics
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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Ene 5	Final Energy Consumption *(Residential)*
Field	Energy
Application field	City energy profile
Indicator summary	
Description	Annual final energy consumption of residential sector of the city
Source	SEAP, SCIS
Calculation	Total final energy consumption by residential sector per year
Unit	TWh
Justification	Contibution of the city residential activity into climate change and air quality
Indicator requirements	
Data source	Data should be gathered from city's statistics
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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Ene 6	**Final Energy Consumption *(Public lighting)***
Field	Energy
Application field	City energy profile
Indicator summary	
Description	Annual final energy consumption of public lighting of the city
Source	SEAP, SCIS
Calculation	Total final energy consumption by public lighting per year
Unit	TWh
Justification	Contibution of the public liginting into climate change and air quality
Indicator requirements	
Data source	Data should be gathered from city's statistics
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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Ene 7	Final Energy Consumption *(Industry)*
Field	Energy
Application field	City energy profile
Indicator summary	
Description	Annual final energy consumption of the industrial sector of the city
Source	SEAP, SCIS
Calculation	Total final energy consumption by industrial sector per year
Unit	TWh
Justification	Contibution of the city industry activity into climate change and air quality
Indicator requirements	
Data source	Data should be gathered from city's statistics
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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Ene 8	Final Energy Consumption *(Electricity)*
Field	Energy
Application field	City energy profile
Indicator summary	
Description	Annual final energy electricity consumption of the city
Source	SEAP, SCIS
Calculation	Total final electricity energy consumption of all sector per year
Unit	TWh
Justification	Contibution of the electricity consumption in the city into climate change and air quality
Indicator requirements	
Data source	Data should be gathered from city's statistics
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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Ene 9	**Final Energy Consumption *(Heat /Cold)***
Field	Energy
Application field	City energy profile
Indicator summary	
Description	Annual final energy consumption to heat and cold uses of the city
Source	SEAP, SCIS
Calculation	Total final energy consumption (thermal and electricty) to heat and cold pear year
Unit	TWh
Justification	Contibution of the energy consumption for thermal uses in the city into climate change and air quality
Indicator requirements	
Data source	Data should be gathered from city’s statistics
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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Ene 10	Final Energy Consumption *(Fossil fuels)*
Field	Energy
Application field	City energy profile
Indicator summary	
Description	Annual final energy consumption from fossil fuels in the city
Source	SEAP, SCIS
Calculation	Total final energy consumption from fossil source pear year
Unit	TWh
Justification	Contibution of the energy consumption with fossil fuels in the city into climate change and air quality
Indicator requirements	
Data source	Data should be gathered from city's statistics
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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Ene 11	**Final Energy Consumption *(Renewable energies)***
Field	Energy
Application field	City energy profile
Indicator summary	
Description	Annual final energy consumption from renewable sources
Source	SEAP, SCIS
Calculation	Total final energy consumption from renewable source pear year
Unit	TWh
Justification	Contibution of the energy consumption with renewables in the city into climate change and air quality
Indicator requirements	
Data source	Data should be gathered from city's statistics
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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Ene 12	Total buildings energy consumption per capita
Field	Energy
Application field	City energy profile
Indicator summary	
Description	Annual final consumption in the existing buildings of the city for heating and electricity uses. Buildings refer to public and private buildings for residential and tertiary uses
Source	SEAP, SCIS. Smartencity
Calculation	(Total energy use/Total city population) x 100
Unit	GWh/inhab
Justification	Contibution of the energy consumption in the buildings of a city into climate change and air quality
Indicator requirements	
Data source	Data should be gathered from city's statistics
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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Ene 13	**Primary energy consumption in the city per year**
Field	Energy
Application field	City energy profile
Indicator summary	
Description	Total primary energy consumption (electricity and thermal) of the city to residential and non -residential
Source	SmartenCity
Calculation	(Total electrical energy consumption x Primary national electrical factor)+(Total thermal energy consumption x Primary national energy factor)
Unit	GWh
Justification	Reducing the energy consumption also reduces greenhouse gas emissions and the ecological footprint, which contribute to combating climate change and achieve a low carbon economy
Indicator requirements	
Data source	Data should be gathered from city’s statistics
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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Ene 14	Primary energy consumption per capita
Field	Energy
Application field	City energy profile
Indicator summary	
Description	Total primary energy consumption (electricity and thermal) of the city to Residential and non -residential
Source	
Calculation	[(Total electrical energy consumption * Primary national electrical factor)+(Total thermal energy consumption *Primary national energy factor)]/Total city population
Unit	MWh/inhabitant
Justification	Reducing the energy consumption also reduces greenhouse gas emissions and the ecological footprint, which contribute to combating climate change and achieve a low carbon economy
Indicator requirements	
Data source	Data should be gathered from city's statistics
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	Primary energy factors used with reference to source and year should be accompanied with the assessment

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Ene 15	Primary energy consumption *(Transport)*
Field	Energy
Application field	City energy profile
Indicator summary	
Description	Total primary energy consumption in transport sector of the city
Source	SEAPs
Calculation	Transport final energy consumption * Primary energy factor
Unit	TWh
Justification	Reducing the energy consumption comming from fossil fuels in the transport sector also reduce the greenhouse gas emissions which contribute to combating climate change
Indicator requirements	
Data source	Data should be gathered from city's statistics
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	Primary energy factors used with reference to source and year should be accompanied with the assessment

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Ene 16	Primary energy consumption *(Municipal)*
Field	Energy
Application field	City energy profile
Indicator summary	
Description	Total primary energy consumption in the municipal sector of the city
Source	SEAPs
Calculation	Municipal final energy consumption * Primary energy factor
Unit	TWh
Justification	Reducing the energy consumption comming from fossil fuels in the municipal sector also reduce the greenhouse gas emissions which contribute to combating climate change
Indicator requirements	
Data source	Data should be gathered from city’s statistics
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	Primary energy factors used with reference to source and year should be accompanied with the assessment

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Ene 17	Primary energy consumption *(Tertiary)*
Field	Energy
Application field	City energy profile
Indicator summary	
Description	Total primary energy consumption in the tertiary sector of the city
Source	SEAPs
Calculation	Tertiary final energy consumption * Primary energy factor
Unit	TWh
Justification	Reducing the energy consumption comming from fossil fuels in the tertiary sector also reduce the greenhouse gas emissions which contribute to combating climate change
Indicator requirements	
Data source	Data should be gathered from city's statistics
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	Primary energy factors used with reference to source and year should be accompanied with the assessment

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Ene 18	Primary energy consumption *(Residential)*
Field	Energy
Application field	City energy profile
Indicator summary	
Description	Total primary energy consumption in the residential sector of the city
Source	SEAPs
Calculation	Residential final energy consumption * Primary energy factor
Unit	TWh
Justification	Reducing the energy consumption comming from fossil fuels in the residential sector also reduce the greenhouse gas emissions which contribute to combating climate change
Indicator requirements	
Data source	Data should be gathered from city's statistics
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	Primary energy factors used with reference to source and year should be accompanied with the assessment

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Ene 19	Primary energy consumption *(Public lighting)*
Field	Energy
Application field	City energy profile
Indicator summary	
Description	Total primary energy consumption in the public lighting sector of the city
Source	SEAPs
Calculation	Public lighting final energy consumption * Primary energy factor
Unit	TWh
Justification	Reducing the energy consumption comming from fossil fuels in the public lighting also reduce the greenhouse gas emissions which contribute to combating climate change
Indicator requirements	
Data source	Data should be gathered from city's statistics
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	Primary energy factors used with reference to source and year should be accompanied with the assessment

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Ene 20	**Primary energy consumption *(Industry)***
Field	Energy
Application field	City energy profile
Indicator summary	
Description	Total primary energy consumption in the industry sector of the city
Source	SEAPs
Calculation	Industry sector final energy consumption * Primary energy factor
Unit	TWh
Justification	Reducing the energy consumption comming from fossil fuels in the industry sector also reduce the greenhouse gas emissions which contribute to combating climate change
Indicator requirements	
Data source	Data should be gathered from city's statistics
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	Primary energy factors used with reference to source and year should be accompanied with the assessment

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Ene 21	Primary energy consumption *(Electricity)*
Field	Energy
Application field	City energy profile
Indicator summary	
Description	Total primary energy consumption from electricy in all sectors of the city
Source	SEAPs
Calculation	Electrical final energy consumption * Electrical Primary energy factor
Unit	TWh
Justification	Contibution of the electricity consumption coming from fossil fuels contribute to combating climate change
Indicator requirements	
Data source	Data should be gathered from city's statistics
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	Primary energy factors used with reference to source and year should be accompanied with the assessment

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Ene 22	Share of local energy production to overall final energy consumption
Field	Energy
Application field	Renewable energies
Indicator summary	
Description	Total energy generated in the city from RES that is used to cover the energy demand of the city in all their uses
Source	N/A
Calculation	(RES energy production / City energy consumption) x 100
Unit	%
Justification	To know how extent the municipality is able to cover the needs of the city with local energy
Indicator requirements	
Data source	Data should be gathered from city's statistics
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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Ene 23	Renewable energy generated within the city
Field	Energy characterization
Application field	Renewable energies
Indicator summary	
Description	Total energy generated in the city from RES
Source	SEAP, SCIS, REPLICATE
Calculation	RES energy production (thermal + electrical) for all uses (heat, cold, electricity) / City energy consumption) x 100
Unit	%
Justification	To know how extent the municipality is able to produce energy from RES sources
Indicator requirements	
Data source	Data should be gathered from city's statistics
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	Renewable sources include geothermal, solar, wind, hydro, wave energy, and biomass

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Ene 24	Non – RES Heat/Cold production
Field	Energy characterization
Application field	Renewable energies
Indicator summary	
Description	Total energy generated in the city from fossil fuels that is used to cover the energy demand of the city in heat/cold
Source	SEAP, SCIS
Calculation	Non-RES energy production/City heat and cold demand
Unit	TWh
Justification	To know how extent the municipality is able to produce energy from fossil fuels for heat/cold uses
Indicator requirements	
Data source	Data should be gathered from city’s statistics
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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Ene 25	RES Heat/Cold production
Field	Energy characterization
Application field	Renewable energies
Indicator summary	
Description	Total energy generated in the city from RES that is used to cover the energy demand of the city in heat/cold
Source	SEAP, SCIS
Calculation	RES energy production/City heat and cold demand
Unit	TWh
Justification	To know how extent the municipality is able to produce energy from RES sources for heat/cold uses
Indicator requirements	
Data source	Data should be gathered from city's statistics
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	Renewable sources include geothermal, solar, wind, hydro, wave energy, and biomass

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Ene 26	Non – RES electricity production
Field	Energy characterization
Application field	Renewable energies
Indicator summary	
Description	Total energy generated in the city from fossil fuels that is used to cover the energy demand of the city in electricity
Source	SEAP, SCIS
Calculation	Non-RES energy production/Electricity demand
Unit	TWh
Justification	To know how extent the municipality is able to produce energy from fossil fuels for electrical uses
Indicator requirements	
Data source	Data should be gathered from city's statistics
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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Ene 27	RES electricity production
Field	Energy characterization
Application field	Renewable energies
Indicator summary	
Description	Total electricity generated in the city from RES
Source	SEAP, SCIS
Calculation	RES energy production/Electricity demand
Unit	TWh
Justification	To know how extent the municipality is able to produce energy from fossil fuels for heat/cold uses
Indicator requirements	
Data source	Data should be gathered from city's statistics
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	Renewable sources include geothermal, solar, wind, hydro, wave energy, and biomass

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Ene 28	Renewable energy per carrier
Field	Energy characterization
Application field	Renewable energies
Indicator summary	
Description	Energy generated in the city from each type of RES sources
Source	SEAP, SCIS
Calculation	RES energy production by each type of RES sources (geothermal, biomass, solar, wind, hydro and wave) and by each type of use (thermal, electrical)
Unit	GWh
Justification	To know how extent the municipality is able to produce energy from each type of RES sources
Indicator requirements	
Data source	Data should be gathered from city's statistics
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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Ene 29	Percentage of renewable energy
Field	Energy characterization
Application field	Renewable energies
Indicator summary	
Description	Percentage of renewable energy consumed in the city (produced or not in the city)
Source	SEAP, SCIS, U4SCC
Calculation	Total final energy consumption in the city that come from RES divided by total energy consumption in the city and multiplied by 100
Unit	%
Justification	To know how extent the energy consumed in the city come from RES sources
Indicator requirements	
Data source	Data should be gathered from city's statistics
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	Renewable sources include geothermal, solar, wind, hydro, wave energy, and biomass

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Ene 30	Green electricity purchased
Field	Energy characterization
Application field	Renewable energies
Indicator summary	
Description	The percentage of green electricity purchased, as a share of the city's total electricity consumption
Source	REPLICATE
Calculation	(Total electricity purchased / total electricity consumed in the city) x 100
Unit	%
Justification	To know how extent the municipality needs to import energy to cover the electricity needs of the city and how extent this energy come from RES sources
Indicator requirements	
Data source	Data should be gathered from city's statistics
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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Ene 31	Smart energy meters
Category core	Energy characterization
Application field	Smart buildings
Indicator summary	
Description	The percentage of buildings in the city with smart meters
Source	REPLICATE
Calculation	(Number of buildings that have installed energy meters / total number of buildings in the city) x 100
Unit	% of buildings
Justification	Efficient solution that allows to monitor the energy consumption along the year and consequently to apply specific measures to reduce the energy consumption
Indicator requirements	
Data source	
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	It could be distinguished for electric and heat networks

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Ene 32	**Number of connections to a district heating network**
Field	Energy characterization
Application field	Smart buildings
Indicator summary	
Description	Number of buildings connected to district heating network of the city
Source	REPLICATE
Calculation	(Total number of buildings connected to a DH/ totalnumber of buildings in the city) x 100
Unit	% of buildings
Justification	Efficient solution to reduce the energy consumption and consequently green house gases
Indicator requirements	
Data source	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Reference period	
Additional notes	

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Ene 33	**Buildings with green/sustainable certificate (LEED, BREEAM, etc)**
Field	Energy characterization
Application field	Energy performance of buildings
Indicator summary	
Description	Percentage of total buildings with green/sustainable certificate (LEED, BREEAM, etc)
Source	CITyFiED
Calculation	(Number of buildings with green/sustainable certificates/Total number of buildings in the city) x 100
Unit	%
Justification	Solution found to reduce the energy consumption in the existing buildings
Indicator requirements	
Data source	Municipality
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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Mobility

Mo 1	Modal split: use of private motor vehicle
Field	Mobility
Application field	Mobility city profile
Indicator summary	
Description	Percentage of trips made in the city using a private motor vehicle as type of transportation
Source	SCIS, REMOURBAN, REPLICATE
Calculation	Share of private motor vehicle as type of transportation in the total trips in the city
Unit	%
Justification	This indicator allows to know how citizens travel in the city
Indicator requirements	
Data source	City statistics
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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Mo 2	Modal split: Walk
Field	Mobility
Application field	Mobility city profile
Indicator summary	
Description	Percentage of trips in the city made walking as type of transportation
Source	SCIS, REMOURBAN, REPLICATE
Calculation	Share of walking as type of transportation in the total trips in the city
Unit	%
Justification	This indicator allows to know how citizens travel in the city
Indicator requirements	
Data source	City statistics
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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Mo 3	Modal split: Bike
Field	Mobility
Application field	Mobility city profile
Indicator summary	
Description	Percentage of trips made in the city using a bike as type of transportation
Source	SCIS, REMOURBAN, REPLICATE
Calculation	Share of bikes as type of transportation in the total trips in the city
Unit	%
Justification	This indicator allows to know how citizens travel in the city
Indicator requirements	
Data source	City statistics
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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Mo 4	Modal split: Passenger Transport
Field	Mobility
Application field	Mobility city profile
Indicator summary	
Description	Percentage of trips made in the city using a passenger transport as type of transportation
Source	SCIS, REMOURBAN, REPLICATE
Calculation	Share of passenger transport as type of transportation in the total trips in the city
Unit	%
Justification	This indicator allows to know how citizens travel in the city
Indicator requirements	
Data source	City statistics
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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Mo 5	Number of fossil fuelled four wheels vehicles per capita
Field	Mobility
Application field	Mobility city profile
Indicator summary	
Description	Number of fossil fuelled vehicles (four wheels) of the city per capita
Source	SCIS
Calculation	Number of fossil fuelled vehicles (four wheels) of the city distinguishing by type (public and private) and divided by the population
Unit	#/cap
Justification	This indicator reflects the penetration of fossil fuel vehicles in the city and therefore the difficulty to engage citizens in the use of public transport or sharing vehicles. In addition, this can reflect the figure of traffic congestion of the city and the requirement for further transport facilities.
Indicator requirements	
Data source	Data should be gathered from city's statistic
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	The total number of registered personal automobiles shall include automobiles used for personal use by commercial enterprises. This number shall not include automobiles, trucks and vans that are used for the delivery of goods and services by commercial enterprises

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Mo 6	Total number of passengers transport vehicles
Field	Mobility
Application field	Mobility city profile
Indicator summary	
Description	Number of available vehicles in the city that are destinated to transport passangers (bus, trams,…) per capita
Source	Based on SmartEnCity
Calculation	(Vehicles destinated to transport passangers/inhabitants) x 100,000
Unit	#/100,000
Justification	This indicator shows the range of vehicles that citizens can use as alternative to private vehicles. City planners can use the values of this indicator with the information gathered from public transport use and access to public transport indicators for designing future actions in the city related to the public transport infrastructure.
Indicator requirements	
Data source	Data should be gathered from city's statistics
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	This indicator refers only to traditional transport vehicles not including options such as sharing vehicles

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Mo 7	Fuel mix
Field	Mobility
Application field	Mobility city profile
Indicator summary	
Description	Percentage of the market share of transport fuel for each type of vehicle
Source	mySMARTLife
Calculation	Ratio of existing vehicles in the city that use the following energy sources (petroleum products, biofuels, natural gas and electricity)
Unit	%
Justification	This indicator summarizes the types of fuel used in the existing vehicles of the city and therefore can provide information about the pollution that can be generated in the city by the transport of vehicles
Indicator requirements	
Data source	Data should be gathered from city'statistics
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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Mo 8	Average occupancy
Field	Mobility
Application field	Mobility city profile
Indicator summary	
Description	Average of number of passengers per vehicle per trip
Source	SmartEnCity
Calculation	This data is usually obtained through surveys or monitoring equipments
Unit	Number of passenger per vehicle
Justification	This indicator can help to understand how efficient is the use of vehicles
Indicator requirements	
Data source	Data should be gathered from city statistics
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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Mo 9	Average vehicle speed
Field	Mobility
Application field	Mobility city profile
Indicator summary	
Description	Average speed by vehicle (peak/off peak)
Source	SmartEnCity
Calculation	This data is usually obtained through surveys or monitoring equipments
Unit	Km/h
Justification	This indicator provides valuable information for detecting how problems of congestion in the city evolutions in the time when this indicator is compared in different years
Indicator requirements	
Data source	Data should be gathered from municipality
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	The peak and off-peak hours must be defined by each city to correspond with the local conditions

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 731297.

Mo 10	Number of electric vehicles in the city
Field	Mobility
Application field	Sustainable transport
Indicator summary	
Description	Number of electric vehicles in the city (including private, public and service (taxi and first mile) vehicles as well as motorbikes) in relation to total number of motorized vehicles (four and two wheels)
Source	REPLICATE
Calculation	(# EVs / total population) x 100,000
Unit	#/100,000
Justification	Pollution is a common problem in modern-day cities that it is mainly caused by road traffic. Sustainable cities should change the mobility and transport model towards a model that minimises environmental and acoustic impact improving citizens' quality of life. The use of electric vehicles can contribute to these goals
Indicator requirements	
Data source	Data should be gathered from city movility department
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	Electric Vehicles included in this indicator refers to private, public and service (taxi and first mile) vehicles as well as motorbikes. The indicator must report in EV, but hybrid vehicles can be also reported in a separate way.

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Mo 11	Public transport use
Field	Mobility
Application field	Sustainable transport
Indicator summary	
Description	Annual numer of public tansport trips per capita
Source	CITYkeys
Calculation	# of trips made annually in the city with public transport / total population
Unit	#/cap/year
Justification	Transport usage is a key indicator of how easy is to travel in the city by modes other than single occupancy vehicles. The indicator might also provide insight into transportation policy, traffic congestion, and urban form. In addition, less vehicle use contributes to an accessible, green and healthy city and moreover contributes to European policy goals for sustainable mobility and transport development. While walking and cycling are alternative modes of transport for short distances, public transport connections are needed
Indicator requirements	
Data source	Transport data should be gathered from a number of sources, including: official transport surveys, revenue collection systems (e.g. number of fares purchased), and national censuses
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	Transport trips shall include trips via heavy rail metro or subway, commuter rail, light rail streetcars and tramways, organized bus, trolleybus, and other public transport services. Cities shall only calculate the number of transport trips with origins in the city itself. Note: Transport systems often serve entire metropolitan areas, and not just central cities. The use of number of transport trips with origins in the city itself will still capture many trips whose destination are outside the city, but will generally capture the impact that the city has on the regional transport network.

This project has received funding from the European Union's Horizon 2020
research and innovation programme under grant agreement No 731297.

Mo 12	Access to public transport
Field	Mobility
Application field	Sustainable transport
Indicator summary	
Description	Share of population with access to a public transport stop within 500m
Source	CITYkeys
Calculation	(Number of inhabitants with a transportation stop <500m/total population) x100
Unit	% of people
Justification	It is presumed that availability of alternatives to cars will lead to less car use, thereby contributing to an accessible, green and healthy neighbourhood and moreover contributes to European policy goals for sustainable mobility and transport development. The quality, accessibility and reliability of transport services will also gain increasing importance in the coming years, inter alia due to the ageing of the population. While walking and cycling are alternative modes of transport for short distances, public transport connections are needed for longer trips. Providing access to public transport is an important means to promote its use.
Indicator requirements	
Data source	It might be possible to use city software and perform the exercise with the help of a computer. One could also obtain a map of the area, point the transportation stops (available at the public transport utilities), draw circles around them and use city resident information (available in city administrative documents) to analyse which buildings outside this area are houses and how many people are registered to them.
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	This indicator describes the percentage of population with nearby access to a public transport stop or connection, including all modes of public transport; train, tram, subway, bus, etc.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 731297.

