



## MAchUP

### **D5.2: Economic evaluation framework**

***WP 5, T 5.2***

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## 0 Abstract

Economic evaluation is a broad term adopted in several domains, which refers to the comparative analysis of costs and effects (benefits) deriving from different projects, programmes or interventions. It aims to support decisions in the allocation and use of resources, as well as to assess the efficiency of implemented interventions. In the scope of smart city projects, economic evaluation can be interpreted as the assessment and monitoring of resources deployed to support the implementation of smart city solutions, as well as the evaluation of their effects and benefits from different perspectives: the city government's one, the societal one, the private investors' one. The implementation of smart city solutions is indeed expected to contribute to the smart city transformation, by delivering a series of environmental, social and economic effects which will impact on different stakeholders. The evaluation of these effects is necessary to understand the desirability of these projects, to communicate the results achieved to stakeholders, as well to inform the development of next smart city projects.

The main objective of WP5 is to define and apply a strong evaluation framework in the three lighthouse cities, with the aim to assess the effectiveness of the proposed interventions, deployed in the associated individual actions, under three perspectives: technical-environmental (Task 5.1), economic (Task 5.2) and social (Task 5.3). This deliverable (D5.2.) describes the process that was undertaken to define an economic evaluation framework for the MAtchUP project and the outcomes of this process, providing information on the indicators proposed for evaluating the business model performances and the economic impact of actions.

**Chapter 2** and **3** describe the key features of MAtchUP evaluation frameworks, describing the purposes, the focuses and the boundaries of WP5 project level and WP1 city level evaluation. These chapters are common to the three WP5 deliverables (D5.1, D5.2. and D5.3) and also describe the common process that was undertaken in the three related tasks to define the project-level evaluation objectives and indicators.

**Chapter 4** provides insight into the key features and issues of economic evaluation of smart city projects, detailing the main initiatives that were considered as reference to identify the proposed economic indicators framework for the MAtchUP project. It also describes the participative process that was undertaken with project partners to define evaluation objectives and select the meaningful indicators, among those identified from the review of existing initiatives, as well as to refine the indicators' set until the final proposal. The evaluation boundaries are also described here, since the economic evaluation needs to consider specific interrelations and synergies among the actions from a financial point of view. Cost-revenue streams may in fact not always coincide with a specific action. Specific economic evaluation action bundles have been defined by partners at this purpose, which correspond to meaningful units of analysis for the scope of the economic evaluation.

The final proposal of economic evaluation framework consists of **11 core indicators**, which target the key financial dimensions of actions, as well as the monetization of two main benefits deriving from the action implementation, in terms of GHG emissions and air pollution reduction. The set also includes **13 complementary indicators**, which aim to evaluate additional aspects and dimensions of actions, including several social and





environmental benefits that would be useful to measure/evaluate in order to have a comprehensive view of the overall impact.

**Chapter 5** provides the full list of economic indicators with their descriptive templates and related implementation guidance, to support MAtchUP cities and local partners in their use and inform potentially interested external stakeholders.

The actual evaluation of the economic impact and business model performances will be carried out as part of Task 5.7 “Economic evaluation process (business models)”, delivering the report D5.6 “Economic evaluation” towards the end of the project.

Technical, economic and social evaluation frameworks have been defined as a joint effort to allow a holistic assessment of MAtchUP demonstrations simultaneously considering these different aspects. These evaluation frameworks are recommended to be used together in order to comprehensively assess the interventions from multiple perspectives. However, in MAtchUP these evaluation frameworks are reported in three different deliverables - D5.1 Technical evaluation procedure, D5.2 Economic evaluation framework and D5.3 Social evaluation framework – to properly address the specificities of these different types of evaluations.



## 1 Introduction

### 1.1 Purpose and target group

The main objective of WP5 is to define and apply a strong evaluation framework in the three lighthouse cities, with the aim to assess the effectiveness of the proposed interventions, deployed in the associated individual actions, under three perspectives: technical-environmental (T5.1), economic (T5.2) and social (T5.3).

The specific objective of Task 5.2. is to create a procedure to evaluate the economic effectiveness of planned actions. This is done by identifying how the performance of complex financial schemes and innovative business models fits with the specific city needs and the main factors that affect the potential replication. This deliverable (D5.2.) describes the process that was undertaken to define an economic evaluation framework for the MAtchUP project and the outcomes of this process, providing information on the indicators proposed for the evaluation of business model performances and the economic impact of actions. The main target groups of this deliverable are the partners of the MAtchUP project, in particular the lighthouse cities that will be engaged in the economic evaluation, and their local partners which are involved in the design, implementation and monitoring of project actions. The deliverable can also be of interest for other cities, their technical and industrial partners, as well as for researchers, who may search for background information on frameworks and methodologies applicable for the economic analysis of smart city solutions.

There is a strong link between WP5 and WP6 on “Exploitation and market deployment – Innovative business models”. WP6 will perform in-depth analysis of business models associated with the interventions implemented in the demo-cases by the MAtchUP lighthouse cities, focusing on their key elements, their strengths and weaknesses, success and failure factors. T5.2. will provide the measurement and the evaluation of the business model performances.

Jointly, these activities will enable to provide insights into the benefits and efficiency of the different solutions and their associated business models, as the basis to produce high level upscaling and replication plans and also to give recommendations at local, regional, national and European level.

### 1.2 Table of acronyms

Acronym	Definition
BAU	Business As Usual
CBA	Cost-Benefit Analysis
DoA	Description of Action
EC	European Commission
EE	Energy Efficiency
EeB	Energy Efficient buildings
EIP-SCC	European Innovation Partnership on Smart Cities and Communities
EU	European Union



FOL	Follower Cities
GHG	Greenhouse Gas
ICT	Information and Communication Technology
IRR	Internal Rate of Return
KPI	Key Performance Indicator
LH	Lighthouse (City, project...)
NPV	Net Present Value
NTA	Non-Technical Action
GPP	Green Public Procurement
PV	Photovoltaic
RES	Renewable Energy Sources
SCC	Smart Cities and Communities
SCC	Social Cost of Carbon
SCIS	Smart Cities Information System
SCTP	Smart City Technology Package
VVTS	Value of Travel Time Savings
WP	Work package

Table 1: Table of acronyms

### 1.3 Contribution from partners

Table 2 depicts the main contributions from participant partners in Task 5.2, which informed the development of this deliverable.

Partner	Task	Contribution
UBIEFE	5.2.	Task and deliverable responsible. Defined the economic evaluation framework and led the work of identifying indicators, linking economic indicators to actions.
LNV/VAL	5.2.	Filled out action cards. Provided feedbacks on proposed indicators. Conducted feasibility check of economic evaluation framework indicators. Defined economic evaluation action bundles.
DRE	5.2.	Filled out action cards. Provided feedbacks on proposed indicators. Conducted feasibility check of economic evaluation framework indicators. Defined economic evaluation action bundles.
ANT/DEM	5.2.	Filled out action cards. Provided feedbacks on proposed indicators. Conducted feasibility check of economic evaluation framework indicators. Defined economic evaluation action bundles.
WP2 local partners	5.2	Filled out action cards.
WP3 local partners	5.2	Filled out action cards.
WP4 local partners	5.2	Filled out action cards.
VTT	5.1.	Coordinated the action card work and consistency between the evaluation frameworks.

Table 2: Contribution from partners



## 1.4 Relation to other project activities

Table 3 depicts the main relationship of this deliverable to other activities (or deliverables) developed within the MAtchUP Project and that should be considered along with this document for further understanding of its contents.

Partner	Task	Relation to other project activities
UBIEFE	6.1/6.2.	Task 6.1. defines the business model evaluation framework and Task 6.2. will apply it to the business models implemented in the project. WP6 will perform in-depth analysis of business models associated with the interventions implemented in the demo-cases by the MAtchUP lighthouse cities, focusing on their key elements, their strengths and weaknesses, success and failure factors. WP5 will provide the measurement and the evaluation of the business model performances.
VTT	5.1.	There are links between some economic evaluation indicators and technical-environmental indicators, since economic indicators aim to translate selected environmental benefits into monetary terms.
KVEL	5.3.	There are links between some economic evaluation indicators and social indicators, since economic indicators aim to translate selected social benefits into monetary terms.
VTT	5.4	The monitoring program should allow the collection of indicator values of T5.2. T5.4 will further analyse datasets and data quality for monitoring of T5.2 indicators.
VTT	5.5	The data collection in monitoring is based on the indicator definitions of T5.2.
CAR	1.3	D5.1, D5.2 and D5.3 as deliverables will be used to select the indicators to measure the impacts of SCTP.
VAL	2.2	Baseline values (when needed) are defined for Valencia for the economic evaluation to be carried out in Task 5.7.
DRE	3.2	Baseline values (when needed) are defined for Dresden for the economic evaluation to be carried out in Task 5.7.
ANT	4.2	Baseline values (when needed) are defined for Antalya for the economic evaluation to be carried out in Task 5.7.
UBIEFE	5.7	Task 5.7. will apply the economic evaluation framework defined in D5.2. to the business models identified by MAtchUP lighthouse cities.

**Table 3: Relation to other project activities**



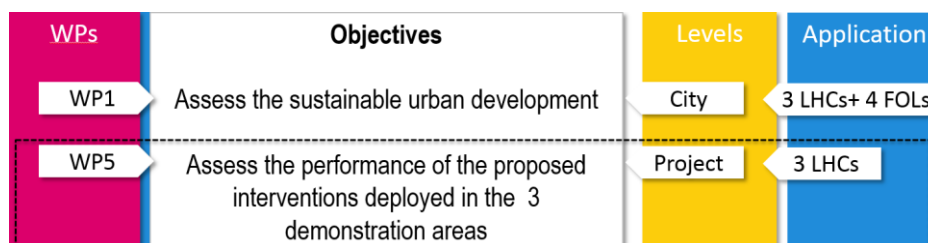
## 2 Purpose of evaluation in MAtchUP

### 2.1 Relation between project and city level evaluation

In order to capture all key project's impact, the scope of MAtchUP evaluation was designed to be broad and comprehensive. To this aim, two levels of evaluation have been defined:

- **Project level evaluation framework** is defined in WP5 as a joint effort between D5.1, D5.2 and D5.3 with the objective of evaluating the technical, environmental, economic and social impacts of the MAtchUP demonstration activities implemented in the three LH cities.
- **City level evaluation framework** has been designed in D1.1. It aims to provide a consistent method to make an advanced city diagnosis for measurement of progress in cities on the road to sustainability and smartness with the intention to guide the cities in the design of strategic plans to deploy innovative technologies in the energy, mobility and ICT sectors. This framework will be applied in the 3 LH cities and 4 follower cities of the project.

Therefore, the final objectives of these evaluation frameworks are different and complementary, since the city level evaluation framework aims at urban planning based on efficient measures and the project level evaluation framework intends to assess the efficiency and benefits of the measures implemented in MAtchUP in the cities. The Figure below summarizes the two levels of evaluation applied in the project.



**Figure 1: Two levels of evaluation in MAtchUP**

In addition, these evaluation frameworks evaluate the effectiveness and the impacts of the demo actions in two different ways.

- WP5 focuses on the evaluation of 140 individual actions that in the case of the categories “buildings and districts” and “city infrastructure” are grouped in interventions when these actions are implemented in the same building or location. Furthermore, for the purposes of the economic evaluation framework, specific action bundles are defined which correspond to different business models (see also par. 4.4). Project indicators defined in D5.1, D5.2 and D5.3 will be calculated to assess the effects of the demo actions within their scope and comparing ex-ante and ex-post evaluations.
- WP1 focuses on the evaluation of technical actions grouped in a set of complete replicable solutions named as Smart City Technology Packages (SCTP). A set of project indicators from D5.1, D5.2 and D5.3 will be used to analyse the suitability of these solutions to meet the city demand. The

effectiveness of these solutions will be evaluated through estimations found in literature.

A total of 25 interventions have been defined in the DoA in the three LH cities (see also for reference D5.1. and D5.3.).