Mo 13	Access to vehicle sharing solutions for city travel
Field	Mobility
Application field	Sustainable transport
Indicator summary	
Description	Number of vehicles available for sharing per 100,000 inhabitants
Source	CITYkeys
Calculation	(# vehicle for sharing / total population) x 100 000
Unit	#/100,000
Justification	Car-sharing is about not owning a car, but renting it from a car-sharing company or sharing the car with friends, family, neighbours or co-workers. Car-sharing contributes to an accessible, green and healthy neighbourhood but also to decreases the need for parking space, less vehicles are on the road and less pollution is emitted.
Indicator requirements	
Data source	Consult vehicle sharing companies in the city for the total number of vehicles available. Some companies might be run by the government and information might be available on the city website
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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Mo 14	Length of bike route network
Field	Mobility
Application field	Sustainable transport
Indicator summary	
Description	Length of lanes in the city for bikes per 100,000 inhabitants
Source	SCIS
Calculation	(Km of Bicycle Paths And Lanes/ total Population) x 100000
Unit	km / 100000 inhabitants
Justification	A transportation system that is conducive to bicycling can reap many benefits in terms of reduced traffic congestion and improved quality of life. Economic rewards both to the individual and to society are also realized through reduced health care costs and reduced dependency on auto ownership (and the resulting in insurance, maintenance and fuel costs). Bicycle lanes also require smaller infrastructure investments than other types of transportation infrastructure. This indicator provides cities with a useful measure of a diversified transportation system.
Indicator requirements	
Data source	The department of traffic/mobility will have information on the length of streets and bicycle lanes/paths. Information might also be available on the local city website, e.g for Vienna (1). The urban audit database also has information on the length of bicycle network (dedicated cycle paths and lanes)
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	Bicycle paths shall refer to independent road or part of a road designated for cycles and sign-posted as such

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Mo 15	Total charging points
Field	Mobility
Application field	Charging points
Indicator summary	
Description	Number of public charging points in the city for all types of electic vehicles. It has to specify by type and capacity
Source	SmartEnCity
Calculation	
Unit	#
Justification	The existence of charging infrastructure in the city is key to increase the penetration of EV. Although private charging points are needed for private vehicles, public infrastructure can be used during the working day as well as for people not inhabitant the city
Indicator requirements	
Data source	Data could be gathered from city mobiliity department
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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Mo 16	**Infrastructure growth e-car**
Field	Mobility
Application field	Charging points
Indicator summary	
Description	Number of charging points available in the city for e-cars
Source	REPLICATE
Calculation	
Unit	#
Justification	Identify the existing e-infrastructure for four wheels motorized vehicles
Indicator requirements	
Data source	Data could be gathered from city mobiliity department
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

Mo 17	Infrastructure growth e-bike
Field	Mobility
Application field	Charging points
Indicator summary	
Description	Number of charging points available in the city for e-bikes
Source	REPLICATE
Calculation	
Unit	#
Justification	Identify the existing e-infrastructure for two wheels motorized vehicles (e-bikes and e-motorbikes)
Indicator requirements	
Data source	Data could be gathered from city mobiliity department
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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Mo 18	Charging points per e-Vehicle
Field	Mobility
Application field	Charging points
Indicator summary	
Description	Percentage of charging points per e-vehicle in the city. It has to specify by type and capacity
Source	SmartEnCity
Calculation	Total charging points/# eVehicles
Unit	#
Justification	This indicator reflects the range of points of recharge for the existing EV in the city. City planners can gather suitable information from this indicator and establish the future actions in the city in aspects of movility taking into account also the information collected related to rechargers made in this infrastructure
Indicator requirements	
Data source	Data should be gathered from city statistics
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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Mo 19	Total kWh recharged in the EV charging stations
Field	Mobility
Application field	Charging points
Indicator summary	
Description	Number of kWh recharged by all types of electric vehicles during a year in the public charging stations
Source	SmarttEnCity
Calculation	
Unit	kWh/year
Justification	It is a measure of the use of electric vehicles since the distances travelled by EV can be calculated with this information. Additional analysis can be done using the particular kWh recharged over the city, showing information about what charging point is used more intensively, given useful information to municipalities in order to optimize the charging network.
Indicator requirements	
Data source	Data should be gathered from municipality or energy provider
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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Mo 20	Recharges per year
Field	Mobility
Application field	Charging points
Indicator summary	
Description	Number of recharges in public electric car recharge infrastructures in the city during a year
Source	SmartEncity
Calculation	
Unit	#/year
Justification	It is a measure of the use of the public charging infrastructures in the city
Indicator requirements	
Data source	Data should be gathered from municipality or energy provider
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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Mo 21	Congestion
Field	Mobility
Application field	Transport problems
Indicator summary	
Description	Increase in overall travel times when compared to free flow situation (Uncosted situation)
Source	CITYkeys
Calculation	((travel times in peak hours - travel times during non-congested periods (free flow*))/travel times during non-congested periods)x100
Unit	% in hours
Justification	The same forces that draw inhabitants to congregate in large urban areas also lead to sometimes intolerable levels of traffic congestion on urban streets and thoroughfares. It is necessary to manage congestion in such a way as to reduce its overall impact on individuals, families, communities and societies.
Indicator requirements	
Data source	Within the city, the traffic and transportation management department should be able to provide this statistic. Several commercial services also exist based on route navigation, e.g. https://www.tomtom.com/en_gb/trafficindex/#/list provides congestion levels for 103 European cities. TomTom uses their database on speed measurements to calculate the travel times on individual road segments and entire networks.
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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Mo 22	Traffic accidents
Field	Mobility
Application field	Transport problems
Indicator summary	
Description	Number of transportation fatalities per 100 000 population
Source	CITYkeys
Calculation	(Number of Fatalities Related To Transportation Of Any Kind/total Population) x 100,000
Unit	#/100 000 people
Justification	Traffic accident rates and, specifically, fatality rates, can serve as indicators for the overall safety of the transportation system, the complexity and congestion of the roadway and transport network, the amount and effectiveness of traffic law enforcement, the quality of the transportation fleet (public and private), and the condition of the roads themselves
Indicator requirements	
Data source	City statistics bureau, municipal traffic department and police office. The urban audit database als contains information on the number of deaths in road accidents
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	The city shall include in this indicator deaths due to any transportation related proximate causes in any mode of travel (automobile, public transport, walking, bicycling, etc.). The city shall count any death directly related to a transportation incident within city limits, even if death does not occur at the site of the incident, but is directly attributable to the accident

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Urban infrastructure

UI 1	Empty dwellings
Field	Urban infrastructure
Application field	Uses of territory
Indicator summary	
Description	Percentage of empty homes with respect to total housing
Source	EUROSTAT
Calculation	(Number of empty dwellings in the city/total number of dwellings) x 100
Unit	%
Justification	This indicator gives an idea about the need to implement policies to inhabit these dwellings in those cases that it exists a scarce of space for the extension of the city and/or a need of retrofitting for making them liveable.
Indicator requirements	
Data source	From the municipality statistics
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	.

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UI 2	**Balance between residential and no-residential building use**
Field	Urban infrastructure
Application field	Uses of territory
Indicator summary	
Description	Contribution of the buildings with tertiary uses (commercial, cultural and institutional) in the urban land use
Source	SmartEnCity
Calculation	[Built surface for terciary sector/Total build surface] x100
Unit	%
Justification	Measure of the uses of the available buildings in the city
Indicator requirements	
Data source(s)	Data should be gathered from municipality or from statistical data source
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	Built surface for tertiary sector includes buildings for the following uses: residential, commercial, cultural and institutional.

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UI 3	Green and blue space
Field	Urban infrastructure
Application field	Green spaces
Indicator summary	
Description	Share of green and water surface area as percentage of total land area
Source	CITYkeys
Calculation	{ [(Water area) + (Green space area)] / (Total land area) } x 100
Unit	% in km^2
Justification	Green and water spaces are regarded as an index representing the degree of the nature conservation and improving the public health and quality of life as they are directly related to the natural water circulation, environmental purification and the green network. More green and blue also reduces vulnerability to extreme weather events like urban heat islands and flooding by heavy rainfall.
Indicator requirements	
Data source	Data can be retrieved from the urban planning and environment department of the city. The urban audit database contains information on 'water and wetland', 'green space area (km2)' and'total land area according to cadastral register)'. The surface area can also be estimated using a map of the city.
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	Green areas are forest and park areas that are partly or completely covered with grass, trees, shrubs, or other vegetation. Water areas here meaning lakes, ponds, rivers

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UI 4	Traffic management system
Field	Urban infrastructure
Application field	Traffic management
Indicator summary	
Description	Existence of an automated traffic management system in the city
Source	SmartEnCity
Calculation	Is there an automated system for the management of the traffic in the city?
Unit	Yes/No
Justification	Traffic management systems adresses avoid traffic congestion in the cities
Indicator requirements	
Data source	Data should be gathered from the municipality
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	It is a system that manages the road traffic in a city automatically by combination of algorithms, equipment's and communication networks without involvement of human personnel in decision making according to various kinds of situations of road traffic that arise in a city

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UI 5	**Parking management systems**
Field	Urban infrastructure
Application field	Traffic management
Indicator summary	
Description	Existence of an automated system for the management of free parking spaces at city level
Source	SmartEnCity
Calculation	Is there an automated system for the management of free parking spaces at city level?
Unit	Yes/No
Justification	Parking management systems adresses avoid traffic congestion in the cities
Indicator requirements	
Data source	Data should be gathered from the municipality
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	This system gives real time indication about free parking spaces available

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UI 6	Public bicycles management system
Field	Urban infrastructure
Application field	Traffic management
Indicator summary	
Description	Existence of an automated system for hiring public bicycles
Source	SmartEnCity
Calculation	Is there an automated system in the city for hiring public bicyles?
Unit	Yes/No
Justification	This system can increase the use of public bicycles by overcoming some barriers which restrain the hiring of this vehicles
Indicator requirements	
Data source	Data should be gathered from the municipality
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	Automated systems for hiring public bicycles consist of: - Card operating systems: The user has a smart card that is recognized by a card reader that centralizes system operation commands and transmits them to each anchor point, so that releases or locks the bike. - Systems that operate with mobile phone: in which case the control system would be on the bike or at the base. The user sends an SMS message to lock and unlock the bike. There is also the Near Field Communication (NFC), with which you can identify the user through the mobile phone, without the cost of message.

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UI 7	Public transport management system
Field	Urban infrastructure
Application field	Traffic management
Indicator summary	
Description	Existence of an automated system for public transport in the city
Source	SmartEnCity
Calculation	Is there an automated system for the management of the public transport in the city?
Unit	Yes/No
Justification	This system can solve some barriers that restrain the use of public transport by some citizens that found this system as uncomfortable due to the lack of information and requirement of time to purchase tickets
Indicator requirements	
Data source	Data should be gathered from the municipality
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	This system automates the ticketing system of a public transportation network and gives information about these vehicles at real time (e.g. the arrival time and the nearest stop)

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UI 8	Number of public transport stops with real time info
Field	Urban infrastructure
Application field	Traffic management
Indicator summary	
Description	Percentage of public transport stops with real time information
Source	REPLICATE
Calculation	(Number of public transport stop with real time information/total number of public transport stop) x 100
Unit	%
Justification	This system can solve some barriers that restrain the use of public transport by some citizens that found this system as uncomfortable due to the lack of information
Indicator requirements	
Data source	Data should be gathered from the municipality
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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UI 9	Lighting system connected
Field	Urban infrastructure
Application field	Lighting management
Indicator summary	
Description	Existence of an automated system for public lighting in the city
Source	SmartEnCity
Calculation	Is there an automated lighting management system in the city?
Unit	Yes/No
Justification	Smart lighting is a lighting technology designed for energy efficiency
Indicator requirements	
Data source	Data should be gathered from the municipality
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	This system includes high efficiency fixtures and automated controls that make adjustments based on conditions such as occupancy or daylight availability

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UI 10	Waste management system
Field	Urban infrastructure
Application field	Waste management
Indicator summary	
Description	Existence of an automated system for the collection of waste in the city
Source	SmartEnCity
Calculation	Is there an automated wasted management system in the city?
Unit	Yes/No
Justification	Managing the wastes in an efficient way reduce the human effort, time and cost
Indicator requirements	
Data source	Data should be gathered from the municipality
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	This system includes a network of sensors which calculate the most efficient routes to collect the waste according to the needs of the moment. In addition, the process of tracking, collecting, and managing the solid waste is totally automated

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UI 11	Access to public free WiFi
Field	Urban infrastructure
Application field	Communication infrastructure
Indicator summary	
Description	Public space Wi-Fi coverage
Source	CITYkeys
Calculation	(Sum of wifi node's coverage/Total city urban surface) x 100
Unit	% of m^2
Justification	Public Wi-Fi coverage has proven instrumental in improving the image of public spaces, as well as the reputation of the city itself. It also improves the city's attractiveness to potential visitors, and facilitates basic internet access to those not wealthy enough to afford their own connection, reducing the technology gap, and improving quality of life and equity of opportunities, thus strengthening social tissue. In addition, Wi-Fi coverage connects the variety of sensors, actuators, and other devices that make the smart city to the fiber optics network running through the city, providing capillarity to it. Lastly, city officials themselves can connect to this Wi-Fi area, allowing the city administration's data intake and output to reach even further.
Indicator requirements	
Data source	A map of publicly owned Wi-Fi nodes is often held by the city government, and the surface covered can be obtained from that.
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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UI 12	Access to high speed internet
Field	Urban infrastructure
Application field	Communication infrastructure
Indicator summary	
Description	Fixed (wired)-broadband subscriptions per 100 inhabitants
Source	CITYkeys
Calculation	
Unit	#/100
Justification	The internet has proven to be an important enabler, being the broadband speed an important factor for driving economic growth, both on micro and macro level. This indicator aims to ensure good city connectivity and the provision of efficient digital infrastructures and focuses on the fixed (wired)-broadband subscriptions.
Indicator requirements	
Data source	Internet access records are kept by internet service and telecommunications providers in the form of subscriber locations and accounts. Other sources include government censuses, telecommunications records and official estimates
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	Fixed (wired)-broadband subscriptions refers to the number of subscriptions for high-speed access to the public Internet (a TCP/IP connection). High-speed access is defined as downstream speeds equal to, or greater than, 256 Kbits/s. Fixed (wired) broadband includes cable modem, DSL, fiber and other fixed (wired)-broadband technologies (such as Ethernet LAN, and broadband-over-power line (BPL) communications). Subscriptions with access to data communications (including the Internet) via mobile-cellular networks are excluded.

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UI 13	Number of Internet connections per 100,000 inhabitants
Field	Urban infrastructure
Application field	Communication infrastructure
Indicator summary	
Description	Total number of internet connections in the city in relation to the population of the city
Source	SmartEnCity
Calculation	(Number of internet connections /inhabitants) x 100,000
Unit	#/100,000
Justification	The internet has proven to be an important enabler, being the broadband speed an important factor for driving economic growth, both on micro and macro level. This indicator aims to ensure good city connectivity and the provision of efficient digital infrastructures and focuses on the fixed (wired)-broadband subscriptions.
Indicator requirements	
Data source	Internet access records are kept by internet service and telecommunications providers in the form of subscriber locations and accounts. Other sources include government censuses, telecommunications records and official estimates
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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UI 14	**Data privacy**
Field	Urban infrastructure
Application field	Urban platform
Indicator summary	
Description	The level of data protection by the city
Source	CITYkeys
Calculation	Does the city follow EU General Data Protection Regulation 679/2017 (GDPR)?
Unit	Qualitative Likert scale (1 to 5)
Justification	If personal data is being collected, the purpose of data collection should be known and the collected data shouldn't be used for any other purpose. The owner of the data i.e. the administrator of the register should also be defined. If the city collects private data from the citizens (e.g. on energy consumption), authorisations from the end-users need to be acquired. It is recommended that such authorisations are made in form of a written agreement that clearly specifies the data to be collected, collection interval, use purpose and that the data won't be used for other purposes, and who will have access to the data. It is to be noted that information based on personal or private data can often be anonymised e.g. through aggregation.
Indicator requirements	
Data source	City's security or IT department
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	This indicator analyses the extent to which regulations on data protection are followed and to which proper procedures to protect personal or private data are implemented. Data protection refers to the tools and processes used to store data relevant to a certain ICT system or environment, as well as recover lost data in case of an incident – be it fraudulent, accidental or caused by a natural disaster. One critical element about data is the concept of data ownership, which refers to who is in charge of data, who can authorize or deny access to certain data, and is responsible for its accuracy and integrity, in particular personally identifiable information.

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UI 15	Number of data publisher
Field	Urban infrastructure
Application field	Urban platform
Indicator summary	
Description	Number of data publisher that publish data into the exiting urban platform
Source	Telefónica Foundation
Calculation	
Unit	#
Justification	How interested is the municipality in the deployment of an urban platform
Indicator requirements	
Data source	IT Department
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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UI 16	Number of sensors/devices connected
Field	Urban infrastructure
Application field	Communication infrastructure
Indicator summary	
Description	Number of IoT sensors/devices from any field that are connected in the current urban platform (e.g. website)
Source	Telefónica Foundation
Calculation	
Unit	#
Justification	How interested is the municipality in the deployment of an urban plarform
Indicator requirements	
Data source	IT Department
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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UI 17	Number of services deployed
Field	Urban infrastructure
Application field	Communication infrastructure
Indicator summary	
Description	Number of available services in the current urban platform (e.g. website)
Source	Telefónica Foundation
Calculation	
Unit	#
Justification	How interested is the municipality in the deployment of an urban platform
Indicator requirements	
Data source	IT Department
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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UI 18	Number of available open API
Field	Urban infrastructure
Application field	Communication infrastructure
Indicator summary	
Description	Number of available APIs in the current urban platform (e.g. website)
Source	Telefónica Foundation
Calculation	
Unit	#
Justification	How interested is the muncipality in the deployment of an urban platform
Indicator requirements	
Data source	IT Department
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	API is a set of functions and procedures that allow the creation of applications which access the features or data of an operating system, application, or other service. Open means anyone can freely access, use, modify, and share for any purpose (subject, at most, to requirements that preserve provenance and openness).

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UI 19	Number of available open data sources
Field	Urban infrastructure
Application field	Communication infrastructure
Indicator summary	
Description	Number of available Open Data sources in the current urban platform (e.g. website). Open means anyone can freely access, use, modify, and share for any purpose (subject, at most, to requirements that preserve provenance and openness)."
Source	Telefónica Foundation
Calculation	
Unit	#
Justification	How interested is the municipality in the deployment of an urban platform
Indicator requirements	
Data source	IT Department
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	Open means anyone can freely access, use, modify, and share for any purpose (subject, at most, to requirements that preserve provenance and openness).

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UI 20	Number of accesses to the urban platform API's
Field	Urban infrastructure
Application field	Communication infrastructure
Indicator summary	
Description	Number of accesses that have been made into the API's of the urban platforms (e.g. website)
Source	Telefónica Foundation
Calculation	
Unit	#
Justification	How interested is the municipality in the deployment of an urban platform
Indicator requirements	
Data source	IT Department
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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Economy

Eco 1	Unemployment rate
Field	Economy
Application field	Employment
Indicator summary	
Description	Percentage of the labour force unemployed
Source	CITYkeys
Calculation	(# working-age city residents without work/ total labour force) x 100
Unit	%
Justification	The unemployment rate is considered one of the single, most informative labour market indicators reflecting the general performance of the labour market and the health of the economy as a whole.
Indicator requirements	
Data source(s)	Statistics from local labour bureau, city statistical office
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	Working-age city residents refers to those who were not in paid employment or self-employment, but available for work, and seeking work

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Eco 2	Youth unemployment rate
Field	Economy
Application field	Employment
Indicator summary	
Description	Percentage of youth labour force unemployed
Source	CITYkeys
Calculation	(# unemployed youth inhabitants/ total labour force) x 100
Unit	%
Justification	The youth unemployment rate is a key indicator for quantifying and analyzing the current labour market trends for young people. Widespread youth unemployment and underemployment also prevents companies and countries from innovating and developing competitive advantages based on human capital investment, thus undermining future prospects.
Indicator requirements	
Data source(s)	Statistics from local labour bureau or city statistical office
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	Unemployed youth refer to individuals above the legal working age and under 24 years of age who are without work, actively seeking work in a recent past period (past four weeks), and currently available for work

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Eco 3	Gross Domestic Product (GDP)
Field	Economy
Application field	Economic performance
Indicator summary	
Description	City's gross domestic product per capita
Source	CITYkeys
Calculation	GDP/city population
Unit	€/cap
Justification	Well-known and accepted method for measuring of economic performance
Indicator requirements	
Data source(s)	Cities statistics bureau, national statistics bureau if it provides geographical desaggregation or Eurostat NUTS3 level as proxy if no other data is available
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	This gives an idea of the economic wealth in the city

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Eco 4	Median disposable income
Field	Economy
Application field	Economic performance
Indicator summary	
Description	Median disposable annual household income
Source	CITYkeys
Calculation	
Unit	€/household
Justification	This gives an idea of the economic wealth in the city
Indicator requirements	
Data source(s)	The information might be available at the Urban Audit database, the cities statistics bureau
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	Median disposable annual household income includes income from economic activity (wages and salaries; profits of self-employed business owners), property income (dividends, interests and rents), social benefits in cash (retirement pensions, unemployment benefits, family allowances, basic income support, etc.), and social transfers in kind (goods and services such as health care,, education and housing, received either free of charge or at reduced prices)

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Eco 5	New business registered
Field	Economy
Application field	Economic performance
Indicator summary	
Description	Number of new businesses registered (including start-up) in a year per 100,000 population. An average of the last 5 years with available data
Source	CITYKEYS
Calculation	(Number of new companies registered/Total Population) x 100,000 inhabitants
Unit	#/100,000
Justification	The number of businesses can inform a city's level of economic activity and economic performance. It provides one indication of the overall business climate in a jurisdiction, and attitudes towards entrepreneurship. Strong entrepreneurial activity is closely associated with a dynamic and growing economy. The number of businesses is also used to inform competitiveness of a city.
Indicator requirements	
Data source(s)	Business demography statistics are available at NUTS 2 level at Eurostat. City statistics office and/or economic board and the chamber of commerce might be able to provide the information
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	This indicator assesses the number of new businesses created (including start-ups). An enterprise birth occurs when an enterprise (for example a company) starts from scratch and begins operations, amounting to the creation of a combination of production factors with the restriction that no other enterprises are involved in the event. An enterprise birth occurs when new production factors, in particular new jobs, are created.

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	Enterprise births do not include: - dormant enterprises being reactivated within two years; - new corporate entities being created from mergers, breakups, spin-offs/split-offs or the restructuring of enterprises or a set of enterprises; - the entry into a sub-population resulting only from a change of activity.

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Eco 6	Fuel poverty
Field	Economy
Application field	Equity
Indicator summary	
Description	The percentage of households unable to afford the most basic levels of energy
Source	CITYkeys
Calculation	Self-defined
Unit	% of households
Justification	Fuel poverty occurs when a household is unable to afford the most basic levels of energy for adequate heating, cooking, lighting and use of appliances in the home. In absolute sense, when more than 10% of the income is spent on energy bills this is considered too much (DECC, 2013).
Indicator requirements	
Data source(s)	Household income data may be available from the city statistical office. Energy prices should be metered prices and should be available from the local energy providers. Energy consumption data per household is usually modelled based on statistics on dwellings, household size, etc
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	The energy costs include all building related energy, i.e. for heating/cooling, warm water and electricity

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Eco 7	Population living in poverty
Field	Economy
Application field	Equity
Indicator summary	
Description	It reflects levels of economy and social marginality and/or inclusiveness in a city
Source	REMOURBAN, ISO 37120:2014, U4SCC
Calculation	(People living below the poverty threshold/total city population)x 100
Unit	%
Justification	The percentage of the city's population living in poverty is an indicator of social equality and reflects levels of economic and social marginality and/or inclusiveness in a city
Indicator requirements	
Data source(s)	City statistical department. City social or housing department
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	National poverty thresholds can be used to determine the poverty level of a city. Poverty threshold from each country can be retrieved from these websites: www.povertynet.org / www.worldbank.org

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Eco 8	Cost of housing
Field	Economy
Application field	Equity
Indicator summary	
Description	The percentage of gross household income spent on housing
Source	CITYkeys, U4SCC
Calculation	(Fixed housing costs/Gross household income) x 100
Unit	% in euros
Justification	Many European cities face spatial segregation of social groups. Gentrification combined with an increase in housing costs, make it more difficult for low-income residents to find affordable housing. Smart cities aim to maintain or increase the diversity within neighborhoods to ensure that also inhabitants with low incomes can remain in developing neighborhoods and not being pushed into suburbs or outside the city.
Indicator requirements	
Data source(s)	City statistical department. City social or housing department
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	For this indicator affordable housing is defined as: less than 40% of the household income is spend on housing expenditures. This includes rents, hereditary tenure, mortgage payments, but excludes expenditures for services or utilities.