On the other hand, SCTPs have been defined in WP1 under three categories:

- Energy SCTP: District/building actions and/or City infrastructure actions connected + Urban platform actions + NTA actions
- Mobility SCTP: Mobility actions connected + Urban platform actions + NTA actions
- ICT SCTP: Urban platform actions + NTA actions

They are built by technical and non-technical actions and group different categories. Own partners from each LH selected the actions that take part to each SCTP according to the dependence found among actions that act as enablers. Further information about these SCTP can be found in D1.3 and D1.5 where these technology packages are defined and characterized, respectively.

## 2.2 Evaluation objectives in WP5

According to the DoA, specific objectives must be met in each LH in terms of energy consumption and CO<sub>2</sub> due to the implementation of energy and mobility actions. These are the goals that cities have in MAtchUP project and need to be evaluated after two years of monitoring. The detailed energy and CO<sub>2</sub> reduction goals for each LH city are reported in detail in Deliverable 5.1. – Technical evaluation framework.

Furthermore, MAtchUP project expects to achieve these impacts after the implementation of 140 actions:

I-1	MAtchUP promotes the development of tailored solutions to address city challenges
I-2	MAtchUP assures the establishment of strong links and fosters an active cooperation between fellow projects and involving cities with different typologies (size, geography, climatic zones and economical situations)
I-3	MAtchUP assures the <b>increase on the energy efficiency at district (and city) scale, maximizing the share of Renewable energies and their smart integration in the energy system</b> ( <i>48 % of improvement with respect to the national regulation, with a share of RES of 39 %, all the values in average</i> )
I-4	MAtchUP contributes to the <b>local energy system more secure, more stable and cheaper</b> for the citizens and public authorities
I-5	MAtchUP <b>stimulates self-energy consumption and local production, reducing curtailment to the minimum</b>



I-6	MATchUP increases <b>local air quality</b>
I-7	MATchUP ensures <b>the roll-out of electric vehicles in cities while containing the need for excessive upgrading of the electricity grid and reduce transport based CO<sub>2</sub> emissions (TEST 443 gCO<sub>2</sub>/kWh)</b>
I-8	MATchUP deploys innovative <b>replicable and integrated solutions in energy and transport sectors enabled by ICT and the accompanying business models</b> resulting in a significantly increase of the innovation capacity of the Consortium
I-9	MATchUP will <b>transform the local economy to improve the economic future of the urban areas and the quality of life for the citizens, and to attract potential investors</b> (not delocalised businesses)
I-10	MATchUP will trigger the <b>creation of 2,458 new jobs</b> through the establishment of newly emerging businesses and start-ups
I-11	MATchUP is directly linked to the relevant industry actors and will contribute to the consolation of the European Economic Recovery
I-12	MATchUP will contribute to <b>mobilise public and private investments</b> through the Replication and Upscaling Strategy
I-13	MATchUP promotes actions to decarbonise the energy system
I-14	MATchUP triggers the <b>knowledge transfer between cities</b> by providing an excellent environment for active mentoring and staff Exchange
I-15	MATchUP fosters the dissemination of new knowledge at professional level
I-16	MATchUP will impact on citizens as pillars of the Urban Planning, Upscaling and Replication
I-17	MATchUP aligns with European policies and supports the development of standards through the collaboration with existing EU initiatives like H2020-SCC-3-2015 ESPRESSO Project

The previous expected impacts were the basis to define project indicators identified in WP5 under four categories: technical, environmental, economic and social, where D5.1 deals with technical and environmental indicators, D5.2 with economic indicators and D5.3 with social indicators. Final objectives of economic evaluation and corresponding indicators can be found in Annex A1.

On the other hand, 188 city indicators have been defined in WP1 to evaluate main aspects of the city in each one of the fields considered in the Project (energy, mobility, ICT, citizens) and allow city managers to measure how the city is progressing towards the global objective of sustainability through the implementation of actions in the fields of energy, mobility, ICT and citizens.

Figure below represents the evaluation structure of MATchUP WP1 at city level.





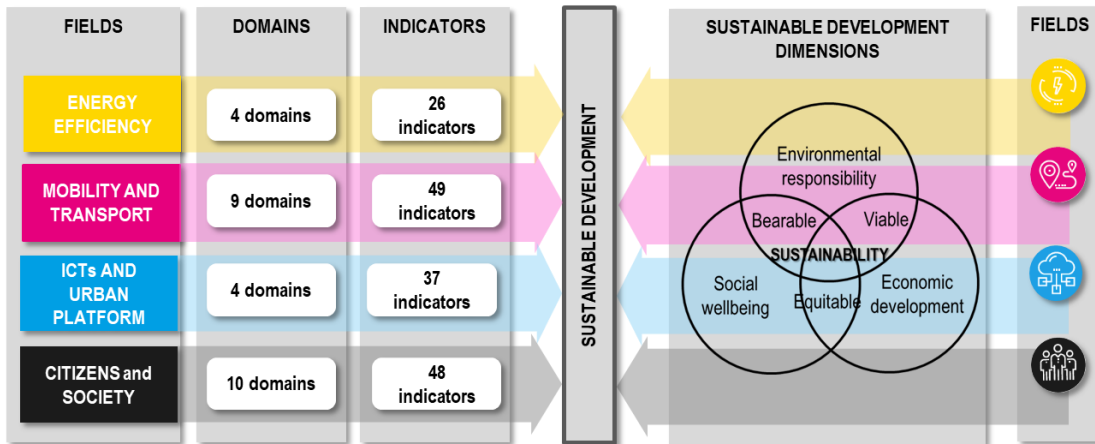


Figure 2: MATCHUP City level evaluation framework approach

While the main scope of this particular deliverable and WP5 in general is limited to specific MATCHUP actions and their impacts, later tasks in WP5 (D5.5, D5.6 and D5.7) will attempt to up-scale the impacts of interventions at wider city scale with links to WP1.



### 3 Development of evaluation frameworks

MATchUP WP5 evaluates three types of impacts of demonstration actions: technical (T5.1), economic (T5.2) and social (T5.3). During the first year, these three first tasks have been progressing in parallel. The following picture visualizes all tasks and their relationships in WP5:

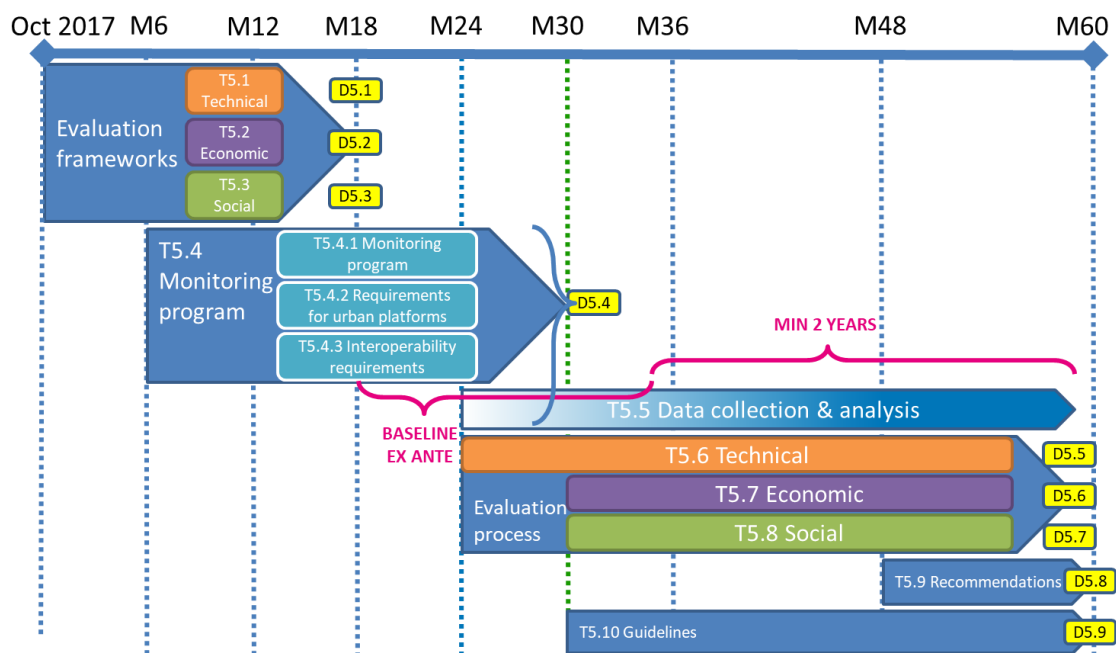


Figure 3: WP5 tasks and their relationships

The development of technical, economic and social evaluation frameworks has progressed simultaneously and with extensive efforts to find a consistent approach to all three. Uniform frameworks would increase the exploitability and replicability of evaluated actions. However, there were several challenges that needed to be solved related not only to the theoretical work, but also to the respective evaluation procedures. The following Table presents the relationship between the evaluation frameworks and action categories adopted in MATchUP.

	Buildings and districts	City infrastructures	Mobility	Urban platform and ICT development	Non-technical actions
Technical–Environmental evaluation	ENERGY		MOBILITY	ICT	
Economic evaluation	ECONOMIC				
Social evaluation	SOCIAL (CITIZEN)				

Table 4: Relationship between the evaluation frameworks (column on left) and action categories (top row)



Each individual MAtchUP action can be found under one category (Building and districts, City infrastructures, Mobility, Urban platform and ICT development, and Non-technical actions). On the other hand, an individual action can be evaluated at the same time under Technical-Environmental, Economic and Social framework. Technical evaluation framework does not have a role when assessing the impacts of Non-technical actions, but economic and social frameworks can be applied to actions from all categories.

The project evaluation team identified technical indicators for action categories and sub-categories, core and complementary economic and social indicators. This classification led, however, to a practical challenge, because actions in cities are not separate, but several actions can form groups i.e. interventions. One intervention can include for example construction of new buildings, installation of PV panels, integration of energy storage and smart controls to manage the whole system. When for example energy savings, economic feasibility or user satisfaction are evaluated, it is not possible to define impacts from individual actions. Also, for example exploitation of renewable energy from PV system will be more efficient when there is an electric storage integrated.

To integrate technical, economic and social aspects as uniform evaluation frameworks has another practical challenge: as these form separate disciplines in academic world, the cities' administrative structures follow the discipline specific form as well. At the same time when we tackle climate change with technologies, we have to recognise the importance of economic and social factors to break barriers and accelerate the transition. We have created successful cooperation with scientific partners in MAtchUP and wish this would smooth the way for cities' professionals to break the organisational boundaries, as well.

The first WP5 indicator workshop was held in the MAtchUP kick-off meeting in Valencia on November 2017. In the workshop, the existing CITYkeys indicator framework was introduced and the partners were invited to discuss and match their actions with the framework (see the structure of CITYkeys below). As a result, the most relevant subthemes from CITYkeys were identified.

#### Themes, Subthemes and # of project indicators

People	Planet	Prosperity	Governance	Propagation
<ul style="list-style-type: none"> <li>• Health (3)</li> <li>• Safety (4)</li> <li>• Access to (other) services (7)</li> <li>• Education (3)</li> <li>• Diversity &amp; social cohesion (3)</li> <li>• Quality of housing and the built environment (6)</li> </ul>	<ul style="list-style-type: none"> <li>• Energy &amp; mitigation (7)</li> <li>• Materials, water and land (10)</li> <li>• Climate resilience (1)</li> <li>• Pollution &amp; waste (4)</li> <li>• Ecosystem (2)</li> </ul>	<ul style="list-style-type: none"> <li>• Employment (2)</li> <li>• Equity (2)</li> <li>• Green economy (3)</li> <li>• Economic performance (5)</li> <li>• Innovation (5)</li> <li>• Attractiveness &amp; competitiveness (1)</li> </ul>	<ul style="list-style-type: none"> <li>• Organisation (6)</li> <li>• Community involvement (5)</li> <li>• Multi-level governance (2)</li> </ul>	<ul style="list-style-type: none"> <li>• Scalability (10)</li> <li>• Replicability (8)</li> </ul>

Figure 4: CITYKeys framework structure



After the workshop, the draft lists of relevant action-level indicators were formulated. In order to be able to communicate about the needed indicators, we established WP5 Action cards (see Annex A2) on April in the MAtchUP consortium meeting in Antalya where VTT, UBIEFE and KVEL organized discussions about action objectives, matching indicators and data sources by pillar: Energy, Mobility, ICT. In each of these groups the technical, economic and social issues were dealt. After the Antalya meeting, a responsible partner of each action filled and stored the Action cards in the MAtchUP repository. The following iteration round was done by technical partners (VTT, UBIEFE, KVEL and CAR), who combined the information from the cards and analyzed it further in order to formulate frameworks with technical, economic and social indicators.