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Eco 9	Average price for buying an apartment per m^2
Field	Economy
Application field	Equity
Indicator summary	
Description	Average price for buying an apartment per m^2 in a city
Source	EUROSTAT
Calculation	The indicator has been redefined and the new proposed indicator should be: House price index. The house price index captures price changes of all residential properties purchased by households (flats, detached houses, terraced houses, etc.), both new and existing, independently of their final use and their previous owners. Only market prices are considered, self-build dwellings are therefore excluded. The land component is included. The data are expressed as quarterly index (2015=100), annual rate of change and quarterly rate of change.
Unit	€/m^2
Justification	For most citizens, buying a residential property (dwelling) is the most important transaction during their lifetime. This indicator tries to measure how affordable are the dwelling for citizens
Indicator requirements	
Data source(s)	Eurostat
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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Eco 10	Diversity of housing
Field	Economy
Application field	Equity
Indicator summary	
Description	Percentage of social dwellings as share of total housing stock in the city
Source	CITYkeys
Calculation	(Number of social dwellings/Total housing stock in the city) x 100
Unit	%
Justification	The indicator focuses on variety in ownership (public or private) but also as a supportive measure which is directed at those who cannot serve their own housing needs
Indicator requirements	
Data source	Housing categories for existing neighbourhoods can be derived from city administration/planning documents
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	The definition of ‘social housing’ can be different in various countries. The share considered ‘correct’ can vary between countries

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Eco 11	New start-up
Field	Economy
Application field	Innovation
Indicator summary	
Description	Number of new businesses registered (including start-up) in the last year per 100,000 population.
Source	Adapted from CITYkeys
Calculation	(Number of new start-up registered/Total Population) x 100,000 inhabitants
Unit	#/100,000
Justification	It shows how attractive is the city for starting new economic activities
Indicator requirements	
Data source(s)	Data should be gathered from commercial registry or city statistics office
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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Eco 12	Research intensity
Field	Economy
Application field	Innovation
Indicator summary	
Description	R&D expenditure as percentage of city's GDP
Source	CITYkeys
Calculation	(R&D expenditure/city's GDP)x 100
Unit	% in euros
Justification	It shows how innovative is the city for deploy economic activities in new fields
Indicator requirements	
Data source(s)	The expenditures on R&D might be available in the municipal Economics department. Eurostat contains the GERD on the NUTS 2 level if no city statistics are present.
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	This indicator analyses the total expenditure on R&D by all stakeholders as a percentage of the GDP of the city

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Eco 13	Employment ICT sector
Field	Economy
Application field	Innovation
Indicator summary	
Description	This indicator measures the proportion of employees in ICT sector, usually linked with software and computer services industries, among all employees in the city.
Source	REMOURBAN
Calculation	(Number of employees in ICT sector/total number of employees in the city) x 100
Unit	%
Justification	It shows how relevant is the ICT sector for the economy of the city
Indicator requirements	
Data source(s)	Data should be gathered from the municipality statistics
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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Eco 14	E-commerce
Field	Economy
Application field	Innovation
Indicator summary	
Description	E-commerce represents the number of e-commerce transactions per 100 inhabitants through electronic and mobile payment
Source	REMOURBAN
Calculation	Number of transaction per 100 inhabitants
Unit	Number of e-commerce transations/100 inhabitants
Justification	It shows how extent citizens use the new payment ways
Indicator requirements	
Data source(s)	Data could be gathered from the municipality statistics
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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Eco 15	Green public procurement
Field	Economy
Application field	Green economy
Indicator summary	
Description	Percentage annual procurement using environmental criteria as share of total annual procurement of the city administration.
Source	CITYkeys
Calculation	(Millon EUR annual procurement using environmental criteria/Millon EUR total annual procurement of the city administration) x 100
Unit	% of €
Justification	Europe's public authorities are major consumers. By using their purchasing power to choose environmentally friendly goods, services and works, they can make an important contribution to sustainable consumption and production – what we call Green Public Procurement, or GPP.
Indicator requirements	
Data source(s)	A first entry could be the city's corporate facilities department (but this might be limited to its own sustainable purchasing (i.e. printing paper, catering etc.). Information on the rest of the organisation will likely be scattered over different departments (e.g. the transport department for sustainable procurement of roads; the housing department for sustainable procurement of a large-scale urban development project, etc).
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	This is useful for measure how ecoinnovation has been implemented in the ciy

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Eco 16	Tourism intensity
Field	Economy
Application field	Tourism
Indicator summary	
Description	The ratio of nights spent at tourist accommodation establishments relative to the total permanent resident population of the area and multiply per 100,000
Source	CITYkeys
Calculation	(# of tourist nights / total population) x 100,000
Unit	nights/100,000
Justification	The number of tourists visiting the city is an indication of the attractiveness of the city to foreigners. In addition, tourism as an industry adds value to the local economy
Indicator requirements	
Data source(s)	City's tourism office, tourism tax information, European Cities Marketing Benchmarking Report
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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Citizens

Cit 1	Average population age
Field	Citizen
Application field	Age-structure
Indicator summary	
Description	The median age of population is the age that divides a population into two numerically equal groups; that is, half the people are younger than this age and half are older
Source	SmartEnCity
Calculation	Self-defined
Unit	Years
Justification	This indicator reflects the proportion of people of working age, being very useful for planning actions in social and economic fields.
Indicator requirements	
Data source(s)	City's statistics office
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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Cit 2	Population Dependency Ratio
Field	Citizen
Application field	Age-structure
Indicator summary	
Description	Number of economically dependent persons (net consumers) per 100 economically active persons (net producers)
Source	CITYkeys
Calculation	((Population (0-14) + Population (65+)) / Populación (15-64) x 100
Unit	#/100
Justification	Changes in the dependency ratio provides an indication of the potential social support requirements. In addition, a healthy dependency ratio contributes to an attractive and competitive city.
Indicator requirements	
Data source(s)	City’s statistics office
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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Cit 3	People > 75 years
Field	Citizen
Application field	Age-structure
Indicator summary	
Description	Population elder than 75 years old living in the city
Source	SmartEnCity
Calculation	(Population elder than 75 years old living in the city/Population of the city) x 100
Unit	%
Justification	This indicator helps to detect a demographic problem that could be linked with the lack of renovation rate of the population. Additionally, this indicator expresses the requirement of expenditure to provide a range of related services.
Indicator requirements	
Data source(s)	City's statistics office
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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Cit 4	Number of high education degrees
Field	Citizen
Application field	Education level
Indicator summary	
Description	It is calculated collecting the number of people with higher degrees divided per total population. The result shall be multiplied by 100,000.
Source	REPLICATE
Calculation	(# people with tertiary education/total population) x 100,000
Unit	#/100,000
Justification	Education is critical to enhance social quality and to prevent social exclusion. Higher levels of educational attainment are generally linked to better occupational prospects and higher income for individuals, hence having a positive effect on their quality of life. People who have completed tertiary education improve their possibilities to secure a job: the unemployment rate decreases with the educational level.
Indicator requirements	
Data source	Data should be gathered from statistical office
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	High education degrees corresponds with tertiary education and refers to all post-secondary education, including but not limited to universities

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Cit 5	Access to public amenities
Field	Citizen
Application field	Accessibility of services
Indicator summary	
Description	Share of population with access to at least one type of public amenity within 500m
Source	CITYkeys
Calculation	(Number of inhabitants with a public amenity <500m/total population) x100
Unit	% people
Justification	Amenities in the urban environment make an area more enjoyable and contribute to its desirability. On the other hand, it is presumed that nearby availability of amenities leads to a lively neighbourhood and less car use.
Indicator requirements	
Data source(s)	It might be possible to use GIS software. One could also obtain a map of the area, point the public amenities (available at the city planning office), draw circles of 500m around them and use city resident information (available in city administrative documents) to analyse which buildings fall outside this area are houses and how many people are registered to them
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	Public amenities are services/facilities which are provided by the government or town/city councils for the general public to use, with or without charge. Examples of the types of public amenities considered here are social welfare points, social meeting centers, theatres and libraries. (note: other public amenities such as green spaces, public recreation and healthcare facilities are already covered in separate indicators).

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Cit 6	Access to commercial amenities
Field	Citizen
Application field	Accessibility of services
Indicator summary	
Description	Share of population with access to at least six types of commercial amenities providing goods for daily use within 500m
Source	CITYkeys
Calculation	(Number of inhabitants with a commercial amenity <500m/total population) x100
Unit	% people
Justification	Access to commercial amenities is an indicator which partially exposes the mix and distribution of different uses in an urban area, indicating the availability of commercial amenities in a close proximity of residential location of inhabitants. On the other hand, it is presumed that availability of amenities leads to a lively neighbourhood and less car use. Amenities in the urban environment make an area more enjoyable and contribute to its desirability.
Indicator requirements	
Data source	Open government data and city maps. To measure this, the city can be analyzed with a package of spatial statistics
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	Commercial amenities are services/goods for daily use provided by private actors. Typical commercial amenities include shops for bread, fish, meat, fruits and vegetables, general food shops (i.e. supermarkets), press, and pharmaceutical products

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Cit 7	Number of information contact points for citizens
Field	Citizen
Application field	Channels of communication
Indicator summary	
Description	Total number of contact points (physical meeting places and online systems) established in the city by the municipality to share information from the city to the citizens (tourism, events, mobility, etc)
Source	SmartEnCity
Calculation	(Number of contacts points/population of city) x100,000
Unit	#/capita
Justification	If citizens and tourists are aware of the more significant events or available services in the municipality, it will increase the participation of these people in the activities held in the city (exhibitions, concerts) and a higher use of the existing public urban services (e.g. public transport, public libraries).
Indicator requirements	
Data source(s)	Data can be gathered from municipality (e.g. through the municipal website)
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	Whereas online systems are used for most citizens, physical meeting places contact points is the usual channel of people with limit use of technology

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Cit 8	Number of municipal websites for citizens
Field	Citizen
Application field	Channels of communication
Indicator summary	
Description	Total number of municipal websites which belong to the municipality for sharing information of the city to the citizens
Source	SmartEnCity
Calculation	(Number of municipal websites/population of city) x100,000
Unit	#/capita
Justification	Municipal websites are nowadays a relevant channel of communication used by citizens and companies to be aware of the city council services (school admission, public transport lines, opening times of museums), city information (budgets, expenditures, pollution) and arrange payment, licences and permits as citizen or company
Indicator requirements	
Data source(s)	Data can be gathered from municipality or in internet
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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Cit 9	Voter participation
Field	Citizen
Application field	Citizen involvement
Indicator summary	
Description	The percentage of people that voted in the last municipal election as share of total population eligible to vote
Source	CITYkeys, U4SCC
Calculation	(number of people who voted in last municipal elections/total population eligible to vote) x 100
Unit	%
Justification	The percentage of the eligible voting population that voted in the last municipal election is an indicator of the public's level of participation and degree of interest in local government. However, this indicator will only reveal the level of participation, not the level of satisfaction of the population.
Indicator requirements	
Data source	Data should be gathered from city's statistic
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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Cit 10	Emails suggestions, complains and comments
Field	Citizen
Application field	Citizen involvement
Indicator summary	
Description	Emails received from the main municipality contact about a political or social issue per 100000 population
Source	CIRCLE
Calculation	(Emails petitions/inhabitants) x 100000
Unit	#/cap
Justification	Engaging people in decisión making improves the quality and the inclusiveness of the decisions. It also helps improve on the existing laws and regulations
Indicator requirements	
Data source	Data can be gathered from municipality
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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Cit 11	Written suggestions, complains and comments
Field	Citizen
Application field	Citizen involvement
Indicator summary	
Description	Written petitions received from the main municipality contact about a political or social issue per 100000 population.
Source	CIRCLE
Calculation	(Written petitions/inhabitants) x 100,000
Unit	#/capita
Justification	Engaging people in decisión making improves the quality and the inclusiveness of the decisions. It also helps improve on the existing laws and regulations
Indicator requirements	
Data source(s)	Data can be gathered from municipality
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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Cit 12	Citizen registered in city web/services
Field	Citizen
Application field	Citizen involvement
Indicator summary	
Description	Percentage of citizens registered in government applications over total population in the city
Source	REMOURBAN
Calculation	(number of citizens registered in government applications/total city population) x 100000
Unit	%
Justification	How ICTs are engaging citizens to be aware of the municipality services
Indicator requirements	
Data source(s)	Data can be gathered from municipality (e.g. through the municipal website)
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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Cit 13	Web Apps/Services use
Field	Citizen
Application field	Citizen involvement
Indicator summary	
Description	Number of visits of city apps for city services in a year per 100000 population.
Source	REMOURBAN
Calculation	(Number of visits of city apps/inhabitants) x 100,000
Unit	#/cap
Justification	How ICTs are engaging citizens to be aware of the municipality services
Indicator requirements	
Data source(s)	Data can be gathered from municipality (e.g. through the municipal website)
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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Cit 14	Number of local associations per capita
Field	Citizen
Application field	Citizen involvement
Indicator summary	
Description	Total number of community associations registered with the local authority related to total city population
Source	SmartEnCity
Calculation	(Number of community associations / Total city population) x100,000
Unit	#/capita
Justification	Engaging people in associations helps to improve the decisión making process in the city and to extend the number of activities addressed to the citizens realized in a city
Indicator requirements	
Data source(s)	Data should be gathered from municipality
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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Cit 15	Number of discussion forums
Field	Citizen
Application field	Citizen involvement
Indicator summary	
Description	Total number of discussion forums organized by the municipality in a year dedicated to discuss face to face with citizens about the needs, opportunities and solutions to be implemented the city
Source	SmartEnCity
Calculation	(Number of discussion forums in a year/population of city) x100,000
Unit	#/capita
Justification	This indicator can give an idea about how local government is interested in engage citizens in city activities
Indicator requirements	
Data source(s)	Data should be gathered from municipality
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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Cit 16	Number of interactive social media initiatives
Field	Citizen
Application field	Citizen involvement
Indicator summary	
Description	Number of accounts created by the municipality in social networks (e.g. Facebook, Twitter) for sharing information about different aspects of the city (e.g. news, cultural agenda, etc).
Source	SmartEnCity
Calculation	(Number of accounts in social media/population of city) x100,000
Unit	#/capita
Justification	This indicator can give an idea about how local government is interested in engage citizens in city activities through ICT tools
Indicator requirements	
Data source(s)	Data should be gathered from municipality
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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Governance

Gov 1	Existence of an Agenda 21
Field	Governance
Application field	Urban planning
Indicator summary	
Description	Existence of an Agenda 21 in the city which guides the city towards the sustainability
Source	REPLICATE
Calculation	Has the city elaborated an Agenda 21?
Unit	Yes/No
Justification	Agenda 21 was the first instrument created for accelerating sustainable development in developing countries. Additioinally, the actions to be included should be obtained through a participant process with main stakeholders of the municipality and citizens
Indicator requirements	
Data source	Data should be gathered from policy documents of the city
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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Gov 2	Existence of local sustainability plans
Field	Governance
Application field	Urban planning
Indicator summary	
Description	Existence of an urban strategic planning in the city focused to achieve a sustainable city
Source	SmartEnCity
Calculation	Is there any specific sustainability plan in the city?
Unit	Yes/No
Justification	The fact that cities have sustainable plans gives an idea about the level of commitment of local goverment with the environment
Indicator requirements	
Data source	Data should be gathered from policy documents of the city
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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Gov 3	Signature and compliance of the Covenant of Mayors
Field	Governance
Application field	Urban planning
Indicator summary	
Description	Commitment of the municipality with the European Commission to reduce CO2 emissions through the signature of the Covenant of Mayors as well as the posterior fulfillment of the target agreed
Source	REPLICATE
Calculation	Has the city signed the Covenant of Mayors. And is the city complying with it? (both questions need to be answered)
Unit	Yes/No
Justification	This is the major standard commitment at European level that a city can assume in terms of city transformation. Also, this instrument contributes to to achieve the targets adopted in 2008 by the EU in energy savings, use of RES and CO_2 reduction through the correspondiing implementation of sustainable energy policies by local authorities
Indicator requirements	
Data source	Data should be gathered from the municipality or through the website of Covenant of Mayors
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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Gov 4	Existence of smart cities strategies
Field	Governance
Application field	Urban planning
Indicator summary	
Description	Inclusion of smart cities strategies in the urban strategic plans of the city
Source	REPLICATE
Calculation	Is there any specific Smart City strategy in the city?
Unit	Yes/No
Justification	The fact that cities have smart cities strategies as included in the urban planning provides the development aspirations of the local goverment in terms of use of ICTs and the implementation of smart projects
Indicator requirements	
Data source	Data should be gathered from policy documents of the city
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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Gov 5	Smart city policy
Field	Governance
Application field	Urban planning
Indicator summary	
Description	The extent to which the city has a supportive smart city policy
Source	CITYkeys
Calculation	Likert scale: Not at all – 1 — 2 — 3 — 4 — 5 — Very supportive 1. Not at all: the complete absence of a long-term smart city vision (including and absence of long-term targets & goals) from the side of the government or an opposing vision create a difficult environment for starting smart city initiatives. 2. Poor: The long-term vision of the government does, to some extent, hamper the environment for smart city initiatives. 3. Neutral: The long-term vision of the government has had no significant, positive or negative, impact on the environment for smart city initiatives. 4. Somewhat supportive: The long-term vision of the government has to some extent benefitted the environment for smart city initiatives. The city has created roadmaps and actions to support vision implementation 5. Very supportive: The comprehensive long-term vision on the future of the city stimulates the environment for smart city initiatives to a great extent.
Unit	Qualitative Likert scale
Justification	The existence of such comprehensive smart city visions, alongside with a strong smart city strategy, provides ways in which smart city projects can connect to larger development aims within the city, as well as benefit from supporting measures.
Indicator requirements	
Data source	Data should be gathered from policy documents of the city
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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Gov 6	Existence of plans/programs to promote energy efficient buildings
Field	Governance
Application field	Urban planning
Indicator summary	
Description	Inclusion of efficient buildings in the urban plans developed by the own local government to design the future vision of the city
Source	SmartEnCity
Calculation	Is there any specific plan/program for promoting energy efficient buildings in the city? How many?
Unit	First question: YES/NO Second question: #
Justification	The design of specific plans or programs by local government to promote energy efficient buildings is a key step in the deployment of projects for the implementation of energy solutions in buildings or the energy refurbishment of buildings in the city
Indicator requirements	
Data source	Data should be gathered from policy documents of the city
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	A plan is a long term roadmap to achieve some broad goals whereas programs refer to the instruments to meet improvements in the short term

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Gov 7	Existence of plans/programs to promote sustainable mobility
Field	Governance
Application field	Urban planning
Indicator summary	
Description	Inclusion of sustainable mobility actions in the urban plans developed by the own local government to design the future vision of the city
Source	SmartEnCity
Calculation	Is there any specific plan for promoting sustainable mobility in the city? How many?
Unit	First question: YES/NO Second question: #
Justification	The creation of plans/programs by the local government to promote the sustainable mobility of the city is a key step in the deployment of non-fossil fuel vehicles in the city (EV, biogas vehicles, biodiesel vehicles, etc) or alternatives to the private vehicles (shared vehicles, public transport)
Indicator requirements	
Data source	Data should be gathered from policy documents of the city
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	A plan is a long term roadmap to achieve some broad goals whereas programs refer to the instruments to meet improvements in the short term

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Gov 8	Existence of regulations for development of energy efficient districts
Field	Governance
Application field	Urban planning
Indicator summary	
Description	Existence of laws in the city as specific instruments to foster the implementation of energy solutions in buildings or the energy refurbishment of buildings.
Source	SmartEnCity
Calculation	Is there any sepecific regulation for developing energy efficient district in the city? How many?
Unit	First question: YES/NO Second question: #
Justification	Regulation is in this case an instrument derived from a political decision to protect the environment and the society which aims to create proper scenarios which foster the development of energy efficient districts
Indicator requirements	
Data source	Data should be gathered from policy documents of the city
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	Following instruments are considered as regulations in energy efficient districts: building codes, procurement regulations, energy efficiency obligations and quotas, mandatory audits, mandatory labelling and certification programs and utility demand-side management programs.

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Gov 9	Existence of regulations for development of sustainable mobility
Field	Governance
Application field	Urban planning
Indicator summary	
Description	Existence of laws in the city as specific instruments to foster the implementation of sustainable mobility actions
Source	SmartEnCity
Calculation	Is there any sepecific regulation for developing sustainable mobility in the city? How many?
Unit	First question: YES/NO Second question: #
Justification	Regulation is in this case an instrument derived from a political decision to protect the environment and the society which aims to create proper scenarios which foster the development of sustainable mobility actions in the city
Indicator requirements	
Data source	Data should be gathered from policy documents of the city
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	Land use planning (parking areas, car free urban districts (temporal or permanent restrictions)), ecolabels (energy, CO_2), etc

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Gov 10	**Climate resilience strategy**
Field	Governance
Application field	Urban planning
Indicator summary	
Description	The extent to which the city has developed and implemented a climate resilient strategy
Source	CITYkeys
Calculation	Likert scale: No action taken – 1 — 2 — 3 — 4 — 5 — 6 – 7 – implementation, monitoring and evaluation on the way 1. No action has been taken yet 2. The ground for adaptation has been prepared (the basis for a successful adaptation process) 3. Risks and vulnerabilities have been assessed 4. Adaptation options have been identified 5. Adaptation options have been selected 6. Adaptation options are being implemented 7. Monitoring and evaluation is being carried out.
Unit	Qualitative likert scale
Justification	Urban areas in Europe and worldwide are increasingly experiencing the pressures arising from climate change and are projected to face aggravated climate-related impacts in the future. Cities and towns play a significant role in the adaptation to climate change in the EU, which has been recognised by the EU Strategy on adaptation to climate change. Several cities and towns across Europe are already pioneering adaptation action and many others are taking first steps to ensure that European cities remain safe, liveable and attractive centres for innovation, economic activities, culture and social life (climate-adapt.org).
Indicator requirements	
Data source	To be derived from interviews with the department for urban planning of the local government and/or their documentation

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Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	

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Gov 11	Preservation of cultural heritage
Field	Governance
Application field	Urban planning
Indicator summary	
Description	The extent to which preservation of cultural heritage of the city is considered in urban planning
Source	CITYkeys
Calculation	Likert scale: Not at all – 1 — 2 — 3 — 4 — 5 — Very much 1. Not at all: no attention has been paid to existing cultural heritage in urban planning. 2. Fair: heritage places have received some attention in urban planning, but not as an important element. 3. Moderate: some attention has been given to the conservation of heritage places. 4. Much: heritage places are reflected in urban planning 5. Very much: preservation of cultural heritage and connections to existing heritage places are a key element of urban planning.
Unit	Qualitative Liker scale
Justification	An important aspect in promoting the feeling of community/home is ‘place-making’; the creation of place and identity. This identity can be created by building on local and regional history, culture and character. This entails integrating urban design and heritage conservation so that it enhances or connects to the existing character of the place, e.g. preservation, restoration and/or adaptive re-use of historic buildings and cultural landscapes. Keeping these locations’ special identity could also bring economic as well as other benefits to the area
Indicator requirements	
Data source	To be derived from interviews with the department for urban planning of the local government and their documentation
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year

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Gov 12	Cross – departmental integration
Field	Governance
Application field	Governance collaboration
Indicator summary	
Description	The extent to which administrative departments contribute to "smart city" initiatives and management
Source	CITYkeys
Calculation	Likert scale: Only one department involved – 1 – 2 – 3 – 4 – 5 – All departments are actively involved 1. There is a silo-ed smart city governance structure, only one department actively contributes to smart city initiatives and decides on the strategy. 2. The local authority is poorly oriented towards cross-departmental "smart city" management: officially there is no "mainstreaming approach", some civil servants from a few departments work on this portfolio on the side or provide data for the initiatives, but there is no real strategy and commitment. 3. The local authority is somewhat oriented towards cross-departmental "smart city" management: there is a strategy for a "mainstreaming approach" and several departments contribute in human, data or financial resources. 4. The local authority is clearly oriented towards cross-departmental "smart city" management: there is a strategy for a "mainstreaming approach" and almost all departments provide financial, data and human resources for the smart city themes. 5. The local authority is committed towards cross-departmental "smart city" management: there is a well anchored "mainstreaming approach" with shared performance targets and all departments are actively contributing to the smart city themes in financial, data and human resources.
Unit	Likert scale
Justification	Smart city projects are multi-disciplinary projects. Therefore, they can benefit from an integrated approach and the involvement of many disciplines and departments within the city administration.