The following chapters describe the process undertaken to define an economic evaluation framework for the MAtchUP project and the outcomes of this process, providing information on the indicators proposed for evaluating the business model performances and the economic impact of actions.



## 4 Definition of the economic evaluation framework

### 4.1 Economic evaluation for smart city projects

Economic evaluation is a broad term adopted in several domains, which refers to the comparative analysis of costs and effects (benefits) deriving from different projects, programmes or interventions. It aims to support decisions in the allocation and use of resources, as well as to assess the efficiency of implemented interventions. Different methodologies of economic evaluation are available, which depend on the field and objectives of the analysis, as well as from the viewpoint adopted (private vs. public perspective)<sup>2</sup>.

It is necessary to differentiate between financial and economic analysis, which serve different purposes. A financial analysis is focused on costs and benefits for a particular organization (Newcomer e a., 2015). It is used to document a reasonable expected return on investment to investors, it is based on market prices and it does not consider externalities generated by the investment (COWI, 2016). An economic analysis considers costs and benefits that regard any organization impacted by a programme, to capture its value to society (Newcomer e a., 2015). In fact, the economic analysis is used to document that the project is a net benefit to society as a whole, is based on economic prices (which exclude taxes, tariffs, subsidies) and considers the externalities (positive and negative) generated by the project, which are quantified in monetary terms and included in the evaluation (COWI, 2016). Economic evaluation methodologies like Cost-Benefit Analysis and Cost-Effectiveness Analysis (see D6.1 for their description), can be conducted with a financial or an economic/social perspective.

In the scope of smart city projects, economic evaluation can be interpreted as the assessment and monitoring of resources deployed to support the implementation of smart city solutions, as well as the evaluation of their effects and benefits from different perspectives: the city government's one, the societal one, the private investors' one. The implementation of smart city solutions is indeed expected to contribute to the smart city transformation, by delivering a series of environmental, social and economic effects which will impact on different stakeholders. Both costs and benefits deriving from smart city projects can be direct monetary costs and profits or non-monetary "costs" (e.g. noise, visually uglier environment) and benefits (e.g. less pollution, healthier people), namely positive and negative externalities. The evaluation of these costs and effects is necessary to understand the desirability of these projects, to communicate the results achieved to stakeholders, as well to inform the development of next smart city projects<sup>3</sup>.

Over time, many evaluation frameworks and indicators set have been developed to assess the performances of smart cities as well as of specific smart and sustainable projects. Indicators are useful instruments that assemble different types of data and

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<sup>2</sup> Chapter 3 of MAtchUP Deliverable 6.1 provides an overview of the main methodological approaches applied for economic evaluation, as a general framework useful to the project.

<sup>3</sup> Chapter 3 of MAtchUP Deliverable 6.1. provides a discussion and overview of the main positive externalities and benefits linked to smart city projects, with specific examples from MAtchUP solutions.



simplify complex information to support evaluation, assessment and monitoring. These indicators set may differ according to their main conceptual urban focus, their sectorial application domain and indicator types (input, process, output, outcome, impact) (Huovila et al., 2019). The triple axes of social, environmental and economic sustainability and the 3 related Ps (People, Planet and Prosperity) are often used as a reference framework for the definition of evaluation frameworks and related indicators.

Several initiatives have been put in place to establish common evaluation frameworks for smart city projects. The following paragraph briefly describes the main initiatives which have been considered for the definition of MATCHUP economic evaluation framework.

#### 4.1.1 CITYkeys

The CITYkeys<sup>4</sup> project was a 'horizontal activity' of the Smart Cities and Communities programme to develop an indicator framework for smart city project evaluation and support the Lighthouse projects. The project has defined Key Performance Indicators to assess smart city projects and corresponding indicators at city level, which track the progress towards city and project objectives (Bosch et al., 2017). In particular, project indicators compare the situation before and after project implementation, to capture its impact. The 99 project indicators include common as well as sector-specific indicators.

The CITYkeys evaluation framework is organized into five main themes and sub-themes based on the extended triple bottom line sustainability framework (People, Planet, Prosperity, Governance and Propagation), which include specific policy goals. For the purposes of the economic evaluation, the “Prosperity” theme and its sub-themes are mostly relevant.

##### Prosperity

**Definition of Prosperity:** Contributing to a prosperous and equal society and supporting affordable, green and smart solutions. On the project level Prosperity stands for economic viability and the value of a smart city project for a neighbourhood, for its users and its stakeholders, and even its indirect economic effect on other entities. Economic or financial indicators often need to be accompanied with an in-depth description of the business case, as single indicators are insufficient to evaluate e.g. the distribution of costs and investments.

##### Subtheme definitions

- **Employment:** Improving local employment opportunities and skills
- **Equity:** decreasing poverty and income inequality
- **Green economy:** improving the circular and sharing economy and sustainable/local consumption and production.
- **Economic performance:** increasing GDP and project performance (*internal performance*)
- **Competitiveness and attractiveness:** Improving the appeal of the city for residents and businesses.
- **Innovation:** facilitates innovation and creativity (through e.g. open data, knowledge sharing and cyber resilience).

Source: Bosch et al. (2017)

<sup>4</sup> <http://www.citykeys-project.eu/>



Within the Prosperity theme, the following project indicators have been identified as shown in Table 5:

Prosperity - Sub-theme	Smart city project indicators
Employment	Increased use of local workforce Local job creation
Equity	Fuel poverty Costs of housing
Green economy	Certified companies involved in the project Green public procurement CO <sub>2</sub> reduction cost efficiency
Economic performance	Financial benefit for the end user Net Present Value (NPV) Internal rate of return (IRR) Payback Period Total cost vs. subsidies
Competitiveness and attractiveness	Decreased travel time
Innovation	Involvement of extraordinary professionals Stimulating an innovative environment Quality of open data New start-ups Improved interoperability

**Table 5: CITYkeys project indicators for “Prosperity” (Source: Bosch et al, 2017)**

#### 4.1.2 SCIS – Smart City Information System

The Smart Cities Information System (SCIS) is a knowledge platform to exchange data, experience and know-how, and to collaborate on the creation of smart cities, focusing on solutions in the energy, mobility & transport and ICT sectors<sup>5</sup>. Smart city projects contribute to the platform with data, best practices and lesson learnt from their experience. Projects in the scope of SCIS are mostly co-funded by the European Commission, and include the demonstration projects for Smart Cities and Communities (SCC), Energy Efficient buildings (EeB) and designated projects funded under the calls for Energy Efficiency (EE). As SCC project, MATchUP will contribute to the SCIS database.

According to SCIS (2018a), the economic assessment of smart city measures in the building sector (with specific attention to the energy efficiency dimension) should make possible to answer several questions, including:

- What are the investment costs of energy optimised buildings in comparison to those of conventional buildings?
- Does reducing of the energy consumption result in a reduction of energy costs?

<sup>5</sup> <https://smartcities-infosystem.eu/content/about-smart-cities-information-system-scis>



- Is it economically more reasonable to invest in thermal insulation of the building envelope or its improvement or in technical installations or its modernisation, respectively?
- Do buildings with innovative technical installations possibly have higher maintenance costs than buildings with conventional technical installations?
- How do improved energy efficiency and increased use of renewable energy sources affect life cycle costs of a building?
- To what extent are grants and subsidies needed to make investments in the energy related modernisation of a building economically beneficial from the view of selected stakeholders?
- Are the planning costs of energy optimised buildings higher than those of conventional buildings?

To this purpose, SCIS has elaborated guidelines on the monitoring of economic data in the building sector, defining data collection and assessment procedures. The guidelines define a common cost structure, which enable comparisons between different projects.

SCIS has also developed a set of Key Performance Indicators (KPIs) to measure technical and economic aspects of energy, mobility and ICT related measures in projects, which should be applicable to EU funded projects.

The following economic KPIs have been identified by SCIS as shown in Table 6:

Total Investments
Grants
Total annual costs
Payback period
Return On Investment

**Table 6: General economic performance indicators (Source: SCIS, 2018b)**

### 4.1.3 Espresso

ESPRESSO (Espresso – systEmic Standardisation apPRoach to Empower Smart citieS and cOmmunities)<sup>6</sup> was an Horizon 2020 funded project, focused on the development of a conceptual Smart City Information Framework based on open standards. The framework included the development of a Smart City Platform and a series of data provision and processing services to integrate relevant data, workflows, and processes.

Within the Espresso project, a cost-benefit analysis of the project use-cases was conducted. The following main cost and benefit categories were considered as highlighted in Table 7:

<sup>6</sup> <http://espresso-project.eu/>





Costs
SET-UP/INVESTMENTS COSTS: referring to the initial set-up costs sustained for developing and implementing the solution. The main macro-typologies of costs that can be included in this category span from the planning and development of the solution to the acquisition and implementation of related equipment. Examples of costs that can be included within these categories depending on the type of solution are: hardware/software application, IT training, partners' research and engagement costs etc.
OPERATIONAL COSTS: referring to the costs sustained for running the solution. The main macro-typologies of costs that can be included in this category are: costs for running the solution, costs for monitoring and evaluating the solution, and dissemination costs (e.g. cost for promoting uptake or publicize the service). Examples of costs that can be included within these categories depending on the type of solution are: network infrastructure costs, personnel costs etc.
MAINTENANCE COSTS: referring to the costs sustained for maintaining the systems as fully operative, including depending on the type of solution: hardware and software maintenance, hardware and software upgrades etc.
OTHER INVESTMENT COSTS: including additional investment costs for scaling, upgrading or improving the service.
Monetized Benefits
TIME SAVINGS: referring to the benefits generated by reduced time in work routines and processes as a result from the adoption of the Smart Cities solution based on standards.
INFORMATION BENEFITS: referring to the benefits generated by enhanced information sharing and data resulting from the adoption of the Smart Cities solution based on standards.
RISK BENEFIT: referring to the benefits generated by enhanced security of data of the Smart Cities solution based on standards
FUTURE COST AVOIDANCE: referring to the benefits generated by a reduced need for future capacity expansion, future operating costs, lower cost for future projects.

**Table 7: CBA indicators used in Espresso (Source: Senatore et al., 2017)**

Furthermore, some qualitative benefits were also investigated by ESPRESSO, using indicators defined in CITYkeys, namely: Improved interoperability, Stimulating an innovative environment, Cultural heritage, Solution(s) to development issues.

#### **4.1.4 Action Cluster of Business Models, Finance and Procurement of the EIP on Smart Cities and Communities**

The Action Cluster on Business Models, Finance and Procurement is a platform under the European Innovation Partnership on Smart Cities and Communities (EIP-SCC) aimed to bring together stakeholders to support the development of the a market for smart city solutions. The Action Cluster promotes initiatives around the main topics of innovative business models, financing opportunities and procurement methods, disseminating lessons learnt, creating knowledge exchange opportunities as well as





supporting tools, such as the Business Models Repository<sup>7</sup>. The Business Models repository currently displays about 20 cases from several EU Member States covering differing project typologies and sectors. Paragraph 2.4. of MAtchUP deliverable 6.1 (“Review of business models and financing instruments”) displays the main dimensions used to catalogue the business models in the repository and summarizes information on these cases from the point of view of the financial sources used (public funding/private resources/revenue stream).

For each case study, the repository includes information on the main technologies involved, the needs addressed and the impact of the solution, describing it in a qualitative way. The documentation and developments available on the website of the Action Cluster have informed the analysis for the definition of the economic evaluation and the business model evaluation framework (D5.2. and D6.1.), in particular regarding the main KPIs in use and the main elements that should be taken into account to define a smart city business model.

## 4.2 Definition of preliminary economic indicators list

Based on the review of existing references and documentation for smart city projects presented in par. 4.1, a preliminary list of economic indicators was elaborated, organized in the following dimensions:

- **Funding/financial model:** it aims to describe which funding/financing sources have been adopted to support the actions and their relative importance in the funding model;
- **Costs & revenue structure:** it aims to measure efficiency gains generated by the actions in terms of costs and assess the revenue streams associated with the actions;
- **Profitability & financial performance:** it aims to measure the overall internal performance of actions and related business models from a financial point of view;
- **Efficiency:** it aims to evaluate the cost-efficiency of actions to save energy and reduce GHGs;
- **Societal benefits:** it aims to quantify into monetary terms the benefits/impacts to citizens across a variety of aspects, including improvements in environmental quality, contrast to climate change, increased safety; it also aims to describe some specific benefits to households/consumers related to the implementation of project actions;
- **Employment:** it aims to describe the possible impact on employment generated by the actions;
- **Business involvement & impact on business:** it aims to capture the impact on business activities, sustainable businesses, as well as the impact on specific business sectors potentially linked to a greater urban attractiveness and liveability;

<sup>7</sup> <https://eu-smartcities.eu/business-models-repository>



- **Innovation:** it aims to evaluate whether the project has contributed to innovation promotion and how much green innovation is transferred to public authorities.

These dimensions and related indicators aim to investigate the internal performance of smart city solutions, as well as quantify in monetary terms the benefits generated to society across several dimensions.

### 4.3 Economic evaluation objectives and proposed indicators from partners

As described in previous sections, the methodology used to define the economic indicators was common to the three WP5 evaluation frameworks and relied on the identification of the objectives pursued by actions. This identification process was carried out in two ways:

**Top-down:** Cartif identified the economic objectives of actions and the economic evaluation objectives based on the project documentation (contents and descriptions of interventions and actions), differentiating them according to the different typologies of interventions (see Annex A1).

**Bottom-up:** During the Antalya meeting, held in April 2018, partners were asked to compile “Action cards” (see Annex A2), tables for each lighthouse action where they could propose their ideas on relevant evaluation objectives under a technical, economic, social perspective, propose possible indicators and provide information on available data sources. The process was completed after the meeting, since partners filled out Action cards for all available actions.

The work conducted through the action cards for the economic evaluation led to the identification of the following objectives:

#### Economic objectives of actions:

- Reduce energy bills/obtain economic savings from reduced energy consumption (for different users: city government, companies, citizens)
- Reduce maintenance costs
- Improve the performance of services
- Increase productivity in the use of resources
- Increase the efficiency in the use of infrastructures
- Reduce public expenditure using new and more efficient practices/technologies
- Demonstrate the amortization time of new solutions
- Develop new business models & new market opportunities
- Encourage private investments
- Increase user awareness about the costs of different solutions (e.g. transport options)
- Reduce societal costs due to health problems
- Increase employment opportunities
- Increase attractiveness of area/increase local economic activity

**Table 8: Economic objectives of actions, suggested by partners**



## 4.4 Definition of evaluation boundaries

A relevant issue in performing an economic evaluation is defining the boundaries and the aggregation level that should be considered when evaluating smart city solutions. As described in Chapter 2, it is not always possible to define impacts from individual actions when some dimensions are considered. Several actions implemented in MAtchUP are related among them from a financing point of view (e.g. they are financed by the same programme or funding sources, or one action is able to finance other actions) or because they are jointly interlinked by a specific business model.

For these reasons, it was decided to define specific aggregations of actions (named “economic evaluation action bundles”) that represent meaningful units for the economic analysis. These units can range from (at least) an individual action (if a business model is identifiable and data are available at action level) to (at most) a bundle of actions, specifically identified by partners based on this logic.

Each bundle includes actions that are developed in an integrated way according to a specific business model. Actions in a bundle are interlinked among them from a financing point of view, and/or are jointly able to generate costs and revenues. For these reasons they should be evaluated jointly, in an integrated way. Annex A3 provides a preliminary list of action bundles that lighthouse cities have identified during the definition of the evaluation framework, for the purposes of the economic analysis. The composition of the action bundles may be updated in the next project phase, based on changes occurring to actions or according to specific needs arising within the economic evaluation.

## 4.5 Identification of core/complementary indicators and definition of the proposed indicators set

The preliminary list of economic indicators elaborated in the first phase of the project was reviewed considering the outcomes of the work conducted through the Action Cards. The preliminary list of indicators was integrated and refined based on the partners’ proposals.

It was also decided to organize the indicators into a “core” and a “complementary” set, in order to increase their manageability by partners (Figure 5).

The “**core**” set includes indicators targeting key financial dimensions of actions (funding/financial model, costs & revenues structure, profitability & financial performance, efficiency), which should be applied to all relevant action bundles where economic data can be retrieved. It also includes two main indicators related to the monetization of the societal benefit, namely in terms of GHG emissions and air pollution reduction.

The “**complementary**” set aims to evaluate additional aspects and dimensions of actions, including several social and environmental benefits, that would be useful to measure/evaluate in order to have a comprehensive view of the overall impact. The complementary set was defined consistently with the identification of actions’ benefits conducted within WP6 (see deliverable D6.1 “Review of business models and financial instruments”).





## Economic evaluation framework: overall approach

	Main dimensions covered:	Indicators
<b>Core dimensions/ indicators:</b>	Funding/financial model	1. Funding sources
	Costs & revenue structure	2. Investment per unit, 3. Operation&Maintenance costs variation (efficiency gains) 4. Revenues variation
	Profitability and financial performance	5. Net Present Value (NPV) 6. Internal rate of return (IRR), 7. Payback period
	Efficiency	8. Energy consumption reduction cost 9. CO2 emissions reduction cost
	Societal benefit	10. Benefit from air pollution reduction 11. Benefit from avoided CO2 emissions
<b>Complementary dimensions/ indicators:</b>	Further benefits/impacts on citizens/consumers	12. Property value variation , 13. Financial benefit for the end-user, 14. Increased safety, 15. Value of Travel Time Savings
	Employment	16. Increased use of local workforce 17. Local job creation
	Business involvement & impact on business	18. Certified companies involved in the project 19. New business registered, 20. Increase in job/tourism
	Market dimension	21. Market orientation 22. Market demand
	Innovation	23. Patents 24. Green public procurement

Figure 5: Proposed core and complementary economic indicators



## 4.6 Feasibility assessment of proposed indicators

In order to assess the feasibility of the proposed indicators, a checklist was distributed to Lighthouse cities (Annex A4), with the aim to collect information on:

- the data availability for each indicator, considering the accessibility of data sources, the possibility to produce directly or collect the relevant data;
- the overall feasibility to populate the proposed economic indicators, based on the availability of data and the possibility for Lighthouse Cities to collect them, also in collaboration with their technical local partners and local stakeholders.

The assessment results show different levels of data availability across the three LH cities, depending on the specific indicator. In general, data availability is high for proposed CORE indicators, except for the Profitability & Financial performance ones. It is rather low for several proposed COMPLEMENTARY indicators, with differences across the three cities.

The results of the assessment were used to confirm the subdivision of indicators into core/complementary, and highlighted the importance to provide cities with detailed guidance on the data collection and indicators calculation. It was decided to keep the Profitability & Financial performance indicators in the CORE set, to be consistent with the information requested by SCIS and the proposed key economic project-level indicators in CITYkeys. It was decided to keep in the COMPLEMENTARY set also those indicators for which the assessment results showed a low availability, since they are part of a comprehensive evaluation framework and it would be interesting to calculate them, in case data become available. In the specific template of each indicator, the expected data availability for the three LH cities is reported.

## 4.7 Alignment with SCIS updates

Given the recent updates in SCIS guidelines on monitoring (November 2018), it was necessary to align the proposed economic indicators with the SCIS updated documentation. SCIS guidelines were also used as key reference in the elaboration of indicators templates (see Chapter 5).



## 5 Description of proposed economic evaluation indicators

### 5.1 Indicator template

For each indicator, a descriptive template is provided, presenting the following key elements:

[Indicator code and Name]	
Category	E.g. Funding/financial model
Indicator type	E.g. Core/Complementary
Definition	Description of the indicator and what it aims to measure
Unit	Unit of measure through which the indicator is expressed
Calculation formula and required variables	Description of the calculation formula and list of variables/datasets needed to calculate the indicator
Applicability to interventions/actions	Categories of interventions/actions the indicator can be applied to
Calculation interval	<p>Description of when/how frequently the indicator should be measured.</p> <p>Data will be collected (depending on the indicator):</p> <ul style="list-style-type: none"> <li>- <b>before</b> (if it is possible to define an ex-ante baseline) action implementation</li> <li>- <b>during</b> action implementation</li> <li>- <b>after</b> the action implementation.</li> </ul> <p>The frequency of monitoring during action implementation may vary depending on the typology of action and data availability, but it will mainly be annual.</p>
Data requirements and guidelines for assessment	
Evaluation boundaries	Action/intervention/specific action bundle
Data sources / availability	List of possible data sources and results of availability check with LH cities
Baseline definition	Description of if/how the baseline for the indicator can be defined
Reporting to SCIS	If/how the indicator is linked to SCIS framework and its KPIs.
References	Main references used to define the indicator





## 5.2 Specific templates for indicators description

### 5.2.1 EC1. Funding sources (CORE)

EC1. Funding sources	
Category	Funding/financial model
Indicator type	Core
Definition	This indicator aims to collect information on the typologies of funding sources (public, private) used to support the action. It comprises a qualitative description (typologies of funding sources and origin of funding) and a quantitative dimension (percentage share of funding source on total or absolute value of funding per source).
Unit	€ €/year %
Calculation formula and required variables	<p>For the qualitative part, please select the funding source used to support the action from the following list:</p> <ul style="list-style-type: none"> <li>National funding</li> <li>Regional/state funding</li> <li>EU funding</li> <li>Grants from other public grant-makers</li> <li>Grants from other private grant-makers</li> <li>Purpose taxes or charges</li> <li>Loans</li> <li>Bonds</li> <li>Local tariffs for public services</li> <li>Construction rights</li> <li>Private funding</li> <li>Crowdfunding</li> <li>Third party financing</li> <li>Sponsorships</li> <li>Advertising</li> <li>Others (please specify)</li> </ul> <p>For the quantitative part, please provide the percentage share of each source on total funding (or as alternative the absolute value of funding per source).</p> <p><i>Variables:</i></p> <ul style="list-style-type: none"> <li>• Average annual total funding (€)</li> <li>• Share of each source on total funding (%)</li> <li>• Amount of funding per source per year (€)</li> <li>• Length of funding per source (years)</li> </ul>
Applicability to interventions/actions	It can be applied to all action typologies.
Calculation interval	<ul style="list-style-type: none"> <li>• Before</li> <li>• During</li> <li>• After</li> </ul> <p>These data should be retrieved before action</p>



	<p>implementation.</p> <p>During project implementation and at the end of the project, it could be checked if additional funding was mobilized.</p>
<b>Data requirements and guidelines for assessment</b>	
Evaluation boundaries	This indicator can be calculated at action/intervention/bundle level, according to the available economic data aggregation and the related business models.
Data sources / availability	<p>Project data/documentation</p> <p>Expected availability: High (VAL, DRE*, ANT)</p> <p>* in particular the qualitative information</p>
Baseline definition	This is a descriptive indicator which presents an overview of the share of the different funding sources activated for the action and their amount, therefore it is not possible to define a baseline. The indicator value could be compared with former projects of similar types.
Reporting to SCIS	<p>SCIS has a core KPI on "Grants", which tracks "non-repayable funds that a grant maker, such as the government, provides to a recipient, e.g. a business, for ideas and projects to provide public services and stimulate the economy."</p> <p>In MAtchUP, grants are reported under Indicator #1. "Funding sources" (see list of possible funding sources to be selected).</p>
References	SCIS