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Indicator requirements	
Data source	To be derived from interviews with the smart city coordinator, administration documentation and proposals/reports on smart city project initiatives
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	The level of cross-departmental integration will be estimated by analyzing the number of departments involved in smart city initiatives, whether by contributing financial, data sources or human resources

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Gov 13	Multilevel government
Field	Governance
Application field	Governance collaboration
Indicator summary	
Description	The extent to which the city cooperates with other authorities from different levels
Source	CITYkeys
Calculation	Likert scale: Not at all – 1 – 2 – 3 – 4 – 5 - Very much 1. Not at all: there is no cooperation or coordination with other municipalities and/or other levels of government whatsoever. 2. Poorly: there is little cooperation with other authorities, but this is irregular and very dependent of the people involved. 3. Somewhat: there is some cooperation or coordination with other municipalities and/or other levels of government, which is formalized in a partnership policy. 4. Good: there is good cooperation or coordination with other municipalities and/or other levels of government, which is formalized in partnership policies and in process through regular participation in meetings. 5. Excellent: the city is a driving force in the cooperation or coordination with other municipalities and/or other levels of government, which is formalized in policy and in process through regular meetings initiated by the city.
Unit	Likert scale
Justification	Smart city developments benefit from alignment of objectives throughout layers of government, both vertically (regional/national level) and horizontally (other cities). This makes it easier to implement projects in general and in different cities in particular. Moreover, lessons learned can be transferred.
Indicator requirements	
Data source	To be derived from interviews with the smart city coordinator or city administration
Reference period	Data should be gathered from the last year with available data
Additional notes	It will be evaluated by analyzing the frequency of consultation or coordination in the planning and decision-making processes and the extent to which partnerships have been established at local, regional, national, European and/or international level.

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Gov 14	Availability of government data
Field	Governance
Application field	On-line goverment data
Indicator summary	
Description	The extent to which goverment information is published
Source	CITYkeys
Calculation	Likert scale: Not at all – 1 – 2 – 3 – 4 – 5 – Excellent 1. Not at all: most of the information is not available to the public or only upon appointment with an expert 2. Poorly: most of the information is available to the public, but available in the form of a hard copy which cannot leave city hall 3. Somewhat: most of the information is available to the public, some in the form of a hard copy, some online. 4. Good: most of the information is available online, but structure is lacking 5. Excellent: all government information is available online and neatly structured.
Unit	Likert scale
Justification	Open information flows increase transparency and prevent information asymmetry, thereby enhancing participation.
Indicator requirements	
Data source	To be derived from interviews with the smart city coordinator or city administration
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	This indicator investigates the ratio of unclassified government documents available to citizens, journalist, developer, communities, etc. and whether they are available online in digital form, which is better for share storage. Unclassified government documents include urban planning, operation, budget, strategy and statistics documents.

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Gov 15	Open government dataset
Field	Governance
Application field	On-line goverment data
Indicator summary	
Description	# of open government datasets per 100.000 inhabitants
Source	CITYkeys
Calculation	(number of open government datasets/total population) x 100.000
Unit	#/100,000
Justification	How involved is the local government in built a smart city
Indicator requirements	
Data source	Planning or economic department should be able to provide an overview
Reference period	Data should be gathered from the last year with available data. The value must be reported with the corresponding year
Additional notes	Open data refers those data that can be freely used, re-used and redistributed by anyone

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Annex II: Project level indicators

The purpose of this Annex II is to present a detailed description of the indicators at Project Level where for every indicator a factsheet is fulfilled, including the following information:

Template for the city level indicator description

Indicator code and Name	
Category	Pillar where the indicator is allocated
Description	Definition of the indicator
Reference	Reference document or project on which the indicator is based
Calculation	Description of the calculation formula and list of variables needed to calculate the indicator
Unit	Indicator unit of measurement
Type of indicator	Core or Complementary For energy and mobility indicators: Primary or Secondary
Data source	Possible data sources where needed data should be gathered
Applicability to interventions/actions	Categories of interventions/actions the indicator can be applied to Action names where will be evaluated

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Energy & Environment

Objective 1: Reduction in final energy consumption

E1	Thermal energy consumption
Category pillar	Energy
Description	Thermal energy consumption corresponds to the energy entering the generation system (natural gas, gasoil, etc.) to satisfy the thermal uses in order to keep operation parameters (e.g. comfort levels). To enable the comparability between systems, the energy consumption is related to the size of the system (e.g. building conditioned surface) and the time interval (e.g. year). This indicator can be used to assess the energy efficiency of a system.
Reference	SCIS, CITYKEYS
Calculation	*For buildings actions:* E1 = Thermal energy consumption of all forms of energy / Floor area of the buildings *For city infrastructures:* E1 = Thermal energy consumption of all forms of energy In SCIS, energy consumption is reported at three phases: for refurbished buildings (baseline, (design), monitoring) and for new buildings (reference energy consumption based on regulations and similar buildings, design demand based on simulations, and monitored consumption).
Unit	kWh/year (m^2), kWh/month (m^2)
Type of indicator	Core - Primary
Data source	Energy meters, Energy bills, Calibrated Energy Simulation
Actions/ Interventions	**Action category:** Buildings & District, City infrastructure **Nantes**: Inspiration (A1), Pierre Landais (A4, A7, A17), Oiseau des Iles (A5, A7), Individual houses (A3-A6-A12), Multi-owner buildings retrofitting (A2, A17), District Heating (A16)

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	<u>Hamburg:</u> Schleusengraben- Schilfpark (A1, A13, A18), Bergedorf Süd (A2*, A14), Smart Energy Control in Smart Heating Island (Energy Campus) (A9), Smart Homes (A3), PV in high-performance area (A19a-b), Kampweg (A5, A7) **<u>Helsinki:</u>** Merihaka retrofitting (A1, A4, A,10), New construction Kalasatama (A2, A5, A7, A10, A13), Viikki Environment House (A3, A6, A8, A9)

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E2	Electrical energy consumption
Category pillar	Energy
Description	Electrical energy consumption corresponds to the energy entering the system for all electrical uses to keep operation parameters To enable the comparability between systems, the energy consumption is related to the size of the system and the time interval. This indicator can be used to assess the energy efficiency of a system.
Reference	SCIS, CITYKEYS
Calculation	*For buildings actions:* E2 = Electrical energy consumption / Floor area of the buildings *For city infrastructures:* E2 = Electrical energy consumption
Unit	kWh/year (m^2), kWh/month (m^2)
Type of indicator	Core - Primary
Data source	Energy meters, Energy bills, Calibrated Energy Simulation
Actions/ Interventions	**Action category:** Buildings & District, City infrastructure **Nantes:** Pierre Landais (A4, A7, A17), Individual houses (A3-A6-A12), Multi-owner buildings retrofitting (A2, A17), CIC building (A31-A8-A14-A22), Public buildings PV plants (A21.b) **Hamburg:** Schleusengraben- Schilfpark (A1, A13, A18), Bergedorf Süd (A2*, A14), Smart Energy Control in Smart Heating Island (Energy Campus) (A9), Smart Homes (A3), PV in high-performance area (A19a-b), Kampweg (A5, A7) **Helsinki**: Merihaka retrofitting (A1, A4, A,10), New construction Kalasatama (A2, A5, A7, A10, A13), Viikki Environment House (A3, A6, A8, A9)

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E3	Public lighting energy consumption
Category pillar	Energy
Description	This indicator corresponds to the energy entering the system (in this case public lighting) to satisfy to keep the operation parameters
Reference	mySMARTLife
Calculation	E3 = Energy consumption due to public lighting facility
Unit	kWh/year, kWh/month
Type of indicator	Core - Primary
Data source	Energy meters, Energy bills, Calibrated Energy Simulation
Actions/ Interventions	**Action category:** Public lighting **Nantes**: Public lighting (A18) **Hamburg**: Public lighting (A15, A16) **Helsinki:** Public lighting (A15)

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E4	Annual energy consumption
Category pillar	Energy
Description	The indicator corresponds to the energy entering the system covering all uses and form of energy to keep operation parameters (e.g. comfort levels) and services. The total energy consumption corresponds with the sum of the thermal energy consumption and electrical consumption. To enable the comparability between systems, the total energy consumption is related to the size of the system and the time interval. This indicator can be used to assess the energy efficiency of a system.
Reference	SCIS, CITYKEYS
Calculation	*For buildings and city infrastructure actions:* E4 = (E1 + E2)
Unit	kWh/year (m^2), kWh/month (m^2)
Type of indicator	Core - Secondary
Data source	Energy meters, Energy bills, Calibrated Energy Simulation
Actions/ Interventions	**Action category:** Buildings & District, City infrastructure **Nantes:** Inspiration (A1), Pierre Landais (A4, A7, A17), Oiseau des Iles (A5, A7), Individual houses (A3-A6-A12), Multi-owner buildings retrofitting (A2, A17), CIC building (A31-A8-A14-A22), District Heating (A16), Public buildings PV plants (A21.b) **Hamburg**: Schleusengraben- Schilfpark (A1, A13, A18), Bergedorf Süd (A2*, A14, A10), Smart Energy Control in Smart Heating Island (Energy Campus) (A9), Smart Homes (A3), PV in high-performance area (A19a-b), Kampweg (A5, A7) **Helsinki:** Merihaka retrofitting (A1, A4, A,10), New construction Kalasatama (A2, A5, A7, A10, A13), Viikki Environment House (A3, A6, A8, A9)

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E5	Reduction in annual energy consumption
Category pillar	Energy
Description	The indicator determines the reduction of final energy consumption to reach the same services (e.g. comfort levels) after the interventions, taking into consideration the energy consumption from the reference period. This indicator may be calculated separately determined for thermal (heating or cooling) energy and electricity, o as an addition of both to consider the whole savings.
Reference	SCIS / CITYKEYS
Calculation	The percentage of the reduction in annual energy consumption caused by the project is calculated as the difference between the annual energy consumption related to the project before (reference period) and after project completion (reporting period) *Reduction in thermal energy consumption:* $E5 = \frac{E1\ (reference\ period) - E1\ (reporting\ period)}{E1\ (reference\ period)}\ x100$ *Reduction in electrical energy consumption:* $E5 = \frac{E2\ (reference\ period) - E2\ (reporting\ period)}{E2\ (reference\ period)}\ x100$ *Reduction in lighting energy consumption:* $E5 = \frac{E3\ (reference\ period) - E3\ (reporting\ period)}{E3\ (reference\ period)}\ x100$ *Reduction in total energy consumption:* $E5 = \frac{E4\ (reference\ period) - E4\ (reporting\ period)}{E4\ (reference\ period)}\ x100$ For comparison (in buildings): baseline data energy demand/consumption over a reference period of one year before intervention is compared to monitored energy consumption after intervention. In some cases additional design data on targeted energy demand after intervention, obtained through simulations, is necessary as well. For new buildings a credible method for baseline/reference consumption/demand over one year needs to be established based on local energy regulations on new buildings, other similar buildings and/or simulations. Energy consumption data needs to be collected monthly and, when relevant, be

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	accompanied by weather and/or occupancy data to take into account potential effect of external factors in comparison
Unit	% change in kWh / (m^2 year)
Type of indicator	Core - Secondary
Data source	Can be derived from the data sources used to calculate the energy consumption from reference period and reporting period (energy meters, energy bills, calibrated energy simulations)
Actions/ Interventions	**Action category:** Buildings & District, City infrastructure, Public lighting **Nantes:** Inspiration (A1), Pierre Landais (A4, A7, A17), Oiseau des Iles (A5, A7), District Heating (A16), Public lighting (A18), Individual houses (A3-A6-A12), Multi-owner buildings retrofitting (A2, A17), Public buildings PV plants (A21.b) **Hamburg**: Schleusengraben- Schilfpark (A1, A13, A18), Bergedorf Süd (A2*,A14, A10), Smart Energy Control in Smart Heating Island (Energy Campus) (A9), Smart Homes (A3), PV in high-performance area (A19a-b), Kampweg (A5, A7), Public lighting (A15, A16) **Helsinki**: Merihaka retrofitting (A1, A4, A,10), New construction Kalasatama (A2, A5, A7, A10, A13), Viikki Environment House (A3, A6, A8, A9), Public lighting (A15)

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E6	Energy use for heating
Category pillar	Energy
Description	The energy demand due to heating systems to keep comfort conditions. This should be referred to the total conditioned floor area
Reference	mySMARTLife
Calculation	E6 = Heating energy demand / Floor area of the buildings
Unit	kWh/year (m^2), kWh/month (m^2)
Type of indicator	Core - Primary
Data source	Energy meters, Energy bills, Calibrated Energy Simulation
Actions/ Interventions	**Action category:** Buildings & District **Nantes:** Pierre Landais (A4, A7, A17), Oiseau des Iles (A5, A7), Individual houses (A3-A6-A12), Multi-owner buildings retrofitting (A2, A17) **Hamburg**: Schleusengraben- Schilfpark (A1, A13, A18), Smart Energy Control in Smart Heating Island (Energy Campus) (A9), Bergedorf Süd (A2*, A14), Smart Homes (A3) **Helsinki**: Merihaka retrofitting (A1, A4, A,10), New construction Kalasatama (A2, A5, A7, A10, A13), Viikki Environment House (A3, A6, A8, A9)

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E7	Energy use for DHW
Category pillar	Energy
Description	The energy demand due to Domestic Hot Water (DHW) systems to satisfy the user's needs. This should be referred to the total used conditioned floor area
Reference	mySMARTLife
Calculation	E7 = Domestic Hot Water energy demand / Floor area of the buildings
Unit	kWh/year (m^2), kWh/month (m^2)
Type of indicator	Core - Primary
Data source	Energy meters, Energy bills, Calibrated Energy Simulation
Actions/ Interventions	**Action category:** Buildings & District **Nantes:** Pierre Landais (A4, A7, A17), Oiseau des Iles (A5, A7), Individual houses (A3-A6-A12), Multi-owner buildings retrofitting (A2, A17) **Helsinki**: Merihaka retrofitting (A1, A4, A,10), New construction Kalasatama (A2, A5, A7, A10, A13), Viikki Environment House (A3, A6, A8, A9)

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E8	Energy use for lighting
Category pillar	Energy
Description	The energy demand due to lighting systems to keep the lighting comfort. This should be referred to the total used conditioned floor area
Reference	mySMARTLife
Calculation	E8 = Lighting energy demand / Area
Unit	kWh/year (m^2), kWh/month (m^2)
Type of indicator	Core - Primary
Data source	Energy meters, Energy bills, Calibrated Energy Simulation
Actions/ Interventions	**Action category:** Buildings & District, City infrastructure **Hamburg**: PV in high-performance area (A19a-b), Kampweg (A5, A7)

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E9	Energy use for cooling
Category pillar	Energy
Description	The energy demand due to cooling systems to keep the comfort conditions. This should be referred to the total used conditioned floor area
Reference	mySMARTLife
Calculation	E9 = Cooling energy demand / Area
Unit	kWh/year (m^2), kWh/month (m^2)
Type of indicator	Core - Primary
Data source	Energy meters, Energy bills, Calibrated Energy Simulation
Actions/ Interventions	**Action category:** Buildings & District, City infrastructure **Hamburg**: PV in high-performance area (A19a-b), Kampweg (A5, A7) **Helsinki**: Viikki Environment House (A3, A6, A8, A9)

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E10	Reduction in annual heating energy use ambitious compared to national regulation for new or retrofit building
Category pillar	Energy
Description	Percentage of reduction of the annual heating demand of the building after the implementation of all practices in comparison to the values from this type of building in the existing national regulation during the reference period. Also practical cases could be considered for this comparison.
Reference	mySMARTLife (according to BEST Table)
Calculation	$E10 = \frac{E6\,(existing\,regulation) - E6\,(reporting\,period)}{E6\,(existing\,regulation)}\ x100$
Unit	% in kWh/m^2
Type of indicator	Core - Primary
Data source	Energy meters, Energy bills, Calibrated Energy Simulation
Actions/ Interventions	**Action category:** Buildings & District **Nantes:** Pierre Landais (A4, A7, A17), Individual houses (A3-A6-A12), Multi-owner buildings retrofitting (A2, A17) **Hamburg**: Schleusengraben- Schilfpark (A1, A13, A18), Bergedorf Süd (A2, A14), Smart Energy Control in Smart Heating Island (Energy Campus) (A9) **Helsinki**: Merihaka retrofitting (A1, A4, A,10), New construction Kalasatama (A2, A5, A7, A10, A13), Viikki Environment House (A3, A6, A8, A9)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 731297.

E11	Reduction in annual DHW energy use ambitious compared to national regulation for new or retrofit building
Category pillar	Energy
Description	Percentage of reduction of the annual DHW demand of the building after the implementation of all practices in comparison to the values from this type of building in the existing national regulation during the reference period. Also practical cases could be considered for this comparison.
Reference	mySMARTLife (according to BEST Table)
Calculation	$E11 = \frac{E7\ (existing\ regulation) - E7\ (reporting\ period)}{E7\ (existing\ regulation)}\ x100$
Unit	% in kWh/m^2
Type of indicator	Core - Primary
Data source	Energy meters, Energy bills, Calibrated Energy Simulation
Actions/ Interventions	**Action category:** Buildings & District **Nantes:** Pierre Landais (A4, A7, A17), Oiseau des Iles (A5, A7), Multi-owner buildings retrofitting (A2, A17), Individual houses (A3-A6-A12) **Hamburg**: Schleusengraben- Schilfpark (A1, A13, A18) **Helsinki**: Viikki Environment House (A3, A6, A8, A9)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 731297.

E12	Reduction in annual electricity energy use ambitious compared to national regulation for new or retrofit building
Category pillar	Energy
Description	Percentage of reduction of the annual enery demand of the building for lighting/electricity after the implementation of all practices in comparison to the values from this type of building in the existing national regulation during the reference period. Also practical cases could be considered for this comparison.
Reference	mySMARTLife (according to BEST Table)
Calculation	$E13 = \frac{Electricity\ demand\ (Existing\ regulation) -\ Electricity\ demand\ (reporting\ period)}{Electricity\ demand\ (Existing\ regulation)}\ x1($
Unit	% in kWh/m^2
Type of indicator	Core - Primary
Data source	Energy meters, Energy bills, Calibrated Energy Simulation
Actions/ Interventions	**Action category:** Buildings & District

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 731297.

Objective 2: Increase in the RES production

E13	Total renewable thermal energy production
Category pillar	Energy
Description	Thermal energy produced from local renewable sources in a period of time
Reference	SCIS, CITYKEYS
Calculation	*For buildings actions:* E13 = Thermal renewable energy production / Floor area of the buiding *For city infrastructures:* E13 = Thermal renewable energy production
Unit	kWh/month (m^2) ; kWh/year (m^2)
Type of indicator	Core - Primary
Data source	The information should be gathered from real data measured and monitored by different energy meters installed in the facilities.
Actions/ Interventions	**Action category:** Buildings & District, City infrastructure **Nantes:** Pierre Landais (A4, A7, A17), Individual houses (A3-A6-A12), Multi-owner buildings retrofitting (A2, A17), District Heating (A16) **Hamburg**: Schleusengraben- Schilfpark (A1, A13, A18), Smart Energy Control in Smart Heating Island (Energy Campus) (A9), PV in high-performance area (A19a-b), Kampweg (A5, A7) **Helsinki**: New construction Kalasatama (A2, A5, A7, A10, A13), Viikki Environment House (A3, A6, A8, A9), Urban RES (A16), City infrastructure (A14, A16, A19)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 731297.

E14	Total renewable electrical energy production
Category pillar	Energy
Description	Electrical energy produced from local renewable sources in a period of time
Reference	SCIS, CITYKEYS
Calculation	*For buildings actions:* E14 = Electrical renewable energy production / Floor area of the buiding *For city infrastructures:* E14 = Electrical renewable energy production during the reference period of time (month, year)
Unit	kWh/month (m^2) ; kWh/year (m^2)
Type of indicator	Core - Primary
Data source	The information should be gathered from real data measured and monitored by different energy meters installed in the facilities.
Actions/ Interventions	**Action category:** Buildings & District, City infrastructure **Nantes:** Individual houses (A3-A6-A12), Multi-owner buildings retrofitting (A2, A17), CIC building (A31-A8-A14-A22), Cité des congrès (A21.a), Public buildings PV plants (A21.b) **Hamburg**: Schleusengraben- Schilfpark (A1, A13, A18), Smart Energy Control in Smart Heating Island (Energy Campus) (A9), Local wind farm + decentralised storage (A17, A20), PV in high-performance area (A19a-b), Kampweg (A5, A7), Maximization of RES production (A5, A7) **Helsinki**: New construction Kalasatama (A2, A5, A7, A10, A13), Viikki Environment House (A3, A6, A8, A9), City infrastructure (A17), City infrastructure (A11, A12, A18, A20)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 731297.

E15	Total renewable energy production
Category pillar	Energy
Description	Total energy produced (thermal and electricity) from local renewable sources in a period of time
Reference	SCIS, CITYKEYS
Calculation	E15 = E13 + E14
Unit	kWh/month (m^2) ; kWh/year (m^2)
Type of indicator	Core - Secondary
Data source	The information should be gathered from real data measured and monitored by different energy meters installed in the facilities
Actions/ Interventions	**Action category:** Buildings & District, City infrastructure **Nantes:** Pierre Landais (A4, A7, A17), Individual houses (A3-A6-A12), Multi-owner buildings retrofitting (A2, A17), CIC building (A31-A8-A14-A22), District Heating (A16), Cité des congrès (A21.a), Public buildings PV plants (A21.b) **Hamburg**: Smart Energy Control in Smart Heating Island (Energy Campus) (A9), Local wind farm + decentralised storage (A17, A20), PV in high-performance area (A19a-b), Kampweg (A5, A7), Maximization of RES production (A5, A7) **Helsinki**: New construction Kalasatama (A2, A5, A7, A10, A13), Viikki Environment House (A3, A6, A8, A9), Urban RES (A16), City infrastructure (A14, A16, A19), City infrastructure (A17), City infrastructure (A11, A12, A18, A20)

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E16	Increase in local renewable energy production
Category pillar	Energy
Description	Percentage increase in the share of local renewable energy due to the intervention. It is separately determined for thermal (heating or cooling) energy and electricity.
Reference	SCIS, CITYKEYS
Calculation	The percentage of the increase in local renewable energy production caused by the project is calculated as the difference between the annual renewable energy generation related to the project before (reference period) and after project completion (post-intervention) $E16 = \frac{E15\ (post-intervention) - E15\ (reference\ period)}{E15\ (reference\ period)}\ x100$
Unit	% change in kWh
Type of indicator	Core - Secondary
Data source	The information should be gathered from real data measured and monitored by different energy meters installed in the facilities
Actions/ Interventions	**Action category:** Buildings & District, City infrastructure **<u>Nantes</u>:** Pierre Landais (A4, A7, A17), Multi-owner buildings retrofitting (A2, A17), District Heating (A16), Public buildings PV plants (A21.b), Individual houses (A3-A6-A12), CIC building (A31-A8-A14-A22) **<u>Hamburg</u>**: Smart Energy Control in Smart Heating Island (Energy Campus) (A9), PV in high-performance area (A19a-b), Kampweg (A5, A7), Maximization of RES production (A5, A7) **<u>Helsinki</u>**: New construction Kalasatama (A2, A5, A7, A10, A13), Viikki Environment House (A3, A6, A8, A9), Urban RES (A16), City infrastructure (A14, A16, A19), City infrastructure (A11, A12, A18, A20)

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Objective 3: Fraction of energetic self-supply by RES

E17	Degree of energy self-supply by RES
Category pillar	Energy
Description	Total energy produced from renewable sources that is consumed by the building to cover the energy consumption in a period of time (generally a year). The indicator should be expressed as the share of locally produced RES of total energy consumption (together and separately for thermal and electrical energy).
Reference	SCIS
Calculation	E17 $= \frac{\sum Energy\ produced\ by\ renewable\ sources\ (kWh)}{Total\ energy\ consumption\ (kWh)} * 100$ Where, - Energy produced by renewable sources = E15 - Total energy consumption = E2
Unit	%
Type of indicator	Complementary - Secondary
Data source	The information should be gathered from real data measured and monitored by different energy meters installed in the facilities
Actions/ Interventions	**Action category:** Buildings & District, City infrastructure **<u>Nantes</u>:** Multi-owner buildings retrofitting (A2, A17), CIC building (A31-A8-A14-A22), District Heating (A16), Public buildings PV plants (A21.b) **<u>Hamburg</u>**: Smart Energy Control in Smart Heating Island (Energy Campus) (A9), PV in high-performance area (A19a-b), Kampweg (A5, A7), Maximization of RES production (A5, A7) **<u>Helsinki</u>**: New construction Kalasatama (A2, A5, A7, A10, A13), Viikki Environment House (A3, A6, A8, A9), Urban RES (A16), City infrastructure (A14, A16, A19), City infrastructure (A11, A12, A18, A20)

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E18	Increase of degree of energy self-supply by RES
Category pillar	Energy
Description	Percentage increase in the degree of energy self-supply by RES. The indicator should be expressed as the share of locally produced RES of total energy consumption (together and separately for thermal and electrical energy).
Reference	SCIS
Calculation	In order to calculate the % change, the degree of energetic self-supply by RES (thermal and electrical together and separately) after the intervention is compared to the degree of energetic self-supply by RES before the intervention. $E18 = \frac{E17(reporting\ period) - E17\ (reference\ period)}{E17\ (reporting\ period)}\ x100$
Unit	%
Type of indicator	Complementary - Secondary
Data source	The information should be gathered from real data measured and monitored by different energy meters installed in the facilities
Actions/ Interventions	**Action category:** Buildings & District, City infrastructure **Nantes:** Pierre Landais (A4, A7, A17), Multi-owner buildings retrofitting (A2, A17), District Heating (A16), Public buildings PV plants (A21.b), Individual houses (A3-A6-A12), CIC building (A31-A8-A14-A22) **Hamburg**: Smart Energy Control in Smart Heating Island (Energy Campus) (A9), PV in high-performance area (A19a-b), Kampweg (A5, A7), Maximization of RES production (A5, A7) **Helsinki**: New construction Kalasatama (A2, A5, A7, A10, A13), Viikki Environment House (A3, A6, A8, A9), Urban RES (A16), City infrastructure (A14, A16, A19), City infrastructure (A11, A12, A18, A20)

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Objective 4: Energy provided from existing energy city infrastructures

E24	Recovery
Category pillar	Energy
Description	This indicator aims to quantify the percentage of thermal energy provided to the recovery systems in relation to the total thermal energy consumption
Reference	mySMARTLife
Calculation	E24 =(Thermal energy provided by the heating recovery system / Thermal energy consumption) x 100 Where, thermal energy consumption =E1
Unit	%
Type of indicator	Core - Complementary
Data source	The information should be gathered from real data measured and monitored by different energy meters installed in the facilities
Actions/ Interventions	**Action category:** Buildings & District **Nantes:** Pierre Landais (A4, A7, A17), Oiseau des Iles (A5, A7)

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E25	**Total heat supplied to the buildings connected to district heating network**
Category pillar	Energy
Description	Thermal energy flow produced and distributed by the district heating employed to cover building heating and DHW demands per year
Reference	REPLICATE
Calculation	E25 = Total heat supplied from the district heating to the demosite buildings for covering heating and DHW uses The indicator should be reported as a whole and for each demosite building involved (when this was possible)
Unit	kWh/year
Type of indicator	Complementary - Secondary

E26	**Degree of heating supply by district heating**
Category pillar	Energy **Action category:** Buildings & District, City infrastructure
Description	Ratio of heat supplied from the urban district heating
Actions/ Interventions	**Nantes:** District Heating (A16) **Hamburg:** District heating with renewable hydrogen (A13, A18), Smart heating island (A14) *For city infrastructures:* **Helsinki**: City infrastructure (A14, A16, A19)
Reference	REPLICATE
Calculation	E26 = Total heat supplied from the district heating to the demosite buildings (E25) / Total energy supply by district heating For city infrastructure, the indicator shows the energy supplied by the district heating to cover thermal energy needs in relation to the total energy supplied from DH in the whole city *For buildings actions:* E26 = Total heat supplied from the district heating to the demosite buildings (E25) / Thermal energy consumption of buildings (E2) For buildings, the indicator shows the ratio of thermal energy consumption of the

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	buildings that is covered by the energy supplied from the DH
Unit	%
Type of indicator	Complementary - Secondary
Data source	The information should be gathered from real data measured and monitored by different energy meters installed in the facilities
Actions/ Interventions	**Action category:** Buildings & District, City infrastructure **Nantes:** Inspiration (A1), Pierre Landais (A4, A7, A17), Oiseau des Iles (A5, A7), Multi-owner buildings retrofitting (A2, A17), District Heating (A16) **Hamburg**: District heating with renewable hydrogen (A13, A18), Smart heating island (A14) **Helsinki**: Merihaka retrofitting (A1, A4, A,10), New construction Kalasatama (A2, A5, A7, A10, A13), Viikki Environment House (A3, A6, A8, A9), City infrastructure (A14, A16, A19)

E27	**Degree of energy supply by Urban RES infrastructure**
Category pillar	Energy
Description	Ratio of total energy supplied to the area connected to the urban RES infrastruture in relation to the total final energy consumption in the area
Reference	REPLICATE
Calculation	E27 = RES energy supply/total energy consumption Where RES energy supply correspond with E13, E14, E15
Unit	%
Type of indicator	Complementary - Secondary
Data source	The information should be gathered from real data measured and monitored by different energy meters installed in the facilities
Actions/	**Action category:** City infrastructure

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Interventions	**Hamburg**: Local wind farm (A17, A20), PV in high-performance area (A19a-b), Kampweg (A5, A7)

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Objective 5: Reduction in primary energy consumption

E19	Primary thermal energy consumption
Category pillar	Energy
Description	The primary energy consumption related to heating encompasses all the naturally available energy that is consumed in the heating system. To enable the comparability between systems, the total primary energy consumption can be related to the size of the system (e.g. conditioned area) and the considered time interval (e.g. month, year).
Reference	SCIS
Calculation	E19 = E1 * Primary energy factor for thermal energy from energy carrier Primary energy factor for thermal energy (weighted average based on source/fuel mix in production) Primary energy factors used with reference to source and year should be accompanied with the assessment.
Unit	kWh/year (m^2), kWh/month (m^2)
Type of indicator	Core - Secondary
Data source	Can be derived from energy consumption with help of emission factors based on fuel mix of energy source
Actions/ Interventions	**Action category:** Buildings & District, City infrastructure **Nantes:** Inspiration (A1), Pierre Landais (A4, A7, A17), Oiseau des Iles (A5, A7), Indivual houses (A3-A6-A12), Multi-owner buildings retrofitting (A2, A17), District Heating (A16) **Hamburg**: Schleusengraben- Schilfpark (A1, A13, A18), Smart Energy Control in Smart Heating Island (Energy Campus) (A9), Bergedorf Süd (A2*, A14), Smart Homes (A3), PV in high-performance area (A19a-b), Kampweg (A5, A7) **Helsinki**: Merihaka retrofitting (A1, A4, A,10), New construction Kalasatama (A2, A5, A7, A10, A13), Viikki Environment House (A3, A6, A8, A9)

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E20	Primary electrical energy consumption
Category pillar	Energy
Description	The primary energy consumption related to heating encompasses all the naturally available energy that is consumed in the heating system. To enable the comparability between systems, the total primary energy consumption can be related to the size of the system (e.g. conditioned area) and the considered time interval (e.g. month, year).
Reference	SCIS
Calculation	E20 = E2 * Primary energy factor for electrical energy from energy carrier Primary energy factor for electrical energy (weighted average based on source/fuel mix in production) Primary energy factors used with reference to source and year should be accompanied with the assessment.
Unit	kWh/year (m^2), kWh/month (m^2)
Type of indicator	Core - Secondary
Data source	Can be derived from energy consumption with help of emission factors based on fuel mix of energy source
Actions/ Interventions	**Action category:** Buildings & District, City infrastructure **Nantes:** Pierre Landais (A4, A7, A17), Individual houses (A3-A6-A12), Multi-owner buildings retrofitting (A2, A17), CIC building (A31-A8-A14-A22), Public buildings PV plants (A21.b) **Hamburg**: Schleusengraben- Schilfpark (A1, A13, A18), Energy Campus (A9), Bergedorf Süd (A2*, A14, A10), Smart Homes (A3), PV in high-performance area (A19a-b), Kampweg (A5, A7) **Helsinki**: Merihaka retrofitting (A1, A4, A,10), New construction Kalasatama (A2, A5, A7, A10, A13), Viikki Environment House (A3, A6, A8, A9)

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E21	**Total primary energy consumption**
Category pillar	Energy
Description	The total primary energy consumption corresponds with the sum of the thermal energy primary consumption and electrical primary consumption
Reference	SCIS
Calculation	E21 = (E19 + E20)
Unit	kWh/year (m^2), kWh/month (m^2)
Type of indicator	Core - Secondary
Data source	Can be derived from energy consumption with help of emission factors based on fuel mix of energy source
Actions/ Interventions	**Action category:** Buildings & District, City infrastructure **Nantes:** Inspiration (A1), Pierre Landais (A4, A7, A17), Oiseau des Iles (A5, A7), Individual houses (A3-A6-A12), Multi-owner buildings retrofitting (A2, A17), CIC building (A31-A8-A14-A22), District Heating (A16), Public buildings PV plants (A21.b) **Hamburg**: Schleusengraben- Schilfpark (A1, A13, A18), Smart Energy Control in Smart Heating Island (Energy Campus) (A9), Bergedorf Süd (A2*, A14), Smart Homes (A3), PV in high-performance area (A19a-b), Kampweg (A5, A7), Maximization of RES production (A5, A7) **Helsinki**: Merihaka retrofitting (A1, A4, A,10), New construction Kalasatama (A2, A5, A7, A10, A13), Viikki Environment House (A3, A6, A8, A9)

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E22	Reduction of total primary energy consumption
Category pillar	Energy
Description	This indicator determines the reduction of the primary energy consumption after the interventions, taking into consideration the energy consumption from the reference period.
Reference	SCIS
Calculation	$E22 = \frac{E21(reference\ period) - E21\ (reporting\ period)}{E21\ (reference\ period)}\ x100$ Where E21 refers to total primary energy consumption
Unit	% change in kWh / (m^2 year)
Type of indicator	Core - Secondary
Data source	Can be derived from energy consumption with help of emission factors based on fuel mix of energy source
Actions/ Interventions	**Action category:** Buildings & District, City infrastructure **Nantes:** Inspiration (A1), Pierre Landais (A4, A7, A17), Oiseau des Iles (A5, A7), Individual houses (A3-A6-A12), Multi-owner buildings retrofitting (A2, A17), District Heating (A16), Public buildings PV plants (A21.b) **Hamburg**: Schleusengraben- Schilfpark (A1, A13, A18), Smart Energy Control in Smart Heating Island (Energy Campus) (A9), Bergedorf Süd (A2*, A14, A10), Smart Homes (A3), PV in high-performance area (A19a-b), Kampweg (A5, A7), Maximization of RES production (A5, A7) **Helsinki**: Merihaka retrofitting (A1, A4, A,10), New construction Kalasatama (A2, A5, A7, A10, A13), Viikki Environment House (A3, A6, A8, A9)

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E23	Total primary energy consumption related to heating delivered
Category pillar	Energy
Description	Primary enegy consumption due the heating energy flow
Reference	mySMARTLife
Calculation	E23 = Heating energy flow * Primary energy factor for thermal energy from energy carrier *For city infrastructures:* E23 = Primary enegy consumption due the heating delivered *For buildings actions:* E23 = Primary energy consumption due to the heating consumption
Unit	kWh / (m2 * Year)
Type of indicator	Core - Secondary
Data source	Can be derived from energy meteres with help of emission factors based on fuel mix of energy source
Actions/ Interventions	**Action category:** Buildings & District, City infrastructure **Nantes:** District Heating (A16) **Hamburg**: Schleusengraben- Schilfpark (A1, A13, A18), Bergedorf Süd (A2, A14), Smart Energy Control in Smart Heating Island (Energy Campus) (A9), PV in high-performance area (A19a-b), Kampweg (A5, A7) **Helsinki**: City infrastructure (A14, A16, A19)

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Objective 6: Reduction in greenhouse gas emissions

E28	**Total greenhouse gas emissions (thermal)**
Category pillar	Energy
Description	Greenhouse gases emissions due to energy consumption for thermal uses
Reference	SCIS, CITYKEYS
Calculation	The greenhouse gas emissions will be calculated multiplying the GWP (Global Warming Potential) factors of each energy carrier by the total thermal energy consumption– per energy carrier E28 = Thermal energy consumption (E1) x Emission factor for energy carrier Emmision factors used with reference to source and year should be accompanied with the assessment
Unit	kg CO_{2eq}/ (m_2 *year), kg CO_{2eq}/ (m_2 *month)
Type of indicator	Core - Secondary
Data source	Can be derived from thermal energy consumption with help of emission factors based on fuel mix of energy source.
Actions/ Interventions	**Action category:** Buildings & District, City infrastructure **Nantes:** Inspiration (A1), Pierre Landais (A4, A7, A17), Oiseau des Iles (A5, A7), Individual houses (A3-A6-A12), Multi-owner buildings retrofitting (A2, A17), District Heating (A16) **Hamburg**: Schleusengraben- Schilfpark (A1, A13, A18), Smart Energy Control in Smart Heating Island (Energy Campus) (A9), Bergedorf Süd (A2*, A14), Smart Homes (A3), PV in high-performance area (A19a-b), Kampweg (A5, A7) **Helsinki**: Merihaka retrofitting (A1, A4, A,10), New construction Kalasatama (A2, A5, A7, A10, A13), Viikki Environment House (A3, A6, A8, A9), City infrastructure (A14, A16, A19)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 731297.

E29	Total greenhouse gas emissions (electrical)
Category pillar	Energy
Description	Greenhouse gases emissions due to energy consumption for electrical uses
Reference	SCIS, CITYKEYS
Calculation	The greenhouse gas emissions will be calculated multiplying the GWP (Global Warming Potential) factors of each energy carrier by the total electrical energy consumption– per energy carrier E29 = Electrical energy consumption (E2) x Emission factor for energy carrier Emmision factors used with reference to source and year should be accompanied with the assessment
Unit	kg CO_{2eq}/ (m_2 *year), kg CO_{2eq}/ (m_2 *month)
Type of indicator	Core - Secondary
Data source	Can be derived from electrical energy consumption with help of emission factors based on fuel mix of energy source.
Actions/ Interventions	**Action category:** Buildings & District, City infrastructure **Nantes:** Pierre Landais (A4, A7, A17), Individual houses (A3-A6-A12), Multi-owner buildings retrofitting (A2, A17), Public buildings PV plants (A21.b) **Hamburg**: Schilfpark (A1, A13, A18), Smart Energy Control in Smart Heating Island (Energy Campus) (A9), Bergedorf Süd (A2*, A14, A10), Smart Homes (A3), PV in high-performance area (A19a-b), Kampweg (A5, A7), Maximization of RES production (A5, A7) **Helsinki**: Merihaka retrofitting (A1, A4, A,10), New construction Kalasatama (A2, A5, A7, A10, A13), Viikki Environment House (A3, A6, A8, A9), City infrastructure (A11, A12, A18, A20)

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E30	Total greenhouse gas emissions (lighting)
Category pillar	Energy
Description	Greenhouse gases emissions due to energy consumption of the lighting facility
Reference	SCIS, CITYKEYS
Calculation	The greenhouse gas emissions will be calculated multiplying the GWP (Global Warming Potential) factors of each energy carrier by the total electrical energy consumption– per energy carrier E29 = Public lighting energy consumption (E3) x Emission factor for energy carrier Emmision factors used with reference to source and year should be accompanied with the assessment
Unit	kg CO_{2eq}/ (year), kg CO_{2eq}/ (month)
Type of indicator	Core - Secondary
Data source	Can be derived from public lighting energy consumption with help of emission factors based on fuel mix of energy source.
Actions/ Interventions	**Action category:** Public lighting **Nantes:** Public lighting (A18) **Hamburg**: Public lighting (A15, A16) **Helsinki**: Public lighting (A15)

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E31	Total greenhouse gas emissions
Category pillar	Energy
Description	Greenhouse gases emissions due to total energy consumption
Reference	SCIS, CITYKEYS
Calculation	E31 = E29 + E30
Unit	kg CO_{2eq}/ (m_2 *year), kg CO_{2eq}/ (m_2 *month)
Type of indicator	Core - Secondary
Data source	Can be derived from total energy consumption with help of emission factors based on fuel mix of energy source.
Actions/ Interventions	**Action category:** Buildings & District, City infrastructure, Public lighting **Nantes:** Inspiration (A1), Pierre Landais (A4, A7, A17), Oiseau des Iles (A5, A7), Individual houses (A3-A6-A12), Multi-owner buildings retrofitting (A2, A17), CIC building (A31-A8-A14-A22), Public lighting (A18), District Heating (A16), Public buildings PV plants (A21.b) **Hamburg**: Schleusengraben- Schilfpark (A1, A13, A18), Smart Energy Control in Smart Heating Island (Energy Campus) (A9), Bergedorf Süd (A2*, A14), Smart Homes (A3), PV in high-performance area (A19a-b), Kampweg (A5, A7), Maximization of RES production (A5, A7) **Helsinki**: Merihaka retrofitting (A1, A4, A,10), New construction Kalasatama (A2, A5, A7, A10, A13), Viikki Environment House (A3, A6, A8, A9), City infrastructure (A14, A16, A19), City infrastructure (A11, A12, A18, A20)

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E32	Reduction of total greenhouse gas emissions
Category pillar	Energy
Description	Reduction of greenhouse gases emissions due to energy savings after the implementation of the project actions
Reference	SCIS, CITYKEYS
Calculation	The indicator is calculated as the direct (operational) reduction of the CO_2 emissions over a calender year: before the project and after the project. The result will be divided by the CO_2 emissions before the project, and then it is multiplied by 100 to express the result as a percentage. $$E32 = \frac{E31(reporting\ period) - E31\ (reference\ period)}{E31\ (reporting\ period)}\ x100$$
Unit	% change in kg CO_2 eq /(m_2 * Year)
Type of indicator	Core - Secondary
Data source	Can be derived from total energy consumption with help of emission factors based on fuel mix of energy source
Actions/ Interventions	**Action category:** Buildings & District, City infrastructure, Public lighting **Nantes:** Inspiration (A1), Pierre Landais (A4, A7, A17), Oiseau des Iles (A5, A7), Individual houses (A3-A6-A12), Multi-owner buildings retrofitting (A2, A17), CIC building (A31-A8-A14-A22), District Heating (A16), Public Lighting (A18), Cité des congrès (A21.a), Public buildings PV plants (A21.b) **Hamburg**: Schilfpark (A1, A13, A18), Smart Energy CoS27:T34 Smart Heating Island (Energy Campus) (A9), Bergedorf Süd (A2*, A14, A10), Smart Homes (A3), Public lighting (A15, A16), PV in high-performance area (A19a-b), Kampweg (A5, A7), Maximization of RES production (A5, A7) **Helsinki**: Merihaka retrofitting (A1, A4, A,10), New construction Kalasatama (A2, A5, A7, A10, A13), Viikki Environment House (A3, A6, A8, A9), Public lighting (A15), City infrastructure (A14, A16, A19), City infrastructure (A17), City infrastructure (A11, A12, A18, A20)

Mobility pillar

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M1	Annual number of passengers (or users)
Category pillar	Mobility
Objectives	O2: To benchmark the use of different EV / mobility infrastructure O5: Change in mobility due to solutions implemented *(Travel mode: Use of clean/public transport)*
Description	Number of passengers or users travelling during a year with the new vehicles or on the new infrastuctrure deployed. This indicator measures the level of utilization of the new vehicles / infrastructure
Reference	mySMARTLife
Calculation	M1 = Sum of the total number of users
Unit	# / year
Type of indicator	Primary - Core
Data source	Sensors or surveys
Actions/ Interventions	**Action category: EV & Multimodality** E-buses (Nantes: A23a, A23b – Hamburg: A21 – Helsinki: A23) Pedestrian and bicycle connections (Hamburg: A32)

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M2	Annual number of passengers.km
Category pillar	Mobility
Objectives	O2: To benchmark the use of different EV O5: Change in mobility due to solutions implemented *(Travel mode: Use of clean/public transport)*
Description	Annual number of passengers transported over a distance of one km. This indicator measures the global volume of the transport offer ensured by the bus line
Reference	mySMARTLife
Calculation	M2 = Sum of the distances travelled by all passengers of the buses of the line during one year
Unit	passengers.km
Type of indicator	Secondary – Complementary
Data source	Sensors or surveys
Actions/ Interventions	**Action category: EV** E-buses (Hamburg: A21 – Helsinki: A21, A23)