### 5.2.2 EC2. Investment per unit (CORE)

EC2. Investment per unit	
Category	Costs & Revenues structure
Indicator type	Core
Definition	<p>This indicator aims to express average investments associated with the smart city intervention/action in relation to a specific unit (depending on the typology of action). According to the SCIS guidelines, "An investment is defined as an asset or item that is purchased or implemented with the aim to generate payments or savings over time. The investment in a newly constructed system is defined as cumulated payments until the initial operation of the system. The investment in the refurbishment of an existing system is defined as cumulated payments until the initial operation of the system after the refurbishment. Within SCIS, total investments apply to the energy aspects of the system (e.g. high efficient envelope in a building) and exclude investments non energy related (e.g. refurbishment of bathrooms)."</p> <p>The indicator should be compiled specifying who is investing in the action (i.e. municipality, private company, citizens,</p>





	others...).
Unit	It depends on the action category. See Annex A5 for more detail.  e.g. buildings/energy related investments: €/m <sup>2</sup> (building company); €/kW (energy company) mobility investments: €/km, €/vehicle
Calculation formula and required variables	SCIS includes a calculation formula for energy-related investments/retrofitting, which is here adapted to the different intervention types.  We propose to use the following general formula:  $UI = \frac{I}{R}$  <i>UI</i> = Investment per unit  <i>Variables:</i> <i>I</i> = Total investment for the smart intervention/action [€] <i>R</i> = Total value for the reference variable for the action category, e.g. floor area [m <sup>2</sup> ] (for buildings), or Total kWh produced [kWh] (for energy production) (see Annex A5 for more detail)
Applicability to interventions/actions	It can be applied to all action typologies.
Calculation interval	<ul style="list-style-type: none"> <li>• Before</li> <li>• During</li> <li>• After</li> </ul> <p>These data should be retrieved before action implementation and checked along project implementation.</p>
<b>Data requirements and guidelines for assessment</b>	
Evaluation boundaries	This indicator can be calculated at action/intervention/bundle level, according to the available economic data aggregation and the related business models.
Data sources / availability	Project data/documentation  Expected availability: High (VAL, DRE, ANT)
Baseline definition	It could be compared with investment per unit associated with similar Business as Usual interventions (i.e. in the case of a building retrofit, an intervention which brings the building energy efficiency to what is currently foreseen in the regulations; in the case of a new building, a new building constructed following current regulations).
Reporting to SCIS	This indicator is the same as SCIS core KPI on “Total investments”.
References	SCIS



### 5.2.3 EC3. Operation & Maintenance costs variation (Efficiency Gain) (CORE)

EC3. Operation & Maintenance costs variation (Efficiency Gain)	
Category	Costs & Revenues structure
Indicator type	Core
Definition	<p>This indicator aims to measure the variation of costs generated by the action, by comparing the total annual costs before and after the action implementation.</p> <p>The proposal is to take into account the overall Operation &amp; Maintenance costs related to the action, not only the energy-related ones, in order to capture the overall impacts on costs variation that these types of action can entail (e.g. benefits in terms of maintenance costs reduction).</p> <p>The indicator should be compiled specifying who incurs in the cost (i.e. municipality, company, citizens...).</p>
Unit	<p>€/year for Total Annual Costs before/after and for each cost item</p> <p>Costs variation will be calculated as % variation.</p>
Calculation formula and required variables	<p>The indicator calculates the variation between Total Annual Costs before the action and Total Annual Costs after the action.</p> $TAC_{var} = \left( \frac{TAC_{after} - TAC_{before}}{TAC_{before}} * 100 \right) \%$ <p><math>TAC_{var}</math> = Total Annual Costs variation</p> <p><math>TAC_{before}</math> = Total Annual costs of the intervention before the project implementation, which includes the cost categories defined in SCIS:</p> <ul style="list-style-type: none"> <li>- <b>Capital related costs:</b> encompass depreciation, interests and repairs caused by the investment (€);</li> <li>- <b>Requirement-related costs:</b> include power costs, auxiliary power costs, fuel costs, and costs for operating resources and in some cases external costs (€);</li> <li>- <b>Operation-related costs:</b> include among other things the costs of using the installation and costs of servicing and inspection (€);</li> <li>- <b>Other costs:</b> include costs of insurance, general output, uncollected taxes etc (€).</li> </ul> <p><math>TAC_{after}</math> = Total Annual costs of the intervention after the project implementation, which includes the same cost items as <math>TAC_{before}</math>.</p>



	Data should be retrieved during the monitoring period of MAtchUP as real data (costs measured in the specific year/s). Since the lifetime of the investment is longer than the MAtchUP project duration, an estimation of average annual costs during all the investment lifetime should be provided, in order to account for O&M costs that may take place in the future.
Applicability to interventions/actions	It can be applied to all action categories.
Calculation interval	<ul style="list-style-type: none"> <li>• Before</li> <li>• During</li> <li>• After</li> </ul> <p>These data should be collected before the project implementation, to define the baseline, and periodically during the project (annually). As described in the “Variables” section, an estimation for next years, not covered by the MAtchUP project, should be provided.</p>
<b>Data requirements and guidelines for assessment</b>	
Evaluation boundaries	This indicator can be calculated at action/intervention/bundle level, according to the available economic data aggregation and the related business models.
Data sources / availability	<p>Project data/documentation, energy bills, other bills, survey/interview to action manager.</p> <p>Expected availability: High (VAL), Low (DRE, ANT)</p> <p>For BAU definition, average data on current building/infrastructure performances.</p>
Baseline definition	<p>For actions that foresee an upgrade/retrofit, the baseline are total annual costs before the project implementation (the indicator is built as a comparison between an ex-ante and ex-post situation).</p> <p>For actions that foresee new constructions/new infrastructures, the baseline are total annual costs of a similar intervention which follow Baseline as Usual practice (i.e. in the case of building, a new building constructed following current regulations).</p>
Reporting to SCIS	<p>SCIS has a KPI core indicator named “Total annual costs”. Indicator #3 is based on the SCIS indicator, but it aims to evaluate the overall Operation &amp; Maintenance costs related to the action, not only the energy-related ones, to capture the wider benefits entailed by the action.</p> <p>In SCIS, the total annual costs are defined as “the sum of capital-related annual costs (e.g. interests and repairs caused by the investment), requirement-related costs (e.g.</p>



	power costs), operation related costs (e.g. costs of using the installation, i.e. maintenance) and other costs (e.g. insurance).”
References	SCIS

### 5.2.4 EC4. Revenues variation (CORE)

EC4. Revenues variation	
Category	Costs & Revenues structure
Indicator type	Core
Definition	This indicator aims to measure the variation of revenues generated by the action, by comparing the total annual revenues before and after the action implementation. The indicator should be compiled specifying who benefits from the revenues (i.e. municipality, company, citizens...).
Unit	€/year for Total Annual Revenues before/after. Revenues variation will be calculated as % variation.
Calculation formula and required variables	<p>The revenues will be calculated as a % variation between revenue amounts before and after the project.</p> $TAR_{var} = \left( \frac{TAR_{after} - TAR_{before}}{TAR_{before}} * 100 \right) \%$ <p><math>TAR_{var}</math> = Total Annual Revenues variation</p> <p><math>TAR_{before}</math> = Total Annual Revenues from the intervention before the project implementation, which include:</p> <ul style="list-style-type: none"> <li>• Payments/tariffs for the use of service (€)</li> <li>• other (please specify) (€)</li> </ul> <p><math>TAR_{after}</math> = Total Annual Revenues from the intervention after the project implementation, which includes the same cost items as <math>TAC_{after}</math></p> <p>The duration of revenues per stream should also be provided (in years).</p> <p>Data should be retrieved during the monitoring period of MAtchUP as real data (revenues measured in the specific year/s). Since the lifetime of the investment is longer than the MAtchUP project duration, an estimation of average annual revenues during all the investment lifetime should be provided.</p>
Applicability to interventions/actions	It can be applied only to actions generating revenues (e.g. from the sale of energy, from new services generated by the action...).



Calculation interval	<ul style="list-style-type: none"> <li>• Before</li> <li>• During</li> <li>• After</li> </ul> <p>These data should be collected before the project implementation, to define the baseline, and periodically during the project (annually).</p> <p>As described in the “Variables” section, an estimation for next years, not covered by the MAtchUP project, should be provided.</p>
<b>Data requirements and guidelines for assessment</b>	
Evaluation boundaries	This indicator can be calculated at action/intervention/bundle level, according to the available economic data aggregation and the related business models.
Data sources / availability	Project data/documentation, survey/interview to action manager  Expected availability: High (VAL), Low (DRE, ANT)
Baseline definition	For actions that foresee an upgrade, the baseline is total annual revenues before the project implementation (the indicator is built as a comparison between an ex-ante and ex-post situation).  For actions that foresee new constructions/new infrastructures, the baseline are total annual revenues of a similar intervention which follow Baseline as Usual practice.
Reporting to SCIS	SCIS has a KPI on Total Revenues for Energy Systems only.
References	



## 5.2.5 EC5. Net Present Value (NPV) (CORE)

EC5. Net Present Value (NPV)	
Category	Profitability & financial performance
Indicator type	Core
Definition	The definition of this indicator is taken from CITYkeys: "The Net Present Value (NPV) is a measure of financial project performance. The net present value of an investment is defined as the sum of the discounted annual incoming cash-flows related to the investment less the discounted annual outgoing cash flows over a period of time, thereby comparing the present value of money today to the present value of money in future, taking inflation and returns into account. The discount factor used should always be reported. If the benefits exceed the costs, the NPV is positive and the project is worth pursuing. It is calculated over the project lifetime."
Unit	€
Calculation formula and required variables	$NPV = I_0 + \sum_{t=1}^T \frac{E_t - A_t}{(1+i)^t}$ <p> <math>I_0</math> = Initial investment in t0 [€]  <math>E_t</math> = Cash flow in t [€]  <math>A_t</math> = Cash outflow in t [€]  <math>i</math> = discount rate  <math>T</math> = Reference study period [years] </p> <p>The number of years evaluated could be the mean lifetime of the project.</p>
Applicability to interventions/actions	It could be applied to all actions where in and out cash flows can be detected.
Calculation interval	<ul style="list-style-type: none"> <li>• Before</li> <li>• During</li> <li>• After</li> </ul> <p>The indicator should be applied during project planning in a preliminary way, then updated based on actual data.</p>
Data requirements and guidelines for assessment	
Evaluation boundaries	This indicator can be calculated at action/intervention/bundle level, according to the available economic data aggregation and the related business models.
Data sources / availability	<p>Project data/documentation, cash-flow accounts</p> <p>Expected availability: Low (VAL, DRE, ANT)</p>
Baseline definition	It could be compared with NPV of comparable solutions, developed according to BAU practice (e.g. in case of a building, a new building constructed following current regulations).
Reporting to SCIS	The indicator is not mentioned in SCIS KPIs guide.
References	CITYkeys