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M3	Average number of passengers per working day
Category pillar	Mobility
Objectives	O2: To benchmark the use of different EV / mobility infrastructure O5: Change in mobility due to solutions implemented *(Travel mode: Use of clean/public transport)*
Description	Average number of passengers travelling each working day. This indicator measures the level of attendance or of utilization of the transport service during periods often considered as the busiest of the week.
Reference	mySMARTLife
Calculation	M3 = Average (number of passengers during working day 1; number of passengers during working day 2; …; number of passengers during working day N)
Unit	# / working day
Type of indicator	Primary – Complementary
Data source	Sensors or surveys
Actions/ Interventions	**Action category: EV & Multimodality** E-buses (Nantes: A23a, A23b) Pedestrian and bicycle connections (Hamburg: A32)

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M4	**Annual number of trips**
Category pillar	Mobility
Objectives	O2: To benchmark the use of different EV O5: Change in mobility due to solutions implemented *(Amount of travel)*
Description	Total number of trips done by vehicles during a year.
Reference	mySMARTLife
Calculation	M4 = Sum of the total number of trips made by each e-vehicle during one year. In the case of e-buses, one trip corresponds to one commercial trip realized over the whole line.
Unit	# trips / year
Type of indicator	Primary – Complementary
Data source	Sensors, monitoring or management system of vehicles
Actions/ Interventions	**Action category: EV** E-buses (Nantes: A23a, A23b) / Public fleet (Hamburg: A22) / Private vehicles (Hamburg: A23)

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M5	Annual distance travelled
Category pillar	Mobility
Objectives	O2: To benchmark the use and energy consumption of different EV O5: Change in mobility due to solutions implemented *(Amount of travel)*
Description	Total distance travelled by the vehicles during a year
Reference	mySMARTLife
Calculation	M5 = Sum of the distances travelled by each vehicle during one year
Unit	Km / year
Type of indicator	Primary – Core
Data source	Km meter of vehicles
Actions/ Interventions	**Action category: EV and Urban Freight** E-buses (Nantes : A23a, A23b – Hamburg : A21 – Helsinki : A21, A23), Public fleet (Hamburg : A22), E-community fleet (Hamburg: A23), Electrification of the city logistics and delivery (Helsinki: A22) Platform for greener companies (Nantes: A29), Call for projects on smart urban logistics (Nantes: A30)

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M6	Average distance travelled by trip
Category pillar	Mobility
Objectives	O2: To benchmark the use of different EV O5: Change in mobility due to solutions implemented *(Amount of travel)*
Description	Average distance travelled by each e-vehicle(s) in each trip. This indicator provides information about the vehicle uses.
Reference	mySMARTLife
Calculation	M6 = Average (distance of trip 1; distance of trip 2; …; distance of trip N)
Unit	Km / trip
Type of indicator	Secondary – Complementary
Data source	Km meters, sensors, monitoring or management system of vehicles
Actions/ Interventions	**Action category: EV** E-buses (Nantes : A23a, A23b), Public fleet (Hamburg : A22)

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M7	Availability rate of e-buses
Category pillar	Mobility
Objectives	O2: To benchmark the use of different EV
Description	Percentage of days in which the e-buses are available to provide transportation service. This indicator provides information about the technical reliability and operational availability of the e-buses.
Reference	mySMARTLife
Calculation	*At the bus level:* M7 = number of days in which the bus is in operable conditions (ie. running or available to run) / number of days in which bus line is running *At the fleet level:* M7 = Average (availability rate of bus 1; availability rate of bus 2; … availability rate of bus N)
Unit	%
Type of indicator	Primary – Complementary
Data source	Public transport operator
Actions/ Interventions	**Action category: EV** E-buses (Nantes : A23a, A23b)

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M8	Percentage of e-buses acquired that are equipped for data collection
Category pillar	Mobility
Objectives	O2: To benchmark the use and energy consumption of different EV O5: Change in mobility due to solutions implemented
Description	Ratio of e-buses equipped with data collection equipments.
Reference	mySMARTLife
Calculation	M8 = (Number of new e-buses equipped for data collection) / (Total number of the new e-buses)
Unit	%
Type of indicator	Primary – Complementary
Data source	Public transport operator
Actions/ Interventions	**Action category: EV** E-buses (Nantes : A23a, A23b – Helsinki: A21)

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M9	Annual energy consumption
Category pillar	Mobility
Objectives	O2: To benchmark the use and energy consumption of different EV
Description	Energy consumption of the e-vehicles during a year.
Reference	Adapted from CITYKEYS and SCIS
Calculation	*At vehicle level:* M9 = Measurement of the energy consumption (kWh) by each vehicle during one year *At the fleet level:* M9 = Sum of the energy (kWh) consumed by each vehicle during one year
Unit	kWh / year
Type of indicator	Primary – Core
Data source	Monitoring or management system of the vehicles
Actions/ Interventions	**Action category: EV** E-buses (Nantes : A23a, A23b – Hambourg : A21 – Helsinki: A21, A23), Public fleet (Hamburg: A22), E-community fleet (Hamburg: A23), Electrification of the City logistics and delivery (Helsinki: A22)

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M10	Annual energy consumption per annual distance travelled
Category pillar	Mobility
Objectives	O2: To benchmark the energy consumption of different EV
Description	Energy consumed by the e-vehicles to cover the distance travelled during a year. This indicator provides information about the energy efficiency of the vehicules.
Reference	mySMARTLife
Calculation	*At the vehicle level :* M10 = (Annual energy consumed (M9)) / (Annual distance travelled (M5)) *At the fleet level :* M10 = (Sum of the annual energy consumed by the vehicles of the fleet (M9)) / (Sum of the annual distances travelled by the vehicles of the fleet (M5))
Unit	kWh / km
Type of indicator	Secondary – Complementary
Data source	Km meter (for M5), monitoring or management system of the vehicle (for M9)
Actions/ Interventions	**Action category: EV** E-buses (Nantes : A23a, A23b – Hamburg : A21 – Helsinki: A21, A23), Public fleet (Hambourg: A22), E-community fleet (Hamburg: A23), Electrification of the City logistics and delivery (Helsinki: A22)

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M11	Annual energy consumption per passenger.km
Category pillar	Mobility
Objectives	O2: To benchmark the energy consumption of different EV
Description	Energy consumed by the vehicles to carry a passenger over a distance of one km. This indicator provides information about the energy efficiency of the vehicules.
Reference	mySMARTLife
Calculation	*At the vehicle level :* M11 = (Annual energy consumption (M9)) / (Annual number of passengers.km (M2)) *At the fleet level :* M11 = (Sum of the annual energy consumed by the vehicles of the fleet (M9)) / (Annual number of passengers.km transported by the vehicles of the fleet (M2))
Unit	kWh / passengers.km
Type of indicator	Secondary – Complementary
Data source	Monitoring or management system of the vehicles (for M9), sensors or surveys (for M2)
Actions/ Interventions	**Action category: EV** E-buses (Helsinki: A21, A23)

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M12	Annual energy consumption per trip
Category pillar	Mobility
Objectives	O2: To benchmark the energy consumption of different EV
Description	Energy consumed by the vehicles to cover each trip. This indicator provides information about the energy efficiency of the vehicules.
Reference	mySMARTLife
Calculation	*At the vehicle level :* M12 = (Annual energy consumption (M9)) / (Annual number of trips (M4)) *At the fleet level :* M12 = (Sum of the annual energy consumed by the vehicles of the fleet (M9)) / (Annual number of trips provided by the vehicles of the fleet (M4))
Unit	kWh / trip
Type of indicator	Secondary – Complementary
Data source	Sensors, monitoring or management system of the vehicles
Actions/ Interventions	**Action category: EV** E-buses (Nantes: A23a, A23b, Public fleet (Hamburg: A22), E-community fleet (Hamburg: A23)

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M13	Annual $eqCO_2$ emissions saved
Category pillar	Mobility
Objectives	O1: Reduction in greenhouse gas emissions
Description	Evaluation of the reduction in direct (operational) $eqCO_2$ emissions achieved by the deployed action (example: e-vehicles) during a period of one year. If relevant, the result will be also expressed in terms of $eqCO_2$ emissions / passenger and $eqCO_2$ emissions / trip
Reference	CITYKEYS and SCIS
Calculation	**For public transport e-vehicles (e-buses)** M13 = $eqCO_2$ emissions from former ICE buses – $eqCO_2$ emissions from new e-buses (ICE = Internal Combustion Engine) Considering: • $eqCO_2$ emissions from former ICE buses = annual quantity of fuel consumed (l or kg) x $eqCO_2$ emission factor of the considered fuel (kg $eqCO_2$ / l or kg $eqCO_2$ / kg) or = annual quantity of energy consumed (kWh) x $eqCO_2$ emission factor of the considered fuel (kg eqCO2 / kWh) • CO_2 emissions from new e-buses = annual quantity of energy consumed (kWh) x emission factor of the electricity grid ($eqCO_2$ / kWh) **For individual e-vehicles** M13 = $eqCO_2$ emission from ICE vehicles – eqCO2 emissions from new e-vehicles Considering: • eqCO2 emissions from new e-vehicles = annual quantity of energy consumed (kWh) x emission factor of the electricity grid ($eqCO_2$ / kWh) or = annual distance travelled (km) x average energy consumption* (kWh / km) x emission factor of the electricity grid ($eqCO_2$ / kWh) * by default = 0,18 kWh / km • $eqCO_2$ emissions from ICE vehicles are estimated considering a same

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	level of utilization as e-vehicles (in terms of distance travelled) and an average value of eqCO2 emission (gCO2 / km) established in taking into account the average age of the national cars fleets. Finlande: 214 g eqCO2 / km (average age of cars fleet = 11,2) France: 168 g eqCO2 / km (average age of cars fleet = 9,3) Germany: 196,8 g eqCO2 / km (average age of cars fleet = 9,4
Unit	teqCO_2 / year
Type of indicator	Secondary – Core
Data source	IPCC for net calorific value of fuels (in kWh / kg) Convenant of Mayors (CoM) for average emissions of fuels (in kg eqCO2 / MWh) and emissions factors of electricity grids (in teqCO_2 / MWh) French Environment Agency for density of fuels (in k /l) European Automobile Manufacturers Association for average age of vehicles (https://www.acea.be/publications/article/acea-pocket-guide) Eurostat for historic levels of CO_2 emissions of new vehicles per country (gCO2 / km) (https://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&language=fr&pcode=sdg_13_10&plugin=1)
Actions/ Interventions	**Action category: EV, Charging stations & Urban freight** E-buses (Nantes: A23a, A23b – Hamburg : A21 – Helsinki: A21), Public fleet (Hamburg: A22), e-community fleet (Hambourg: A23), Electrification of the City logistics and delivery (Helsinki: A22) Smart charging points (Nantes: A25) Platform for greener companies (Nantes: A29), Call for projects on smart logistics (Nantes: A30)

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M14	Number of incidents and traffic accidents where the shuttle was involved
Category pillar	Mobility
Objectives	O5: Change in mobility due to solutions implemented *(Journey quality: Safety)*
Description	Number of incidents and trafic accidents where the autonomous shuttle was involved. This indicator provides information about the technical reliability and maturity of the shuttle. It contributes to evaluate the shuttle functioning in terms of road safety that is a key aspect for the social acceptance of the large-scale deployment of such an innovation.
Reference	mySMARTLife
Calculation	M14 = Counting of the number of accidents or incidents involving the shuttle during one year and that have led to formal accident reports or official declarations to insurance companies.
Unit	# / year
Type of indicator	Primary – Complementary
Data source	Accidents reports, insurance declarations
Actions/ Interventions	**Action category: EV** E-buses (Nantes: A23b)

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M15	Number of heavy-duty (HD) vehicles compatible charging points installed
Category pillar	Mobility
Objectives	O5: Change in mobility due to solutions implemented *(Travel mode: Willingness of municipality to introduce clean vehicles)*
Description	Number of charging points compatible with HD vehicles (trucks, municipal vehicles etc)
Reference	mySMARTLife
Calculation	M15 = Counting of the compatible with HD vehicles charging points
Unit	#
Type of indicator	Primary – Core (for Helsinki)
Data source	Charging stations operator
Actions/ Interventions	**Action category: EV** Electrification of the city logistics and delivery (Helsinki: A22)

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M16	Annual energy delivered by each charging point
Category pillar	Mobility
Objectives	O1: Reduction in greenhouse gas emissions O4: To benchmark the use and usage pattern of charging stations O5: Change in mobility due to solutions implemented *(Travel mode: use of clean/public transport)*
Description	Energy delivered in each charging point during a period of one year. This indicator provides information about the level of use of each charging point and allows comparisons between charging points according to their location in the city.
Reference	mySMARTLife
Calculation	M16 = Measurement of the electricity quantity delivered by each charging point during one year
Unit	kWh / year
Type of indicator	Primary – Core
Data source	Charging points management and monitoring system, charging stations operator
Actions/ Interventions	**Action category: Charging stations** Charging points for e-buses (Nantes: A24 – Hamburg: A24 – Helsinki: A24), Smart charging points (Nantes: A25), Fast charging stations (Hamburg: A25), Charging infrastructures for residential quarters (Hambourg: A27), Charging stations connected to Energy campus (Hamburg: A28), Electromobility charging node (Helsinki: A26)

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M17	Annual energy delivered by charging points
Category pillar	Mobility
Objectives	O1: Reduction in greenhouse gas emissions O4: To benchmark the use and usage pattern of charging stations. O5: Change in mobility due to solutions implemented *(Travel mode: Use of clean/public transport)* O6: Impact of energy demand management *(Degree of energy managed)*
Description	Total energy delivered by all the new charging points during a period of one year. This indicator provides information about the level of use of the new charging infrastructures implemented in the city.
Reference	mySMARTLife
Calculation	M17 = Sum of the electricity quantity delivered by all charging points during one year (M16)
Unit	kWh / year
Type of indicator	Secondary – Core
Data source	Charging points management and monitoring system, charging stations operator
Actions/ Interventions	**Action category: Charging stations** Charging points for e-buses (Nantes: A24 – Hamburg: A24 – Helsinki: A24), Smart charging points (Nantes: A25), Fast charging stations (Hamburg: A25), Charging infrastructures for residential quarters (Hamburg: A27), Charging stations connected to Energy campus (Hamburg: A28), Electromobility charging node (Helsinki: A26), Smart personal EV charging (Helsinki: A28)

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M18	Average energy delivered per charging operation in each charging point
Category pillar	Mobility
Objectives	O4: To benchmark the use and usage pattern of charging stations O5: Change in mobility due to solutions implemented *(Travel mode: use of clean/public transport)*
Description	Average quantity of electricity delivered during one charging operation (or session) in each charging point
Reference	mySMARTLife
Calculation	M18 = Average (kWh charged during charging operation 1; KWh charged during charging operation 2; …; kWh charged during charging operation N)
Unit	kWh / charging operation
Type of indicator	Secondary – Complementary
Data source	Charging points management and monitoring system, charging stations operator
Actions/ Interventions	**Action category: Charging stations** Charging points for e-buses (Nantes: A24 – Hamburg: A24), Smart charging points (Nantes: A25), Fast charging stations (Hamburg: A25), Charging infrastructures for residential quarters (Hamburg: A27), Charging stations connected to Energy campus (Hamburg: A28)

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M19	Total number of charges per year
Category pillar	Mobility
Objectives	O4: To benchmark the use and usage pattern of charging stations O5: Change in mobility due to solutions implemented *(Travel mode: use of clean/public transport)*
Description	Number of charging operations performed (in each charging point and in all charging points) during a period of one year. At charging point level, this indicator provides information about the level of use of charging points and allows comparisons between charging stations according to their location in the city. For all charging points, it provides information about the extent of use of the new charging infrastructure in the city
Reference	mySMARTLife
Calculation	*At charging point level:* M19 = Counting of charging operations during one year *For all charging points:* M19 = Sum of the charging operations per charging point during one year
Unit	# / year
Type of indicator	Primary – Complementary
Data source	Charging points management and monitoring system, charging stations operator
Actions/ Interventions	**Action category: Charging stations** Charging points for e-buses (Nantes: A24 – Hamburg: A24), Smart charging points (Nantes: A25), Fast charging stations (Hamburg: A25), Charging infrastructures for residential quarters (Hamburg: A27), Charging stations connected to Energy campus (Hamburg: A28)

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M20	Total operating time for charging operations
Category pillar	Mobility
Objectives	O4: To benchmark the use and usage pattern of charging stations O5: Change in mobility due to solutions implemented *(Travel mode: use of clean/public transport)*
Description	Amount of time that charging points are supplying energy to e-vehicles during a period of one year. This indicator provides information about the level of use of charging points and allows comparisons between charging stations according to their location in the city.
Reference	mySMARTLife
Calculation	*At charging point level:* M20 = Counting of charging operations duration (characterized by energy transfer) over a period of one year for the considered charging point *For all charging points:* M20 = Sum of the charging operations durations over one year for all charging points
Unit	hours / year
Type of indicator	Primary – Complementary
Data source	Charging points management and monitoring system, charging stations operator
Actions/ Interventions	**Action category: Charging stations** Smart charging points (Nantes: A25), Charging points for e-buses (Helsinki: A24), Electromobility charging node (Helsinki: A26)

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M21	Average duration of charging operations
Category pillar	Mobility
Objectives	O4: To benchmark the use and usage pattern of charging stations O5: Change in mobility due to solutions implemented *(Travel mode: use of clean/public transport)*
Description	Average duration of the charging operations (charging operation = period characterized by energy transfer to the e-vehicle) over a period of one year. This indicator provides information about the level of use of charging points and allows comparisons between charging stations according to their location in the city.
Reference	mySMARTLife
Calculation	At charging point level and for all charging points: M21 = Average (duration of charging operation 1; duration of charging operation 2; …; duration of charging operation N)
Unit	hours / charging operation
Type of indicator	Secondary – Complementary
Data source	Charging points management and monitoring system, charging stations operator
Actions/ Interventions	**Action category: Charging stations** Smart charging points (Nantes: A25)

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M22	Total occupancy time of charging points
Category pillar	Mobility
Objectives	O4: To benchmark the use and usage pattern of charging stations O5: Change in mobility due to solutions implemented *(Travel mode: use of clean/public transport)*
Description	Amount of time per year that charging points are occupied by a vehicle (whether or not the charging point transfers electricity to the e-vehicle). Compared to the value of indicator M20 (total operating times for charging operations), this indicator allows to analyse how optimized is the use of the charging points.
Reference	mySMARTLife
Calculation	M22 = Sum of the occupancy * times of charging points * occupancy = presence of a vehicule, pluged or not, being recharged or not
Unit	hours / year
Type of indicator	Secondary – Complementary
Data source	Occupancy sensor, Charging points management and monitoring system, charging stations operator
Actions/ Interventions	**Action category: Charging stations** Charging points for e-buses (Helsinki: A24), Electromobility charging node (Helsinki: A26)

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M23	Average occupancy time of charging points
Category pillar	Mobility
Objectives	O4: To benchmark the use and usage pattern of charging stations O5: Change in mobility due to solutions implemented *(Travel mode: use of clean/public transport)*
Description	Average duration of charging point occupancy by e-vehicles (whether or not the charging point transfers electricity to the e-vehicle). Compared to the value of indicator M21 (average duration of charging operations), this indicator allows to analyse how optimized is the use of the charging points.
Reference	mySMARTLife
Calculation	At charging point level and for all charging points: M23 = Average (duration of vehicle occupancy* 1; duration of vehicle occupancy 2; …; duration of vehicle occupancy N) * occupancy = presence of a vehicule, pluged or not, being recharged or not
Unit	hours / occupancy period
Type of indicator	Secondary – Complementary
Data source	Occupancy sensor, Charging points management and monitoring system, charging stations operator
Actions/ Interventions	**Action category: Charging stations** Fast charging stations (Hamburg: A25), Charging points for e-buses (Helsinki: A24), Electromobility charging node (Helsinki: A26)

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M24	Number of different users per year
Category pillar	Mobility
Objectives	O4: To benchmark the use and usage pattern of charging stations; O5: Change in mobility due to solutions implemented *(Travel mode: use of clean/public transport)*
Description	Number of different users per charging point, separetely for each vehicles category (e-g- e-buses, autonomous e-bus, city maintenance and commercial logistic e-vehicles fleet) and/or persons (users = persons in Hamburg and Nantes, Users= vehicles in Helsinki). This indicator provides information on the level of use of charging stations (diversity and total number of users). It can be used to compare stations according to their location in the city and to assess the level of appropriation of these new equipments or even to estimate the evolution of the penetration rate of e-vehicles.
Reference	mySMARTLife
Calculation	*At charging point level :* M24 = Counting of the number of different users using the charging point over a period of one year *For all charging points :* M24 = Sum of the different users using all the new charging points over a period of one year Note: one user is assimilated to one customer account holder, by ensuring rigorous respect of privacy issues. By default, one user can be assimilated to one category of vehicule (personal car, e-bus, city maintenance and commercial logistic vehicles…).
Unit	# / year
Type of indicator	Primary – Core
Data source	Charging points management and monitoring system, charging stations operator
Actions/ Interventions	**Action category: Charging stations** Smart charging stations (Nantes: A25), Fast charging stations (Hamburg: A25), Electromobility charging node (Helsinki: A26)

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M25	Number of external charging events
Category pillar	Mobility
Objectives	O4: To benchmark the use and usage pattern of charging stations O5: Change in mobility due to solutions implemented *(Travel mode: use of clean/public transport)*
Description	Number of external connection charging events in the shared charging points during a period of a year
Reference	mySMARTLife
Calculation	At charging point level: Counting of the number of external connections to each shared charging point over a period of one year For all shared charging points : Sum of the external connections to all shared charging points over a period of one year
Unit	# / year
Type of indicator	Primary – Complementary
Data source	Charging points management and monitoring system, charging stations operator
Actions/ Interventions	**Action category: Charging stations** Electromobility charging node (Helsinki: A26)

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M26	Utilization ratio of external charging
Category pillar	Mobility
Objectives	O4: To benchmark the use and usage pattern of charging stations O5: Change in mobility due to solutions implemented *(Travel mode: use of clean/public transport)*
Description	Share of external charging events in ratio to all charging events
Reference	mySMARTLife
Calculation	*At charging point level:* M26 = Number of external connections (M25) / Total number of connection over a period of one year *For all shared charging points:* M26 = Sum of the external connections to all charging points over a period of one year / Sum of the connections to all charging points over a period of one year
Unit	%
Type of indicator	Primary – Complementary
Data source	Charging points management and monitoring system, charging stations operator
Actions/ Interventions	**Action category: Charging stations** Electromobility charging node (Helsinki: A26)

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M27	Total charged energy from the external connection
Category pillar	Mobility
Objectives	O4: To benchmark the use and usage pattern of charging stations O6: Impact of energy demand management *(Degree of energy managed)*
Description	Total energy charged through external connection annually
Reference	mySMARTLife
Calculation	Sum of the electricity quantity delivered during external charging events by charging point annually
Unit	kWh/a
Type of indicator	Primary – Complementary
Data source	Charging points management and monitoring system, charging stations operator
Actions/ Interventions	**Action category: Charging stations** Electromobility charging node (Helsinki: A26)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 731297.

M28	**Percentage of electricity charged from the external connection**
Category pillar	Mobility
Objectives	O4: To benchmark the use and usage pattern of charging stations O6: Impact of energy demand management *(Degree of energy managed)*
Description	Share of external charging electricity from total charging electricity provided by the charger
Reference	mySMARTLife
Calculation	Sum of the electricity quantity delivered during external charging events / Sum of the electricity quantity delivered by the charger annually
Unit	%
Type of indicator	Secondary – Complementary
Data source	Charging points management and monitoring system, charging stations operator
Actions/ Interventions	**Action category: Charging stations** Electromobility charging node (Helsinki: A26)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 731297.

M29	Station uptime per year
Category pillar	Mobility
Objectives	O5: Change in mobility due to solutions implemented *(Journey quality: Comfort)*
Description	Percentage of time that the charging points are functioning properly (deliver energy or are in operating conditions to deliver energy). This indicator measures the reliability of the charging stations and their operational availability for users.
Reference	mySMARTLife
Calculation	M29 = (Total hours number of proper functioning) / (Annual hours number* or expected hours number of proper functioning**) * 365 x 24 = 8,760 hours ** proper functioning = charging point delivers or is in operating conditions to deliver energy
Unit	%
Type of indicator	Primary – Complementary
Data source	Charging points management and monitoring system, charging stations operator
Actions/ Interventions	**Action category: Charging stations** Charging points for e-buses (Nantes: A24, Helsinki: A24), Smart charging points (Nantes: A25), Electromobility charging node (Helsinki: A26)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 731297.

M30	Charging points powered by renewable energy sources (number and rate)
Category pillar	Mobility
Objectives	O3: Degreee of energy supplied to EV by RES O6: Impact of energy demand management *(Degree of RES managed)*
Description	Number and rate of charging points that are totally fed with renewable energy sources
Reference	mySMARTLife
Calculation	M30 (Number) = Counting of charging points fed with RES M30 (Rate) = (number of charging points fed with RES) / (Total number of charging points)
Unit	# and %
Type of indicator	Primary – Complementary
Data source	Charging points management and monitoring system, charging stations operator
Actions/ Interventions	**Action category: Charging stations & Multimodality & Demand & Management** Charging points for e-buses (Nantes: A24, Helsinki: A24), Smart charging points (Nantes: A25), Wind- and solar- powerred electric bike charging stations (Helsinki: A25), Electromobility charging node (Helsinki: A26) Neutral multimodal Hub (Nantes: A31) Load management in Carbon Neutral Multimodal Hub (Nantes: A27)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 731297.

M31	Percentage of electricity supplied by renewable energy
Category pillar	Mobility
Objectives	O3: Degreee of energy supplied to EV by RES O6: Impact of energy demand management *(Degree of RES managed)*
Description	Percentage of electricity supplied by renewable energy sources in the total annual energy delivered by the charging points.
Reference	SCIS
Calculation	M31 = (Electricity (KWh) charged by the acharging points coming from RES) / (Total electricity charged (kWh) by the charging points) over a period of one year
Unit	%
Type of indicator	Secondary – Core
Data source	Charging points management and monitoring system, charging stations operator
Actions/ Interventions	**Action category: Charging stations & Multimodality & Demand & Management** Charging points for e-buses (Nantes: A24, Helsinki: A24), Solar road (Nantes: A23b), Electromobility charging node (Helsinki: A26), Charging stations connected to Energy campus (Hambourg: A28) Neutral multimodal Hub (Nantes: A31) Load management in Carbon Neutral Multimodal Hub (Nantes: A27), Load management (Hambourg: 30a)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 731297.

M32	Availability rate of the solar road
Category pillar	Mobility
Objectives	O3: Degreee of energy supplied to EV by RES
Description	Percentage of time that the solar road is functioning properly to produce electicity (delivers energy or is in operating conditions to deliver energy). This indicator measures the technical reliability of the solar road and its operational availability to produce energy.
Reference	mySMARTLife
Calculation	M32 = (Total hours number of proper functioning) / (Annual hours number* or expected hours number of proper functioning**) * 365 x 24 = 8,760 hours ** proper functioning = solar road produces or is in operating conditions to produce energy
Unit	%
Type of indicator	Secondary – Core
Data source	Charging points management and monitoring system, charging stations operator
Actions/ Interventions	**Action category: “Charging stations”** Solar road (Nantes: A23b)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 731297.

M33	Annual energy produced by each charging point or solar road
Category pillar	Mobility
Objectives	O3: Degreee of energy supplied to EV by RES
Description	Renewable energy produced by facilities coupled to charging points or by solar road over a period of one year.
Reference	mySMARTLife
Calculation	At charging point (or charging station) level: M33 = Measurement of renewable energy (kWh) produced during one year by facilities coupled to charging point For all charging points: M33 = Sum of the renewable energy (kWh) produced during one year by facilities coupled to all charging points
Unit	kWh / year
Type of indicator	Primary – Complementary
Data source	Charging points management and monitoring system, charging stations operator
Actions/ Interventions	**Action category: “Charging stations”** Solar road (Nantes: A23b), Wind- and solar-powered electric bike charging stations (Helsinki: A25)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 731297.

M34	Charging capacity managed
Category pillar	Mobility
Objectives	O6: Impact of energy demand management *(Degree of energy managed)*
Description	Number and power of charging points subjected to an energy demand management
Reference	mySMARTLife
Calculation	M34 = Counting of charging points installed, per level of power and type
Unit	#
Type of indicator	Primary – Complementary
Data source	Charging points management and monitoring system, charging stations operator
Actions/ Interventions	**Action category: Demand & Management** Load management (Hambourg: 30a) Smart personal EV charging (Helsinki: A28)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 731297.

M35	Number of charging sessions
Category pillar	Mobility
Objectives	O6: Impact of energy demand management *(Degree of energy managed)*
Description	Annual number of charging sessions
Reference	mySMARTLife
Calculation	*At charging point level:* M35 = Counting of charging sessions over a period of one year *For all charging points:* M35 = Sum of the charging sessions per charging point over one year
Unit	# / year
Type of indicator	Primary – Complementary
Data source	Charging points management and monitoring system, charging stations operator
Actions/ Interventions	**Action category: Demand & Management** Smart personal EV charging (Helsinki: A28)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 731297.

M36	**Number of proposals submitted in response to the call for projects**
Category pillar	Mobility
Objectives	O5: Change in mobility due to solutions implemented *(Willingness of delivery companies to introduce clean vehicles)*
Description	This indicator identifies the number of low-carbon last kilometre delivery companies or services that were interested in the call and submitted a project. It makes it possible to assess the level of interest and involvement of companies and logistics stakeholders in the process.
Reference	mySMARTLife
Calculation	M36 = Counting of projects submitted in response to the call for projects
Unit	#
Type of indicator	Primary – Core (for Nantes)
Data source	Call for projects manager
Actions/ Interventions	**Action category: Urban freight** Last-kilometre delivery services (Nantes: A28), Call for projects on smart urban logistics (Nantes: A30)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 731297.

M37	**Number of projects selected**
Category pillar	Mobility
Objectives	O5: Change in mobility due to solutions implemented *(Travel mode: Clean vehicles penetration)*
Description	This indicator identifies the number of low-carbon last-kilometre delivery services/companies that will be implemented through the call for projects on sustainable logistics.
Reference	mySMARTLife
Calculation	M37 = Counting of projects selected (awarded) in response to the call for projects
Unit	#
Type of indicator	Primary – Complementary
Data source	Call for projects manager
Actions/ Interventions	**Action category: Urban freight** Last-kilometre delivery services (Nantes: A28), Call for projects on smart urban logistics (Nantes: A30)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 731297.

M38	Ratio of projects selected
Category pillar	Mobility
Objectives	O5: Change in mobility due to solutions implemented *(Travel mode: Clean vehicles penetration)*
Description	This indicator measures the share of selected projects among all projects that have been submitted in response to the call for projects.
Reference	mySMARTLife
Calculation	M38 = (Number of projects selected (awarded) M37)) / (Number of projects submitted in response to the call for projects (M36))
Unit	%
Type of indicator	Primary – Core (for Nantes)
Data source	Call for projects manager
Actions/ Interventions	**Action category: Urban freight** Last-kilometre delivery services (Nantes: A28), Call for projects on smart urban logistics (Nantes: A30)

M39	Type of projects selected
Category pillar	Mobility
Objectives	O5: Change in mobility due to solutions implemented *(Travel mode: Clean vehicles penetration)*
Description	Distribution of selected projects according to their main characteristics (mainly: objectives, nature).
Reference	mySMARTLife
Calculation	M39 = Couting of number of projects selected by category
Unit	# / category
Type of indicator	Primary – Complementary
Data source	Call for projects manager
Actions/ Interventions	**Action category: Urban freight** Call for projects on smart urban logistics (Nantes: A30)

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M40	Number of companies involved in the platform
Category pillar	Mobility
Objectives	O5: Change in mobility due to solutions implemented *(Willingness of companies to introduce clean vehicles)*
Description	Number of companies registred and using the platform.
Reference	mySMARTLife
Calculation	M40 = Counting of companies registred in the "platform for greener companies fleets vehicles" and that are using its services.
Unit	#
Type of indicator	Primary – Complementary
Data source	Platform manager
Actions/ Interventions	**Action category: Urban freight** Platform for greener companies (Nantes: A29) Logistics MicroHub (Hamburg: A31)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 731297.

M41	Number of parcel delivery companies
Category pillar	Mobility
Objectives	O5: Change in mobility due to solutions implemented *(Willingness of delivery companies to introduce clean vehicles)*
Description	Number of companies registred and using the microHub
Reference	mySMARTLife
Calculation	M41 = Counting of companies registred in the microHub and that are using its services.
Unit	#
Type of indicator	Primary – Complementary
Data source	MicroHub manager, logistics companies
Actions/ Interventions	**Action category: Urban freight** Logistics MicroHub (Hamburg: A31)

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M42	Number of vehicules in the fleets companies involved in the platform
Category pillar	Mobility
Objectives	O1: Reduction in greenhouse gas emissions O5: Change in mobility due to solutions implemented *(Travel mode: Clean vehicles penetration)*
Description	Total number of vehicles in the fleets of companies involved in the “platform for greener companies”. This indicator measures the number of vehicles that can be concerned by green actions implemented by companies involved in the platform.
Reference	mySMARTLife
Calculation	M42 = Counting of vehicles in the fleets of companies that are registred in the “platform for greener companies”
Unit	#
Type of indicator	Primary – Core (for Nantes)
Data source	Platform manager
Actions/ Interventions	**Action category: Urban freight** Platform for greener companies (Nantes: A29)

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M43	Electric vehicles penetration rate
Category pillar	Mobility
Objectives	O1: Reduction in greenhouse gas emissions O5: Change in mobility due to solutions implemented *(Travel mode: Clean vehicles penetration)*
Description	Number of e-vehicles that operate in the platform and in the community car sharing concept. This indicator allows to appreciate the evolution of the share of e-vehicles in these initiatives
Reference	SCIS
Calculation	M43 = (Number of e-vehicles in companies fleets) / (Total number of vehicles in companies fleets)
Unit	%
Type of indicator	Primary – Core
Data source	Platform manager, logistics companies, company that operates the service
Actions/ Interventions	**Action category: Urban freight & Multimodality** Platform for greener companies (Nantes: A29) Community Car Sharing (Hamburg: A33)

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M44	Deliveries operated with clean vehicles
Category pillar	Mobility
Objectives	O1: Reduction in greenhouse gas emissions O5: Change in mobility due to solutions implemented *(Travel mode: Clean vehicles penetration)*
Description	Number and percentage of deliveries operated with clean vehicles (by type of vehicle).
Reference	mySMARTLife
Calculation	*At company level:* M44 (number) = Counting of deliveries (in terms of number of parcels and/or tonnage) operated with clean vehicles (electric-vehicles, cargo-bikes…) M44 (percentage) = (Number or tonnage of deliveries operated with clean vehicles) / (Total number or tonnage of deliveries) *For all companies :* M44 (number) = Sum of deliveries (in terms of number of parcels and/or tonnage) of all companies operated with clean vehicles M44 (percentage) = (Sum of number or tonnage of deliveries of all companies operated with clean vehicles) / (Sum of total number or tonnage of deliveries of all companies)
Unit	#, %
Type of indicator	Primary – Core
Data source	Platform manager, microHub manager, logistics companies
Actions/ Interventions	**Action category: Urban freight** Call for projects on smart urban logistics (Nante: A30), Logistics MicroHub (Hamburg: A31)

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M45	Total duration of delivery rounds
Category pillar	Mobility
Objectives	O2: To benchmark the use and energy consumption of different EV O5: Change in mobility due to solutions implemented *(Amount of travel)*
Description	Average time that each vehicle takes for delivery rounds (per class of duration of uses)
Reference	mySMARTLife
Calculation	At company level and for all companies: M45 = Average (duration of round 1; duration of round 2; …; duration of round N)
Unit	hours
Type of indicator	Primary – Core
Data source	Platform manager, logistics companies
Actions/ Interventions	**Action category: Urban freight** Call for projects on smart urban logistics (Nante: A30)

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M46	Fuel consumed
Category pillar	Mobility
Objectives	O2: To benchmark the use and energy consumption of different clean vehicles
Description	Quantity of fuel consummed (per type of fuel and per year) by the vehicle fleets of companies registered in the platform
Reference	mySMARTLife
Calculation	*At company level:* M46 = Measurement of the quantity of fuel consumed over a period of one year by the vehicles of the company fleet *For all companies:* M46 = Sum of the quantities of fuel consumed over a period of one year by the vehicles fleets of all companies
Unit	l or kg or KWh
Type of indicator	Primary – Core
Data source	Platform manager, companies
Actions/ Interventions	**Action category: Urban freight** Platform for greener companies (Nantes: A29)

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M47	Evolution of the energy consumption per vehicle.km or t.km
Category pillar	Mobility
Objectives	O2: To benchmark the use and energy consumption of different clean vehicles
Description	This indicator measures the evolution of the energy efficiency of the delivery processes in terms of energy consumption per vehicle.km (or per t. km)
Reference	mySMARTLife
Calculation	M47 = (Energy consumed by vehicles of the fleet over a period of one year) / (Amount of vehicle.km or t.km produced by the fleet over one year)
Unit	kWh / veh.km or kWh / t.km
Type of indicator	Secondary – Core
Data source	Call for projects manager, logistics companies
Actions/ Interventions	**Action category: Urban freight** Call for projects on smart logistics (Nantes: A30)

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M48	Average emissions / 100 km
Category pillar	Mobility
Objectives	O1: Reduction in greenhouse gas emissions
Description	This indicator measures the average eqCO_2 emissions per 100 km of the vehicles of the companies fleets
Reference	mySMARTLife
Calculation	M48= (eqC02 emissions from vehicles of the fleet over a period of one year) x 100 / (Annual distance travelled by the vehicles of the feet)
Unit	g eq$C0_2$ / 100 km
Type of indicator	Secondary – Core
Data source	Call for projects manager, companies
Actions/ Interventions	**Action category: Urban freight** Call for projects on smart logistics (Nantes: A30)

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M49	Length of cycling and pedestrian additionnal lines
Category pillar	Mobility
Objectives	O5: Change in mobility due to solutions implemented *(Travel mode: Density of clean transport network)*
Description	Length of the cycling and pedestrian lines developed
Reference	mySMARTLife
Calculation	M49 = Sum of the lengths of the new cycling and pedestrian lines
Unit	km
Type of indicator	Primary – Complementary
Data source	Municipality or local public authority
Actions/ Interventions	**Action category: Multimodality** Pedestrian and bicycle connections (Hamburg: A32)

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M50	Number of searches
Category pillar	Mobility
Objectives	O5: Change in mobility due to solutions implemented *(Travel mode: Use of clean/public transport)*
Description	Number of searches in multi-modal public transport and pedestrian navigator related to the routes affected by mySMARTLife interventions
Reference	mySMARTLife
Calculation	Sum of mySMARTLife related searches / year
Unit	-
Type of indicator	Primary - Core
Data source	Application database
Actions/ Interventions	**Action category: Multimodality** Multi-modal mobility navigator (Helsinki: A30)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 731297.

M51	Occupancy in front of the charging station
Category pillar	Mobility
Objectives	O5: Change in mobility due to solutions implemented (*Travel mode, Journey quality: Comfort)*
Description	This indicator allows measuring the degree of occupancy of electrical charging points for parking uses.
Reference	mySMARTLife
Calculation	Pending to be defined
Unit	Pending to be defined
Type of indicator	Core
Data source	Pending to be defined
Actions/ Interventions	**Action category: ITS** Parking space detection (Hamburg: A35)

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my SMART Life

ICT/Urban platform pillar

ICT 1	**Data privacy**
Category pillar	Urban platform and ICT developments
Objectives	O1. To evaluate the improvements from the existing urban platforms O2. To evaluate the new particular ICT developments and services O3. To assess the ICT services' features, in terms of performance
Description	Level of compliance of the urban platform with the GDPR
Reference	Based on CITYKEYS
Calculation	**Likert scale**: *Not at all – 1 — 2 — 3 — 4 – Very high* 1. City doesn't follow any regulations/laws on protection of personal data 2. City follows minimum requirement on protection of personal data according to the EU General Data Protection Regulation (GDPR) 3. City follows full requirement on protection of personal data according to the EU General Data Protection Regulation (GDPR) 4. City follows local/national regulation that are more restrictive that EU General DataProtection Regulation (GDPR)
Unit	Likert scale
Type of indicator	Core - Primary
Data source	Urban platform privacy mechanisms
Actions/ Interventions	Applicable to all the urban platform and ICT developments actions

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ICT 2	Number of data publishers
Category pillar	Urban platform and ICT developments
Objectives	O1. To evaluate the improvements from the existing urban platforms O2. To evaluate the new particular ICT developments and services
Description	Number of data publishers that publish data into the existing urban platform in contrast to the total data-sets of the urban platform. This obtains the improvement in terms of data integration.
Reference	Telefonica foundation
Calculation	# of new publishers / # available data-sets
Unit	%
Type of indicator	Core - Primary
Data source	Urban platform databases and logs
Actions/ Interventions	Applicable to all the urban platform and ICT developments actions

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ICT 3	Number of sensors integrated
Category pillar	Urban platform and ICT developments
Objectives	O1. To evaluate the improvements from the existing urban platforms O2. To evaluate the new particular ICT developments and services
Description	Number of IoT sensors/devices from any field that are connected in the current urban platform according to the monitoring plans in cotrast to the total IoT sensors that the urban platform integrates.
Reference	Telefónica foundation
Calculation	# of new sensors or devices / # of total sensors
Unit	%
Type of indicator	Core - Primary
Data source	Urban platform databases
Actions/ Interventions	Applicable to all the urban platform and ICT developments actions

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ICT 4	Number of services deployed
Category pillar	Urban platform and ICT developments
Objectives	O1. To evaluate the improvements from the existing urban platforms O2. To evaluate the new particular ICT developments and services O4: To assess the impact in digital transformation
Description	New services that are deployed in the project in contrast to the total services provided.
Reference	SmartEnCity project
Calculation	# of new services / # of total services
Unit	%
Type of indicator	Core - Primary
Data source	Urban platform services list
Actions/ Interventions	Applicable to all the urban platform and ICT developments actions

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ICT 5	Number of available Open APIs
Category pillar	Urban platform and ICT developments
Objectives	O1. To evaluate the improvements from the existing urban platforms O2. To evaluate the new particular ICT developments and services
Description	The integration of new Open APIs is measured in terms of the ratio of new APIs vs total Open APIs is measured as indicator of success
Reference	Telefónica foundation
Calculation	# of new APIs / # of total APIs
Unit	%
Type of indicator	Core - Primary
Data source	Urban platform APIs list
Actions/ Interventions	Applicable to all the urban platform and ICT developments actions

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ICT 6	Number of available Open Data sets
Category pillar	Urban platform and ICT developments
Objectives	O1. To evaluate the improvements from the existing urban platforms O2. To evaluate the new particular ICT developments and services O4: To assess the impact in digital transformation
Description	Similar to the open APIs, but applicable to the open Data sets.
Reference	Telefónica foundation
Calculation	# of new Open Data sets / # of total Open Data sets
Unit	%
Type of indicator	Core - Primary
Data source	Urban platform data-sets list
Actions/ Interventions	Applicable to all the urban platform and ICT developments actions

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ICT 7	Number of accesses to the urban platform
Category pillar	Urban platform and ICT developments
Objectives	O1. To evaluate the improvements from the existing urban platforms O2. To evaluate the new particular ICT developments and services
Description	Amount of new accesses generated due to the new services developed in the project in contrast to the total accesses. It is also applicable to the number of app downloads when the services is deployed as a mobile app.
Reference	Telefónica foundation
Calculation	# of new accesses / # of total access (it may be normalized per inhabitant)
Unit	%
Type of indicator	Complementary
Data source	Urban platform logs.
Actions/ Interventions	Applicable to all the urban platform and ICT developments actions

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ICT 8	Response time
Category pillar	Urban platform and ICT developments
Objectives	O3. To assess the ICT services' features, in terms of performance
Description	One of the most important performance parameters is the response time, measured in the way of response time related to the services developed and the payload (information exchanged) between them.
Reference	SmartEnCity project
Calculation	Transaction time / payload
Unit	Sec/Byte
Type of indicator	Complementary
Data source	Urban platform logs
Actions/ Interventions	Applicable to all the urban platform and ICT developments actions

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ICT 9	Scalability
Category pillar	Urban platform and ICT developments
Objectives	O3. To assess the ICT services' features, in terms of performance
Description	Depending on the technology used for the development of the urban platforms according to the framework, the scalability level allows to extend the urban platform. The new architectures are then assessed.
Reference	SmartEnCity project
Calculation	**Likert scale:** *Not scalable 1 - 2 - 3 - 4 Fully scalable*
Unit	Likert scale
Type of indicator	Complementary
Data source	Urban platform
Actions/ Interventions	Applicable to all the urban platform and ICT developments actions

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ICT 10	Storage capacity
Category pillar	Urban platform and ICT developments
Objectives	O3. To assess the ICT services' features, in terms of performance
Description	Under the new concepts of big-data, the amount of generated data (size) is an indicator about the digitalization of the city, then the capacity of the system is analysed in terms of data volume
Reference	SmartEnCity project
Calculation	No equation, simply count of databases size
Unit	GB
Type of indicator	Complementary
Data source	Urban platform databases
Actions/ Interventions	Applicable to all the urban platform and ICT developments actions

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ICT 11	Availability
Category pillar	Urban platform and ICT developments
Objectives	O3. To assess the ICT services' features, in terms of performance
Description	As typical performance indicator, the availability is very important and it is measured as percentage of time withouth failures within an established temporal scale
Reference	SmartEnCity project
Calculation	# of hours working / # of total hours
Unit	%
Type of indicator	Complementary
Data source	Urban platform logs
Actions/ Interventions	Applicable to all the urban platform and ICT developments actions

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Economy pillar

Objective 1: Cost-effectiveness of the project actions

Ec 1	Cost of the project (CoP)
Category pillar	Economy
Description	Total cost (CoP) in Euro to implement the intervention. The total cost is the sum of direct costs (C_i) – costs associated with the particular / specific action. Specific categories of direct costs are: labor, materials, equipment, services, software, hardware, etc.
Reference	SCIS, EASME (EU), WorldBank
Calculation	$\mathrm{CoP} = \mathrm{C_i} + \mathrm{C_{ii}} + \cdots + \mathrm{C_n} = \sum_{i=1}^{n} C_i$
Unit	€
Type of indicator	Primary
Data source	Data should be gathered from the owner of the action Data should be gathered when action is ready to its implementation
Actions/ Interventions	To be confirmed in D7.4