## 5.2.6 EC6. Internal rate of return (IRR) (CORE)

EC6. Internal rate of return (IRR)	
Category	Profitability & financial performance
Indicator type	Core
Definition	The definition of this indicator is taken from CITYkeys: "The IRR of an investment is the discount rate at which the net present value of costs (negative cash flows) of the investment equals the net present value of the benefits (positive cash flows) of the investment. It is expressed as the interest rate at which the NPV of the investment is zero."
Unit	% (interest)
Calculation formula and required variables	$NPV = I_0 + \sum_{t=1}^T \frac{E_t - A_t}{(1+i)^t} = 0$ <p> <math>I_0</math> = Initial investment in t0 [€]  <math>E_t</math> = Cash flow in t [€]  <math>A_t</math> = Cash outflow in t [€]  <math>i</math> = discount rate  <math>T</math> = Reference study period [years] </p> <p>The number of years evaluated could be the mean life time of the project.</p>
Applicability to interventions/actions	It could be applied to all actions where in and out cash flows can be detected.
Calculation interval	<ul style="list-style-type: none"> <li>• Before</li> <li>• During</li> <li>• After</li> </ul> <p>The indicator should be applied during project planning in a preliminary way, then updated based on actual data.</p>
Data requirements and guidelines for assessment	
Evaluation boundaries	This indicator can be calculated at action/intervention/bundle level, according to the available economic data aggregation and the related business models.
Data sources / availability	<p>Project data/documentation, cash-flow accounts</p> <p>Expected availability: Low (VAL, DRE, ANT)</p>
Baseline definition	It could be compared with IRR of comparable solutions, developed according to BAU practice (e.g. in case of a building, a new building constructed following current regulations).
Reporting to SCIS	The indicator is not mentioned in SCIS KPIs guide.
References	CITYkeys



## 5.2.7 EC7. Payback period (CORE)

EC7. Payback period	
Category	Profitability & financial performance
Indicator type	Core
Definition	The definition of this indicator is taken from CITYkeys: “The number of years at which the net present value of costs (negative cash flows) of the investment equals the net present value of the benefits (positive cash flows) of the investment”.
Unit	Years
Calculation formula and variables required	$\text{Payback Period} = \text{Amount to be Invested} / \text{Estimated Annual Net Cash Flow} - 1$ <p><i>Variables:</i></p> <p>A = Amount to be invested (€)</p> <p>E = Estimated Annual Net Cash Flow (€)</p>
Applicability to interventions/actions	It could be applied to all actions where in and out cash flows can be detected.
Calculation interval	<ul style="list-style-type: none"> <li>• Before</li> <li>• After</li> </ul> <p>The indicator should be applied during project planning in a preliminary way, then after the project, based on actual data.</p>
Data requirements and guidelines for assessment	
Evaluation boundaries	This indicator can be calculated at action/intervention/bundle level, according to the available economic data aggregation and the related business models.
Data sources / availability	<p>Project data/documentation, cash-flow accounts</p> <p>Expected availability: Low (VAL, DRE, ANT)</p>
Baseline definition	It could be compared with the payback period of similar interventions following a Business as Usual practice (i.e. in the case of a building retrofit, an intervention which brings the building energy efficiency to what is currently foreseen in the regulations; in the case of a new building, a new building constructed following current regulations).
Reporting to SCIS	<p>Payback period is included in SCIS guidelines as KPI, with the following description:</p> <p>“The payback period is the time it takes to cover investment costs. It can be calculated from the number of years elapsed between the initial investment and the time at which cumulative savings offset the investment. Simple payback takes real (non-discounted) values for future monies.</p>





	<p>Discounted payback uses present values. Payback in general ignores all costs and savings that occur after payback has been reached. Payback period is usually considered as an additional criterion to assess the investment, especially to assess the risks. Investments with a short payback period are considered safer than those with a longer payback period. As the invested capital flows back slower, the risk that the market changes and the invested capital can only be recovered later or not at all increases. On the other hand, costs and savings that occur after the investment has paid back are not considered. This is why sometimes decisions that are based on payback periods are not optimal and it is recommended to also consult other indicators.”</p> <p>Three methodologies for the calculation of payback period are provided in SCIS:                  Type A, static                  Type B, dynamic                  Type C, dynamic with energy price increase rate</p> <p>Economic payback, EPP, type A static</p> $EPP = \frac{EPI_{BR}}{m}$ <p>M can be calculated as average annual costs in use savings (€/a)</p> $m = TAC_{after} - TAC_{before}$ <p>Type B dynamic</p> $EPP = \frac{\ln(m \cdot (1 + i)) - \ln(EPI_{BR} - EPI_{BR} \cdot (1 + i) + m)}{\ln(1 + i)} - 1$ <p>Type C dynamic with energy price increase rate</p> $EPP = \frac{\ln(m \cdot (1 + i)) - \ln(EPI_{BR} \cdot (1 + p) - EPI_{BR} \cdot (1 + i) + (1 + p) \cdot m)}{\ln(1 + i) - \ln(1 + p)} - 1$ <p><math>EPI_{BR}</math> (€) Energy-related investment  <math>i</math> (%) Discount rate</p> <hr/> <p><math>p</math> (%) Energy price increase rate  <math>i</math> should be unequal to <math>p</math></p> <p>The SCIS Self-Reporting Tool guide specifies that type C dynamic should be calculated.</p>
References	CITYkeys, SCIS



## 5.2.8 EC8. Energy consumption reduction cost (CORE)

EC8. Energy consumption reduction cost	
Category	Efficiency
Indicator type	Core
Definition	This indicator was adapted from the related indicator on CO <sub>2</sub> reduction in CITYkeys and it considers the costs in euro per unit of energy saved per year.
Unit	€/kWh energy saved per year
Calculation formula and required variables	<p>This indicator is calculated on an annual basis, and measures the annual costs in euro per unit of energy saved per year:</p> $ECRC = C_y / E_y$ <p>ECRC = Energy consumption reduction cost  C<sub>y</sub> = Total annual costs to implement the energy saving measure in year “y” (annualised investment plus current expenditures for a year) [€]  E<sub>y</sub> = Annual energy saved thanks to the measure implementation in year “y” [kWh]  Only the additional costs for energy/CO<sub>2</sub> related measures (to the extent discernible) are taken into account in the total costs calculation.</p>
Applicability to interventions/actions	It could be applied to all actions that can generate a quantifiable energy reduction.
Calculation interval	<ul style="list-style-type: none"> <li>• During</li> <li>• After</li> </ul> <p>The frequency could be annual.</p>
Data requirements and guidelines for assessment	
Evaluation boundaries	This indicator can be calculated at action/intervention/bundle level, according to the available economic data aggregation and the related business models.
Data sources / availability	<p>Project data/documentation, Energy bills</p> <p>Expected availability: Low (VAL, DRE), High (ANT)</p>
Baseline definition	It could be compared with the Energy reduction consumption cost of similar Business as Usual interventions (i.e. in the case of a building retrofit, an intervention which brings the building energy efficiency to what is currently foreseen in the regulations; in the case of a new building, a new building constructed following current regulations).
Reporting to SCIS	This indicator is not present in SCIS.
References	CITYkeys



5.2.9 EC9. CO<sub>2</sub> emissions reduction cost (CORE)

EC9. CO <sub>2</sub> emissions reduction cost	
Category	Efficiency
Indicator type	Core
Definition	The definition of this indicator is taken from CITYkeys: "Costs in euro per ton of CO <sub>2</sub> saved per year"
Unit	€/ton CO <sub>2</sub> saved/year
Calculation formula and required variables	<p><math>CERC = C_y / CE_y</math></p> <p>This indicator is calculated on an annual basis, taking the annual reduction in CO<sub>2</sub> emissions, and the annual costs of the project (which is the annualised investment plus current expenditures for a year).</p> <p>Only the additional costs for CO<sub>2</sub> related measures (to the extent discernible) are taken into account in the total costs calculation.</p> <p><i>Variables:</i></p> <p>CERC = CO<sub>2</sub> Emissions Reduction Cost</p> <p><math>C_y</math> = Total annual costs to implement the CO<sub>2</sub> emission saving measure in year "y" (annualised investment plus current expenditures for a year) [€]</p> <p><math>CE_y</math> = Annual CO<sub>2</sub> emissions saved thanks to the measure implementation in year "y" [tCO<sub>2</sub>]</p> <p>Only the additional costs for energy/CO<sub>2</sub> related measures (to the extent discernible) are taken into account in the total costs calculation.</p>
Applicability to interventions/actions	It could be applied to all actions that can generate a quantifiable CO <sub>2</sub> emission reduction.
Calculation interval	<ul style="list-style-type: none"> <li>• During</li> <li>• After</li> </ul> <p>The frequency could be annual.</p>
Data requirements and guidelines for assessment	
Evaluation boundaries	This indicator can be calculated at action/intervention/bundle level, according to the available economic data aggregation and the related business models.
Data sources / availability	<p>Project data/documentation, Energy bills</p> <p>Expected availability: Low (VAL, DRE), High (ANT)</p>
Baseline definition	It could be compared with the CO <sub>2</sub> reduction cost of similar Business as Usual interventions (i.e. in the case of a building retrofit, an intervention which brings the building energy efficiency to what is currently foreseen in the regulations; in the case of a new building, a new building constructed following current regulations).
Reporting to SCIS	This indicator is not present in SCIS.
References	CITYkeys



## 5.2.10 EC10. Benefit from air pollution reduction (CORE)

EC10. Benefit from air pollution reduction	
Category	Societal benefit
Indicator type	Core
Definition	This indicator aims to monetize the external costs due to air pollution avoided thanks to the action. It is a secondary-level indicator, based on the technical indicator on "Decreased emissions of Nitrogen dioxides (NO <sub>x</sub> )" and "Decreased emissions of Particulate matter (PM <sub>2,5</sub> )".
Unit	€
Calculation formula and required variables	<p>The indicator will be calculated by applying a reference unit cost from literature to emissions of air pollutants reduced by the action.</p> <p>This indicator is therefore linked to the technical indicators "Decreased emissions of Nitrogen dioxides (NO<sub>x</sub>)" and "Decreased emissions of Particulate matter (PM<sub>2,5</sub>)"</p> $B_{ap} = [(NO_{x \text{ after}} - NO_{x \text{ before}}) \times UC \text{ NO}_x] + [(PM_{2,5 \text{ after}} - PM_{2,5 \text{ before}}) \times UC \text{ PM}_{2,5}]$ <p><i>Variables:</i></p> <p>NO<sub>x after</sub> = annual emissions NO<sub>x</sub> after the project implementation (t/year)  NO<sub>x before</sub> = annual emissions NO<sub>x</sub> before the project implementation (t/year)  UC NO<sub>x</sub> = unit cost for avoided externality (€/ton)</p> <p>PM<sub>2,5 after</sub> = annual emissions PM<sub>2,5</sub> after the project implementation (kg/year)  PM<sub>2,5 before</sub> = annual emissions PM<sub>2,5</sub> before the project implementation (kg/year)  UC PM<sub>2,5</sub> = unit cost for avoided externality (€/kg)</p>
Applicability to interventions/actions	Mobility actions
Calculation interval	Annual (linked to Technical indicators frequency)
Data requirements and guidelines for assessment	
Evaluation boundaries	This indicator can be calculated at action/intervention/bundle level, according to the available economic data aggregation and the related business models (also linked to Technical indicators evaluation boundaries).
Data sources / availability	<p>Reduction of air pollutants calculated by Technical Indicators  Literature on unit costs</p> <p>Expected availability: Low (VAL, DRE, ANT)</p>
Baseline definition	The indicator is calculated as avoided costs compared to the ex-ante situation.
Reporting to SCIS	The indicator is not present in SCIS.
References	