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Ec 2	Cost of the project not covered by the municipality (CnM)
Category pillar	Economy
Description	Percentage (%) of the total cost (C_T) not covered by the Municipality (CnM) to implement the action. This percentage refers to all direct expenditure financed or funded by other stakeholders.
Reference	mySMARTlife
Calculation	$CnM = (C_T - C_m)/C_T * 100$
Unit	%
Type of indicator	Primary
Data source	Data should be gathered from the owner of the action Data should be gathered when action is ready to its implementation
Actions/ Interventions	To be confirmed in D7.4

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Ec 3	Public funds covered by the Municipality (PFM)
Category pillar	Economy
Description	Percentage of the total public funds (C_{PF}) - non-repayable - covered by the Municipality to implement the action. C_{MF} is a direct expenditure of the Municipality.
Reference	CONCERTO
Calculation	$PFM = C_{MF}/C_{PF} * 100$
Unit	%
Type of indicator	Primary
Data source	Data should be gathered from the owner of the action Data should be gathered when action is ready to its implementation
Actions/ Interventions	To be confirmed in D7.4

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Ec 4	Cost of the project covered by funds - public or private (CCF)
Category pillar	Economy
Description	Percentage of the total cost (CoT) to implement the intervention covered by funds (C_F) – non-repayable. Funds imply the sum of public or private money allocated to implement the action (direct expenditure).
Reference	SCIS
Calculation	$CCF = C_F / CoT * 100$
Unit	%
Type of indicator	Primary
Data source	Data should be gathered from the owner of the action Data should be gathered when action is ready to its implementation
Actions/ Interventions	To be confirmed in D7.4

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Ec 5	Opex cost of the project (OCP)
Category pillar	Economy
Description	Cost in Euro to manage, operate, and maintain the action (OCP) once it is implemented. The OCP is the sum of direct costs (C_i) associated with the performance of the intervention.
Reference	SCIS
Calculation	$OCP = C_1 + C_2 + \cdots + C_n = \sum_{i=1}^{n} C_i$
Unit	€
Type of indicator	Primary
Data source	Data should be gathered from the owner of the action Data should be gathered when action is implemented (t_0) and after one year (t_1)
Actions/ Interventions	To be confirmed in D7.4

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Ec 6	Cost of the project by m^2 (Cm^2)
Category pillar	Economy
Description	Total cost (CoT) by m^2 in Euro to implement the action. The CoT is the sum of direct construction costs (C_i) – costs associated with the particular / specific action.
Reference	mySMARTlife
Calculation	$Cm^2 = (C_i + C_{ii} + \cdots + C_n) / m^2 = \frac{1}{m^2}\sum_{i=1}^{n} C_i$
Unit	€/m^2
Type of indicator	Primary
Data source	Data should be gathered from the owner of the action Data should be gathered when action is ready to its implementation
Actions/ Interventions	To be confirmed in D7.4

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Ec 7	Income (INC)
Category pillar	Economy
Description	The INC is the sum of incomes (I_i) in Euro received per year because of the implementation of the action.
Reference	mySMARTlife
Calculation	$\text{INC} = \text{I}_\text{i} + \text{I}_\text{ii} + \cdots + \text{I}_\text{n} = \sum_{i=1}^{n} I_i$
Unit	€
Type of indicator	Primary
Data source	Data should be gathered from the owner of the action Data should be gathered when action is implemented (t_0) and after one year (t_1)
Actions/ Interventions	To be confirmed in D7.4

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Ec 8	**Net Present Value (NPV)**
Category pillar	Economy
Description	Net Present Value (NPV) is the difference between the present value of cash inflows and the present value of cash outflows over a period of time. A positive NPV indicates that the project earnings generated by the action (project) or investment exceeds the anticipated costs. An investment with a positive NPV will be profitable (at less has to be considered), and an investment with a negative NPV will result in a net loss.
Reference	CITYkeys, URB-grade, 2DECIDE, Concerto, Eurbanlab
Calculation	$\mathrm{NPV} = \sum_{t=1}^{T} \frac{C_t}{(1+r)^t} - C_0$
Unit	€
Type of indicator	Primary
Data source	Data should be gathered from the owner of the action Data should be gathered form the beginning of the action (t0), when action is implemented (t_1) and after one year (t_2) an following estimations (t_n)
Actions/ Interventions	To be confirmed in D7.4

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Ec 9	**Internal Rate of Return (IRR)**
Category pillar	Economy
Description	Internal rate of return (IRR) is a discount rate that makes the net present value of all cash flows (CF) from a particular project equal to zero. The IRR is an indicator to estimate the profitability of potential actions, projects or investments. IRR calculations rely on the same formula as NPV does. the higher a project's internal rate of return, the more desirable it is to undertake
Reference	CITYkeys, URB-grade, Eurbanlab
Calculation	$\mathrm{IRR} = \sum_{T=0}^{N} \frac{CF}{(1+\mathrm{IRR})^{t}} = 0$
Unit	% (interest)
Type of indicator	Primary
Data source	Data should be gathered from the owner of the action. Data should be gathered form the beginning of the action (t0), when action is implemented (t_1) and after one year (t_2) an following estimations (t_n)
Actions/ Interventions	To be confirmed in D7.4

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Ec 10	Payback Period (PP)
Category pillar	Economy
Description	The payback period (PP) is the length of time required to recover the cost of an initial investment. The PP of a given action or investment is an important determinant of whether to undertake the project, as longer payback periods are typically not desirable for investment positions.
Reference	CITYkeys, SCIS, Concerto, URB-grade, Eurbanlab
Calculation	$\mathrm{PP} = \frac{\text{Initial investment}}{\sum_{i=1}^{n} \text{Cash inflow peryear}_i}$
Unit	Years
Type of indicator	Primary
Data source	Data should be gathered from the owner of the action Data should be gathered form the beginning of the action (t0), when action is implemented (t_1) and after one year (t_2) an following estimations (t_n)
Actions/ Interventions	To be confirmed in D7.4

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Ec 11	Return On Investment (ROI)
Category pillar	Economy
Description	The Return On Investment (ROI) is a performance measure used to evaluate the efficiency of an action or investment or compare the efficiency of a number of different actions and investments. ROI tries to directly measure the amount of return on an particular action or investment, relative to the investment's cost. To calculate ROI, the benefit (or return) of an investment (INC – CoP) is divided by the cost of the investment (CoP)
Reference	SCIS, WorldBank
Calculation	$\mathrm{ROI} = (\mathrm{INC} - \mathrm{CoP})/\mathrm{CoP}$
Unit	%
Type of indicator	Primary
Data source	Data should be gathered from the owner of the action Data should be gathered form the beginning of the action (t0), when action is implemented (t_1) and after one year (t_2) an following estimations (t_n)
Actions/ Interventions	To be confirmed in D7.4

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Ec 12	Change in the cost of housing (CCH)
Category pillar	Economy
Description	Change in percentage of the average cost of housing (CCH) per m2 before and after the action. This indicator measures the impact to what extent the action has increased the market price of housing.
Reference	CITYkeys, Eurbanlab, LED
Calculation	$\mathrm{CCH} = (\frac{\text{Cost of housing } y_1 - \text{cost of housing } y_0}{\text{cost of housing } y_0}) * 100$
Unit	%
Type of indicator	Primary
Data source	Data should be gathered from the owner of the action Data should be gathered before the beginning of the action (t_0) and after the end of the action (t_1)
Actions/ Interventions	To be confirmed in D7.4

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Ec 13	Energy consumption reduction cost
Category pillar	Economy
Description	Sun of total energy payments saved per unit of time (C_s). Is the difference between measured (C_2)and reference data (C_1).
Reference	mySMARTlife
Calculation	$C_s = C_2 - C_1$
Unit	€
Type of indicator	Primary
Data source	Data should be gathered from the owner of the action and owners/residents Data should be gathered form the beginning of the action (t0), when action is implemented (t_1) and after one year (t_2) an following estimations (t_n)
Actions/ Interventions	To be confirmed in D7.4

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Ec 14	Variation in Opex cost (VOC)
Category pillar	Economy
Description	Variation of operation cost of the action (manage, operate, and maintain the action) before and after the implementation of the action.
Reference	mySMARTLife
Calculation	$VOC = \frac{OCP_i - OCP_{i-1}}{OCP_{i-1}} * 100$
Unit	%
Type of indicator	Primary
Data source	Data should be gathered from the owner of the action Data should be gathered when action is implemented (t_0) and after one year (t_1)
Actions/ Interventions	To be confirmed in D7.4

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Objective 2: Economic impact of the action in the city

Ec 15	Expenditure in local economy (ELE)
Category pillar	Economy
Description	Share (%) in total action costs that has been spent on local suppliers, contractors and service providers.
Reference	Eurbanlab
Calculation	$ELE = \frac{\text{Total spent on local suppliers}}{\text{Total project costs}} * 100$
Unit	%
Type of indicator	Primary
Data source	Data should be gatheres from the owner of the action. Data should be gathered form the beginning of the action (t0), when action is implemented (t_1) and after one year (t_2) an following estimations (t_n)
Actions/ Interventions	To be confirmed in D7.4

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Ec 16	Number of job created (JC)
Category pillar	Economy
Description	Number of job created (JC) by the project during the lifetime of infrastructure of the action taking into account jobs of operation, job of construction and the duration of the construction.
Reference	CITYkeys, Pardo-Bosch & Aguado, 2016[18]
Calculation	$JC = \text{jobs of operation} + \left(\frac{\text{num. of jobs construction x duration of construction}}{\text{lifetime of infrastructure}}\right)$
Unit	Number of jobs
Type of indicator	Primary
Data source	Data should be gathered from the owner of the action Data should be gathered form the beginning of the action (t0), when action is implemented (t_1) and after one year (t_2) an following estimations (t_n)
Actions/ Interventions	To be confirmed in D7.4

[18] Pardo-Bosch, F. and Aguado, A. (2016). Sustainability as the key to prioritize investments in public infrastructures. Environ. Impact Assess. Rev., 60: 40–51. doi:10.1016/j.eiar.2016.03.007.

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Ec 17	Number of SMEs introducing innovation to the market (SMEsIM)
Category pillar	Economy
Description	New patents register during the lifetime of the action
Reference	WIPO, OECD, Worldbank
Calculation	Number of new patents register during the lifetime of the action
Unit	Number
Type of indicator	Primary
Data source	Data should be gathered from the owner of the action Data should be gathered from the beginning of the action, when action is implemented (t0) and after one year (t1) an following estimations (tn)
Actions/ Interventions	To be confirmed in D7.4

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Ec 18	Number of large companies introducing innovation to the market (LargeIM)
Category pillar	Economy
Description	New patents register during the lifetime of the action.
Reference	WIPO, OECD, Worldbank
Calculation	Number of new patents register during the lifetime of the action
Unit	Number
Type of indicator	Primary
Data source	Data should be gathered from the owner of the action Data should be gathered from the beginning of the action, when action is implemented (t0) and after one year (t1) an following estimations (tn)
Actions/ Interventions	To be confirmed in D7.4

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Ec 19	Impact in business unit (IBU)
Category pillar	Economy
Description	The extent to which the action has contribute to its business unit (IBU). This contribution could imply different aspects, such as number of jobs, income, etc. that remain as a subjective evaluation. The Linkert scale is a five-level measure to quantify how agree the interviewed is with the statement.
Reference	mySMARTLife
Calculation	**Likert scale:** *Strongly disagree – 1 – 2 – 3 – 4 – 5 – Strongly agree*
Unit	Number
Type of indicator	Primary
Data source	Data should be gathered from the owner of the action Data should be gathered form the beginning of the action (t0), when action is implemented (t_1) and after one year (t_2) an following estimations (t_n)
Actions/ Interventions	To be confirmed in D7.4

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Ec 20	Change in full poverty (CFP)
Category pillar	Economy
Description	Change in the percentage (%) of gross household income spent on energy bills. Fuel poverty is when households cannot afford to keep adequately warn their dwellings at a reasonable cost given their income. This indicator measures the impact of the affordability because of the action.
Reference	CITYkeys, Eurbanlab
Calculation	$\mathrm{CFP} = (\frac{\mathrm{Fuel\ poverty\ y_1} - \mathrm{fuel\ poverty\ y_0}}{\mathrm{Fuel\ poverty\ y_0}}) * 100$
Unit	%
Type of indicator	Primary
Data source	Data should be gathered from the owner and owners/residents Data should be gathered before action is implemented (t_0) and after one year (t_1)
Actions/ Interventions	To be confirmed in D7.4

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Ec 21	Type of job creation (employee qualification required)
Category pillar	Economy
Description	Number of job created per year by the action according educational levels (measured according the ISCED classification) taking into account construction, managing and operations positions.
Reference	ISCED 2011 (UNESCO)
Calculation	Number of job created by category of education level: - Less than primary, primary and lower secondary education (levels 0, 1, 2) - Upper secondary and post-secondary non tertiary education levels (levels 3-4) - Tertiary education (levels 5-8)
Unit	Number per ISCED category
Type of indicator	Primary
Data source	Data should be gathered from the owner of the action Data should be gathered form the beginning of the action (t0), when action is implemented (t_1) and after one year (t_2) an following estimations (t_n)
Actions/ Interventions	To be confirmed in D7.4

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Ec 22	CO_2 reduction cost efficiency (RCE)
Category pillar	Economy
Description	Cost in Euro of each ton of CO_2 saved per year
Reference	Eurbanlab
Calculation	RCE = (ton of CO_2 year$_1$ – ton of CO_2 year $_0$) * Price tonCO_2
Unit	€
Type of indicator	Primary
Data source	Data should be gathered from the owner of the action Data should be gathered when action is implemented (t_0) and after one year (t_1)
Actions/ Interventions	To be confirmed in D7.4

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Social pillar

Objective 1: Social Acceptance

So1	Degree of satisfaction
Category pillar	Social Evaluation
Description	Level of satisfaction and acceptance of people affected by the action in the topics analysed: • Technical point of view: perceived adequateness, perceived benefit (e.g. comfort), perceived usefulness, perceived ease of use, aesthetical solution satisfaction • Economic point of view: cost, risk, benefit
Reference	SCIS
Calculation	Percentage of respondents for each Likert or YES/NO item Mean average of results
Unit	% and/or 5-Point Likert Scale
Type of indicator	Core - Primary
Data source	Questionnaire or interviews
Actions/ Interventions	To be confirmed in D7.4

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So2	**Social factors**
Category pillar	Social Evaluation
Description	Citizens' perception in the social factors identified *(e.g. divergence of interest, resistance to change, perception on amount of information received, perception on involvement in decision-making, interviewed profile)*
Reference	Adapted from SCIS
Calculation	Percentage of respondents for each Likert or YES/NO item Mean average of results
Unit	% and/or 5-Point Likert Scale
Type of indicator	Core - Primary
Data source	Questionnaire or interviews
Actions/ Interventions	To be confirmed in D7.4

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So3	Active/pro active citizens's behaviour
Category pillar	Social Evaluation
Description	The indicator addresses the question whether and to which extend housholders changed their behaviour regarding an action (e.g. willingness to invest in energy savings measures or pay more for RES or service, recommend the project to others)
Reference	SCIS
Calculation	Percentage of respondents for each Likert item Mean average of results
Unit	% and/or 5-Point Likert Scale
Type of indicator	Core - Primary
Data source	Questionnaire or interviews
Actions/ Interventions	To be confirmed in D7.4

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Objective 2: Target people reached in citizen involvement activities

So 4	Number of people reached
Category pillar	Social
Description	Percentage of people in the target group that have been reached and/or are activated by the project
Reference	CITYKEYS
Calculation	(number of citizens reached/total number of citizens considered as the total target grouop of the project) * 100
Unit	% # (if is not knonw the size of target group)
Type of indicator	Core - Primary
Data source	To be derived from apps or other channel developed in the Project such as estimation of organizers of citizen engagement activities
Actions/ Interventions	To be confirmed in D7.4

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So 5	Range of people from diverse social backgrouds reached
Category pillar	Social
Description	Indication how inclusive presencial citizen involvement activities have been and to which extend diversity was considered. This diversity is understood as range of age and nationality as well as other parameters that could be measured in each case
Reference	mySMARTLife
Calculation	5-Point likert scale (e.g. Special consideration of children and youngsters / Elder people, inmigrants, etc in citizen engagement activities)
Unit	Likert scale
Type of indicator	Complementary - Primary
Data source	Estimation of organizers of citizen engagement activities
Actions/ Interventions	To be confirmed in D7.4

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Governance pillar

Objective 1: Satisfaction with urban planning methodology

Go 1	Perception of satisfaction with urban planning methodology
Category pillar	Governance
Description	The level of satisfaction with the methodology applied to develop a long-term advanced urban planning and to identify the most replicable and scalable smart solutions in the participant cities
Reference	mySMARTLife project
Calculation	**Likert scale:** *Very dissatisfied– 1 – 2 – 3 – 4 – 5 – Very satisfied* 1-Very dissatisfied: The urban planning methodology applied to the cities does not allow reaching the objetives of the project. 2-Slightly dissatisfied: The urban planning methodology applied to the cities allows reaching few objetives of the project. 3-Neutral: The urban planning methodology applied to the cities allows reaching some objetives of the project. 4-Moderately satisfied: The urban planning methodology applied to the cities allows reaching enough objetives of the project. 5-Very satisfied: The urban planning methodology applied to the cities allows reaching high number of objectives of the project. The final score will be an average of the total score obtained from Likert scale between stakeholders.
Unit	Likert scale
Type of indicator	Primary
Data source	To be derived from surveis completed by the target audience defined by city partners (e.g. partners working in the application of the urban planning methodology, stakeholders, policy makers, citizens, etc)

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Actions/ Interventions	**Action category: Urban planning** Nantes: A34: Advanced urban planning, A37: Replication plan Hamburg: A43: Advanced urban planning, A46: Replication plan Helsnki: A35: Advanced urban planning, A38: Replication plan

Objective 2: Participants engaged in urban planning methodology

Go 2	**Target people reached in urban planning methodology**
Category pillar	Governance
Description	Total number of people in the target group that have heard/
Reference	mySMARTLife project
Calculation	The indicator shall be calculated as the total amount people that have heard of / have been engaged with
Unit	Number of people
Type of indicator	Primary
Data source	To be derived from from surveis completed by the target audience defined by city partners (e.g. partners working in the application of the urban planning methodology, stakeholders, policy makers, citizens, etc)
Actions/ Interventions	**Action category: Urban planning** Nantes: A34: Advanced urban planning, A37: Replication plan Hamburg: A43: Advanced urban planning, A46: Replication plan Helsinki: A35: Advanced urban planning, A38: Replication plan

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Objective 3: Satisfaction with coaching/mentoring activities

Go 3	Perception of satisfaction with coaching / mentoring activity
Category pillar	Governance
Description	The extent to which the coaching/ mentoring process has offered positive learning to the participants
Reference	mySMARTLife project
Calculation	**Likert scale:** *Insufficient– 1 – 2 – 3 – 4 – 5 –Excellent* 1-Insuficient: The mentoring/coaching session does not allow cities to identify projects of interest. 2-Below average: The mentoring/coaching session allows cities to identify few projects of interest. 3-Average: The mentoring/coaching session allows cities to identify some projects of interest 4-Above average: the mentoring/coaching session allows cities to identify enough projects of interest 5-Excellent: the mentoring/coaching session allows cities to identify high number of projects of interest The final score will be an average of the total score obtained from Likert scale between the number of attendees
Unit	Likert scale
Type of indicator	Primary
Data source	To be derived from surveys completed by the people involved in the mentoring/coaching activities
Actions/ Interventions	**Action category: Staff exchange** Nantes: A40: City mentoring strategy, A41: City coaching strategy Hamburg: A51: City mentoring strategy, A52: City coaching strategy Helsinki: A42: City mentoring strategy, A43: City coaching strategy

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Objective 4: Participants engaged with coaching/mentoring activities

Go 4	People reached in coaching / mentoring activities
Category pillar	Governance
Description	Total number of people in the target group that have participated in urban coaching/mentoring activities.
Reference	mySMARTLife project
Calculation	The indicator shall be calculated as the total amount people involved in mentoring/coaching activities
Unit	Number of people
Type of indicator	Primary
Data source	To be derived from mentoring-coaching sessions
Actions/ Interventions	**Action category: Staff exchange** Nantes: A40: City mentoring strategy, A41: City coaching strategy Hamburg: A51: City mentoring strategy, A52: City coaching strategy Helsinki: A42: City mentoring strategy, A43: City coaching strategy

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Objective 5: Impact of the project in the strategy of the city

Go 5	New rules /regulations due to the project
Category pillar	Governance
Description	New rules /regulations/city policies developed in cities to allow the implementation of project actions such as mobility regulations, taxes, subsidies, etc
Reference	mySMARTLife
Calculation	The indicator shall be calculated as the value of total amount of new rules/regulations developed to facilitate and allow the implementation of project actions. Apart the value, it will be required to include the description of the new rules/regulation and some details on the reasons why they were generated.
Unit	Number of new rules/regulations
Type of indicator	Primary
Data source	To be derived from desk research and interviews with the project leader in the city and/or with the legislative department within local administration
Actions/ Interventions	**Action category: All actions in LH cities + Policy improvements** Nantes: A32: Single window / desk for energy retrofitting Hamburg: A37: Development of structural and economic policies, A39: Evaluation of institutional framework conditions, A39: Evaluation of institutional framework conditions

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Go 6	Change in rules and regulations
Category pillar	Governance
Description	The extent to which the project has contributed to, or inspired, changes in rules and regulations.
Reference	CITYkeys
Calculation	**Likert scale:** *No impact – 1 – 2 – 3 – 4 – 5 – High impact* 1-No impact: the project has not, at any level, inspired changes in rules and regulations. 2-Little impact: the project has led to a localised discussion about the sustainability of the current rules and regulations. 3-Some impact: the project has led to a public discussion, leading to a change in rules and regulations. 4- Notable impact: the project has led to a public discussion, leading to a change in rules and regulations. This in its turn has sparked a discussion amongst other administrations about the sustainability of the current rules and regulations. 5-High impact: the project has led to a public discussion, leading to a change in rules and regulations. This in turn has inspired other administrations to reconsider their rules and regulations.
Unit	Likert scale
Type of indicator	Primary
Data source	To be derived from desk research and interviews with the project leader and with the legislative department within local administration
Actions/ Interventions	**Action category: All actions in LH cities + Policy improvements** Nantes: A32: Single window / desk for energy retrofitting Hamburg: A37: Development of structural and economic policies, A39: Evaluation of institutional framework conditions, A39: Evaluation of institutional framework conditions

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Go 7	Change in public procurement
Category pillar	Governance
Description	The extent to which the project has contributed to, or inspired, new forms of public procurement procedures
Reference	CITYkeys
Calculation	**Likert scale:** *No impact – 1 – 2 – 3 – 4 – 5 – High impact* 1-No impact: the project used a new procurement procedure, but this is not known to the outside world. 2-Little impact: the project used a new procurement procedure but is hardly known for this. 3-Some impact: the project developed and used a new procurement procedure and has received some professional attention because of this. 4- Notable impact: the project developed and used new procurement procedure and has attracted a lot of professional attention because of this which has led to a few further experiments with the new public procurement procedure. 5-High impact: the project developed and used a new procurement procedure and has attracted a lot of public and professional attention because of this which has led to several further experiments with the new public procurement procedure.
Unit	Likert scale
Type of indicator	Primary
Data source	To be derived from desk research and interviews with the project leader and with the legislative department within local administration.
Actions/ Interventions	**Action category:** All actions in LH cities

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