5.2.11 EC11. Benefit from avoided CO<sub>2</sub> emissions (CORE)

EC11. Benefit from avoided CO <sub>2</sub> emissions	
Category	Societal benefit
Indicator type	Core
Definition	This indicator aims to monetize the external costs due to CO <sub>2</sub> emissions avoided thanks to the action. It is a secondary-level indicator, based on the technical indicator on "CO <sub>2</sub> emission reduction".
Unit	€
Calculation formula and required variables	<p>The indicator will be calculated by applying a reference value of social cost of carbon from literature to CO<sub>2</sub> emissions avoided by the action.</p> <p>This indicator is therefore linked to the technical indicator on "CO<sub>2</sub> emission reduction"</p> <p>This indicator is therefore linked to the technical indicators "Decreased emissions of Nitrogen dioxides (NO<sub>x</sub>)" and "Decreased emissions of Particulate matter (PM<sub>2,5</sub>)"</p> $B_{cc} = [(CO_{2 \text{ after}} - CO_{2 \text{ before}}) \times SCC]$ <p><i>Variables:</i>  CO<sub>2 after</sub> = CO<sub>2</sub> emissions after the project implementation (tCO<sub>2</sub>/year)  CO<sub>2 before</sub> = CO<sub>2</sub> emissions before the project implementation (tCO<sub>2</sub>/year)  SCC = Social Cost of Carbon (€/tCO<sub>2</sub>)</p>
Applicability to interventions/actions	Applicable to all actions where energy savings or RES production can be detected, since they decrease CO <sub>2</sub> emissions.
Calculation interval	Annual (linked to Technical indicators frequency)
Data requirements and guidelines for assessment	
Evaluation boundaries	This indicator can be calculated at action/intervention/bundle level, according to the available economic data aggregation and the related business models (also linked to Technical indicators evaluation boundaries).
Data sources / availability	Reduction of CO <sub>2</sub> emissions calculated by Technical Indicators Literature on social cost of carbon  Expected availability: High (VAL), Low (DRE, ANT)
Baseline definition	The indicator is calculated as avoided costs compared to the ex-ante situation.
Reporting to SCIS	The indicator is not present in SCIS.
References	



## 5.2.12 EC12. Property value variation (COMPLEMENTARY)

EC12. Property value variation	
Category	Further benefits/impacts on the population/consumers
Indicator type	Complementary
Definition	This indicator aims to measure if a variation of property values took place in the districts where project actions will be implemented. It should be considered that several interrelated factors impact on property values, so the indicator value should be interpreted considering the wider socio-economic context.
Unit	€/m <sup>2</sup> for property value % for variation
Calculation formula and required variables	$PV_{var} = \left( \frac{PV_{after} - PV_{before}}{PV_{before}} * 100 \right) \%$ <p> <i>PV<sub>var</sub></i> = Property value variation  <i>PV<sub>after</sub></i> = average property value after the implementation of project actions (€/m<sup>2</sup>)  <i>PV<sub>before</sub></i> = average property value before the implementation of project actions (€/m<sup>2</sup>) </p>
Applicability to interventions/actions	Even if a direct relation between the project interventions and property value variation cannot be established, it would be interesting to consider the joint effect of actions on energy, buildings and mobility in the districts.
Calculation interval	<ul style="list-style-type: none"> <li>• Before</li> <li>• After</li> </ul>
Data requirements and guidelines for assessment	
Evaluation boundaries	Intervention/bundle or district level, according to available data.
Data sources / availability	Real estate data/analyses. Specific data requests to real estate experts  Expected availability: Low (VAL, DRE, ANT)
Baseline definition	The indicator is already built as a comparison between an ex-ante and an ex-post situation.
Reporting to SCIS	The indicator is not present in SCIS.
References	



### 5.2.13 EC13. Financial benefit for the end-user (COMPLEMENTARY)

EC13. Financial benefit for the end-user	
Category	Further benefits/impacts on the population/consumers
Indicator type	Complementary
Definition	Total cost savings in euros for end-users per household per year
Unit	€/household/yr
Calculation formula and required variables	<p>Total (direct) costs before the project - total (direct) costs after the project = cost savings.</p> <p><i>Variables:</i></p> <ul style="list-style-type: none"> <li>• Total (direct) costs before the project (€)</li> <li>• Total (direct) costs after the project (€)</li> </ul>
Applicability to interventions/actions	It could be applied to all actions that generate a benefit for households.
Calculation interval	<ul style="list-style-type: none"> <li>• Before</li> <li>• During</li> <li>• After</li> </ul> <p>It also depends on the possible timing of related surveys.</p>
Data requirements and guidelines for assessment	
Evaluation boundaries	This indicator can be calculated at action/intervention/bundle level, according to the available economic data aggregation and the related business models.
Data sources / availability	<p>Energy bills, data from survey with households</p> <p>Expected availability: High (DRE), Low (VAL, ANT)</p>
Baseline definition	The indicator is already built considering the variation between an ex-ante and ex-post situation.
Reporting to SCIS	The indicator is not present in SCIS.
References	CITYkeys



## 5.2.14 EC14. Increased safety (COMPLEMENTARY)

EC14. Increased safety	
Category	Further benefits/impacts on the population/consumers
Indicator type	Complementary
Definition	This indicator aims to express into monetary values the increased safety for the population/city users deriving from the action implementation.
Unit	€
Calculation formula and required variables	<p>This indicator is built as secondary-level indicator based on the CITYkeys indicator: “Reduction in crime rate”, which calculates the percentage reduction in number of violence incidents, annoyances and crimes due to a project.</p> <p>It could be calculated by applying values attributed to increased safety from individuals (e.g. within a survey) or reference unit costs from literature to crime reduction rate generated by the action.</p> <p>As highlighted in CITYkeys, it could be difficult to estimate the influence of the project on the crime rate.</p>
Applicability to interventions/actions	It is mainly related to public lighting actions, since an improvement in lighting may contribute to improve the safety in a district and reduce the crime rate. However, since crime rate variation will not be measured/assessed within the project, it is not possible to apply this indicator. If data at district/city level become available, it could be interesting to apply it.
Calculation interval	<ul style="list-style-type: none"> <li>• Before</li> <li>• After</li> </ul>
Data requirements and guidelines for assessment	
Evaluation boundaries	District or city level
Data sources / availability	<p>Literature on value attributed to safety.</p> <p>Data from survey with households</p> <p>Expected availability: Low (VAL, DRE, ANT)</p>
Baseline definition	The indicator is already built considering the variation between an ex-ante and ex-post situation, because it is based on the CITYkeys indicator on “Reduction in crime rate”.
Reporting to SCIS	The indicator is not present in SCIS.
References	CITYkeys





## 5.2.15 EC15. Value of Travel Time Savings (COMPLEMENTARY)

EC15. Value of Travel Time Savings	
Category	Further benefits/impacts on the population/consumers
Indicator type	Complementary
Definition	This indicator aims to express into monetary values the travel time reduction for the population/city users deriving from the action implementation.
Unit	€
Calculation formula and required variables	<p>This indicator is built as secondary-level indicator based on the CITYkeys indicator: “Decreased travel time”, which calculates the percentage decrease in travel time due to the project.</p> <p>It could be calculated by applying values attributed to time savings from individuals (e.g. within a survey) or reference unit costs from literature.</p> <p>The “Value of Travel Time Savings” (VTTS) expresses the benefits from reduced travel time costs. As stated in the guidance by the Transportation Economics Committee, in estimating the VTTS an important aspect is the definition of travel time unit costs that are applied to the time savings. These are influenced by several factors, including the types of trips, travellers, and travel conditions. If possible, different travel time unit costs should be assigned to different types of travellers and travel conditions.</p> <p>It must be considered that the effect of a project on decreased travel time is small.</p>
Applicability to interventions/actions	It is related mainly to mobility actions. However, since decreased travel time will not be measured/assessed within the project, it is not possible to apply this indicator. If data at district/city level become available, it could be interesting to apply it.
Calculation interval	<ul style="list-style-type: none"> <li>• Before</li> <li>• After</li> </ul>
Data requirements and guidelines for assessment	
Evaluation boundaries	District or city level
Data sources / availability	<p>Mobility survey in the district area/city (if implemented), literature for unit costs</p> <p>Expected availability: Low (VAL, DRE, ANT)</p>
Baseline definition	The CITYkeys indicator is already built considering the variation between an ex-ante and ex-post situation.
Reporting to SCIS	The indicator is not present in SCIS.
References	CITYkeys, Transportation Economics Committee



### 5.2.16 EC16. Increased use of local workforce (COMPLEMENTARY)

EC16. Increased use of local workforce	
Category	Employment
Indicator type	Complementary
Definition	This indicator aims to quantify the share in the total project costs that has been spent on local suppliers, contractors and service providers.
Unit	%
Calculation formula and required variables	<p>(Use of local workforce (project costs) in project/total use of workforce (project costs) in project)*100%</p> <p><i>Variables:</i></p> <ul style="list-style-type: none"> <li>• Use of local workforce (project costs) in project (€)</li> <li>• Total use of workforce (project costs) in project (€)</li> </ul>
Applicability to interventions/actions	It could be applied to all actions
Calculation interval	<ul style="list-style-type: none"> <li>• During</li> <li>• After</li> </ul>
Data requirements and guidelines for assessment	
Evaluation boundaries	This indicator can be calculated at action/intervention/bundle level, according to the available economic data aggregation and the related business models.
Data sources / availability	<p>Project data/documentation, specific collection process by the action manager</p> <p>Expected availability: High (VAL, DRE), Low (ANT)</p>
Baseline definition	In this case the definition of a baseline seems not applicable. The value could be compared with projects/interventions carried out following Business As Usual practice.
Reporting to SCIS	The indicator is not present in SCIS.
References	CITYkeys



## 5.2.17 EC.17 Local job creation (COMPLEMENTARY)

EC.17 Local job creation	
Category	Employment
Indicator type	Complementary
Definition	This indicator aims to quantify if/how many new jobs have been created by the project actions. It should be considered that the impact of the project on job creation may have a medium term and city-wide perspective which is addressed by WP1 city level evaluation. In WP5, the evaluation will be focused on new jobs stimulated by the project directly (in partners part of the consortium) and indirectly (for example through the support to new businesses and start-ups that will be launched thanks to the project actions).
Unit	# of jobs
Calculation formula and required variables	Collection of data from partners on the absolute value of number of new jobs created (see also the definition above). The following types of jobs should be included: new contracts (both temporary and long-term) related to the project and/or needed to ensure the implementation of project actions (e.g. for the construction & retrofitting works).
Applicability to interventions/actions	It could be applied to all actions
Calculation interval	<ul style="list-style-type: none"> <li>• (During)</li> <li>• After</li> </ul>
Data requirements and guidelines for assessment	
Evaluation boundaries	This indicator can be calculated at action/intervention/bundle/overall project or also district level, according to the available economic data aggregation.
Data sources / availability	Project data/documentation, specific collection process by the action bundle manager through data requests to the other local partners and companies involved in the implementation of the project actions.  Expected availability: High (VAL) Low (DRE, ANT)
Baseline definition	In this case the definition of a baseline seems not applicable. The value could be compared with projects/interventions carried out following Business As Usual practice, if available.
Reporting to SCIS	This indicator is present in SCIS under the social monitoring.
References	CITYkeys, SCIS, MAtchUP (WP1)



### 5.2.18 EC18. Certified companies involved in the project (COMPLEMENTARY)

EC18. Certified companies involved in the project	
Category	Business involvement & impact on business
Indicator type	Complementary
Definition	This indicator aims to quantify the share of companies involved in the intervention/action holding an ISO 14001 certificate.
Unit	%
Calculation formula and required variables	$\left(\frac{\text{Number of companies with ISO 140001 certificate}}{\text{total companies involved}}\right) * 100\%$ <p><i>Variables:</i></p> <ul style="list-style-type: none"> <li>• Total companies involved in the action (absolute number)</li> <li>• Number of companies with ISO 140001 certificate (absolute number)</li> </ul>
Applicability to interventions/actions	It could be applied to all actions
Calculation interval	<ul style="list-style-type: none"> <li>• (During)</li> <li>• After</li> </ul>
Data requirements and guidelines for assessment	
Evaluation boundaries	This indicator can be calculated at action/intervention/bundle/overall project or also district level, according to the available economic data aggregation.
Data sources / availability	<p>Project data/documentation, specific collection process by the action manager</p> <p>Expected availability: High (VAL, DRE) Low (ANT)</p>
Baseline definition	In this case the definition of a baseline seems not applicable. The value could be compared with similar projects/interventions carried out following Business As Usual practice, if available.
Reporting to SCIS	The indicator is not present in SCIS.
References	CITYkeys



## 5.2.19 EC19. New business registered (COMPLEMENTARY)

EC19. New business registered	
Category	Business involvement & impact on business
Indicator type	Complementary
Definition	This indicator aims to quantify the number of new businesses registered (including start-ups) in a year because of the action.
Unit	# of businesses
Calculation formula and required variables	<p>Number of new businesses registered (including start-up) in a year because of the action.</p> <p>In CITYkeys, this indicator at city level is calculated, which considers the “Number of new businesses per 100,000 population”.</p> <p>However, it could be challenging to localize this indicator in the intervention/action area, in particular to determine whether the intervention/action has had a direct effect in creating the conditions for new businesses.</p> <p><i>Variables:</i></p> <ul style="list-style-type: none"> <li>• Number of new businesses registered (including start-up) in a year because of the action (absolute number)</li> </ul>
Applicability to interventions/actions	It could be applied to all actions, however some actions are specifically focused on supporting new businesses/start-ups.
Calculation interval	<ul style="list-style-type: none"> <li>• (During)</li> <li>• After</li> </ul>
Data requirements and guidelines for assessment	
Evaluation boundaries	This indicator can be calculated at action/intervention/bundle/overall project or also district level, according to the available economic data aggregation.
Data sources / availability	<p>Project data/documentation, specific collection process by the action manager</p> <p>Expected availability: High (DRE) Low (VAL, ANT)</p>
Baseline definition	In this case the definition of a baseline seems not applicable. The value could be compared with similar projects/interventions carried out following Business As Usual practice, if available.
Reporting to SCIS	The indicator is not present in SCIS.
References	



### 5.2.20 EC20. Increase in job/tourism local attractiveness (COMPLEMENTARY)

EC20. Increase in job/tourism local attractiveness	
Category	Business involvement & impact on business
Indicator type	Complementary
Definition	This indicator aims to measure if a variation of incoming tourist/workers flows took place in the districts where project actions will be implemented. It should be considered that several interrelated factors impact on incoming tourist/workers flows, so the indicator value should be interpreted considering the wider socio-economic context.
Unit	% change of tourist nights % change of incoming workers
Calculation formula and required variables	<p>The indicator could be calculated as a % variation between annual total tourist nights in the area before and after the actions implementation (or total incoming workers).</p> $TF_{var} = \left( \frac{TF_{after} - TF_{before}}{TF_{before}} * 100 \right) \%$ $WF_{var} = \left( \frac{WF_{after} - WF_{before}}{WF_{before}} * 100 \right) \%$ <p>In CITYkeys, this indicator at city level is calculated, which considers the “Number of tourist nights per year per 100.000 inhabitants”. However, it could be challenging to localize this indicator in the intervention/action area, in particular to determine whether the intervention/action has had a direct effect on tourist flows. Furthermore, not all the districts interested by the project actions have propensity as touristic or workplace areas.</p> <p><i>Variables:</i></p> <p><math>TF_{var}</math> = Tourists flow variation  <math>TF_{after}</math> = annual number of tourist nights in the area after actions implementation (absolute number)  <math>TF_{before}</math> = annual number of tourist nights in the area before actions implementation (absolute number)</p> <p><math>WF_{var}</math> = Workers flow variation  <math>WF_{after}</math> = average number of incoming workers in the area after actions implementation in a year (absolute number)  <math>WF_{before}</math> = average number of incoming workers in the area before actions implementation in a year (absolute number)</p>
Applicability to interventions/actions	It is related to actions that impact on local attractiveness, for example building projects or mobility infrastructures that enable more efficient transport and therefore can contribute to increase the number of visitors in an area.



Calculation interval	<ul style="list-style-type: none"> <li>• Before</li> <li>• After</li> </ul> <p>It also depends on the possible timing of related surveys.</p>
<b>Data requirements and guidelines for assessment</b>	
Evaluation boundaries	District or wider level, according to available data.
Data sources / availability	<p>Official local statistics on tourism, specific collection process by municipality.</p> <p>Mobility survey in the district area/city (if implemented).</p> <p>Expected availability: Low (VAL, DRE, ANT)</p>
Baseline definition	The indicator is already built considering the variation between an ex-ante and ex-post situation.
Reporting to SCIS	The indicator is not present in SCIS.
References	

### 5.2.21 EC21. Market orientation (COMPLEMENTARY)

EC21. Market orientation	
Category	Market dimension
Indicator type	Complementary
Definition	This indicator aims to measure the extent to which the project was planned on the basis of a market analysis.
Unit	Likert scale
Calculation formula and required variables	<p>The value is directly evaluated by an expert/consultant using a Likert scale, based on information available on the context in which the project was conceived and implemented and/or interviews with the project manager/involved stakeholders.</p> <p>Likert Scale:</p> <p>No market orientation – 1 – 2 – 3 – 4 – 5 - Extensive feasibility study</p> <ol style="list-style-type: none"> <li>1. No market orientation has taken place in whatever shape or form.</li> <li>2. There was some discussion about market orientation, but this was never formalized.</li> <li>3. Somewhat attention was given to market orientation in the form of a SWOT analysis or other business tools.</li> <li>4. Significant attention was given to market orientation in the form of a SWOT analysis or other business tools, combined with a project team workshop.</li> <li>5. A full-scale feasibility study was carried out.</li> </ol>
Applicability to interventions/actions	It could be applied to all actions except to some non-technical actions.



Calculation interval	<ul style="list-style-type: none"> <li>• Before</li> </ul>
<b>Data requirements and guidelines for assessment</b>	
Evaluation boundaries	This indicator can be calculated at action/intervention/bundle level, according to the available economic data aggregation and the related business models.
Data sources / availability	The data is generated by the expert/consultant evaluation.  Expected availability: High (VAL, DRE, ANT)
Baseline definition	In this case the definition of a baseline seems not applicable. The value could be compared with market orientation of similar projects/interventions carried out following Business As Usual practice, if available.
Reporting to SCIS	The indicator is not present in SCIS.
References	CITYkeys

### 5.2.22 EC22. Market demand (COMPLEMENTARY)

EC22. Market demand	
Category	Market dimension
Indicator type	Complementary
Definition	This indicator aims to measure the extent to which there is a general market demand for the solution.
Unit	Likert scale
Calculation formula and required variables	<p>The value is directly evaluated by an expert/consultant using a Likert scale, based on information available on the context in which the project was conceived and implemented and/or interviews with the project manager/involved stakeholders.</p> <p>Likert scale:</p> <p>No demand – 1 — 2 — 3 — 4 — 5 — Very high demand</p> <p>1. No demand: There is no discernible market demand for the offered solution.</p> <p>2. Little demand: There is little market demand for the offered solution.</p> <p>3. Some demand: There is some market demand for the offered solution.</p> <p>4. High demand: There is a large market demand for the offered solution.</p> <p>5. Very high demand: There is a widespread market demand for the offered solution.</p>
Applicability to interventions/actions	It could be applied to all actions except to some non-technical actions.
Calculation interval	<ul style="list-style-type: none"> <li>• Before</li> <li>• After</li> </ul>
<b>Data requirements and guidelines for assessment</b>	
Evaluation	This indicator can be calculated at





boundaries	action/intervention/bundle level, according to the available economic data aggregation and the related business models.
Data sources / availability	The data is generated by the expert/consultant evaluation. Expected availability: High (VAL, DRE, ANT)
Baseline definition	In this case the definition of a baseline seems not applicable. The value could be compared with market demand for similar projects/interventions carried out following Business As Usual practice, if available.
Reporting to SCIS	The indicator is not present in SCIS.
References	CITYkeys

### 5.2.23 EC23. Patents (COMPLEMENTARY)

EC23. Patents	
Category	Innovation
Indicator type	Complementary
Definition	This indicator aims to quantify the total number of new patents generated by the action/project, issued to residents and organizations of the city per year.
Unit	# of new patents generated by the action
Calculation formula and required variables	Total number of new patents generated by the action/project, issued to residents and organizations of the city per year
Applicability to interventions/actions	It could be applied to all actions
Calculation interval	<ul style="list-style-type: none"> <li>• After</li> </ul>
Data requirements and guidelines for assessment	
Evaluation boundaries	This indicator can be calculated at action/intervention/bundle level, according to the available economic data aggregation and the related business models.
Data sources / availability	Patent office data, specific collection process by action manager Expected availability: High (DRE), Low (VAL, ANT)
Baseline definition	In this case the definition of a baseline seems not applicable.
Reporting to SCIS	The indicator is not present in SCIS.
References	ISO 37120 has a similar indicator at city level (calculated as n. patents per 100.000 inhabitants)



### 5.2.24 EC24. Green public procurement (COMPLEMENTARY)

EC24. Green public procurement	
Category	Innovation
Indicator type	Complementary
Definition	This indicator aims to evaluate the extent to which GPP criteria were taken into account for the procurement processes related to the project
Unit	Likert scale
Calculation formula and required variables	<p>The value is directly evaluated by an expert/consultant using a Likert scale,</p> <p>Not at all -1 - 2 - 3 – 4 -5-Excellent</p> <p>1. Not at all: GPP criteria were not taken into account for the procurement processes related to the project</p> <p>2. Poor: GPP criteria were to a large extent not taken into account for the procurement processes related to the project</p> <p>3. Somewhat: GPP criteria were somewhat taken into account for the procurement processes related to the project</p> <p>4. Good: GPP criteria were to a large extent taken into account for the procurement processes related to the project</p> <p>5. Excellent: GPP criteria were completely taken into account for the procurement processes related to the project, followed to the letter</p>
Applicability to interventions/actions	It could be applied to actions where procurement processes by public authorities take place.
Calculation interval	<ul style="list-style-type: none"> <li>• After</li> </ul>
Data requirements and guidelines for assessment	
Evaluation boundaries	This indicator can be calculated at action/intervention/bundle level, according to the available economic data aggregation and the related business models.
Data sources / availability	<p>The data is generated by the expert/consultant evaluation.</p> <p>Expected availability: Low (VAL, DRE, ANT)</p>
Baseline definition	In this case the definition of a baseline seems not applicable. The value could be compared with GPP consideration for similar projects/interventions carried out following Business As Usual practice, if available.
Reporting to SCIS	The indicator is not present in SCIS.
References	CITYkeys



### 5.3 Data sources

The main sources for the data collection will be:

- **Project data/documentation:** main references will be the description of actions, documentation on the resources mobilized for each action and the costs, including energy bills and other types of bills.
- **Specific data collection/production process:** the action bundle lead will collect specific information and request integrative information to the other partners or companies involved in the financing and implementation of the actions.
- **Expert/consultant evaluations:** for some indicators, a direct evaluation will be performed within the project, with specific reference to the considered action bundle.
- **Existing data sources:** where possible, already existing data sources at district/city level will be used (i.a. real estate analysis, mobility surveys, tourism statistics, patent data).



## 6 Conclusions

This deliverable has defined the methodological approach and the overall framework for the economic evaluation of business models and related action bundles in the three MAtchUP lighthouse cities of Valencia, Dresden and Antalya. The economic evaluation framework has been elaborated taking as main reference the key initiatives in place to define common approaches for the evaluation of smart city projects, including CITYkeys and SCIS projects, as well as the activities of the EIP-SCC Action Cluster on Business Models, Finance and Procurement. The report is also grounded on the outcomes of Deliverable 6.1., where an overview of the literature on smart city business models and their evaluation approaches is provided.

The proposed economic evaluation framework is composed by 11 core and 13 complementary indicators, which aim to measure a series of financial aspects and efficiency performances of actions and related business models, as well as translate into monetary terms a selected range of social, economic and environmental benefits. In order to support the cities in the implementation of the evaluation framework, specific data collection and calculation tools will be implemented, based on the guidance provided in this report.

To perform the economic evaluation, the situation before and after the implementation of the action bundles will be assessed (in some cases also during the implementation, depending on the indicator).

### 6.1 Next steps

Next steps for the implementation of the economic evaluation include:

- Development of data collection and indicators calculation tools for the LH cities, based on the methodological guidance provided in this report;
- Set up the actual data collection procedure, also considering the timeline of implementation of the different actions composing each bundle;
- Coordinate with partners responsible for the technical and social evaluation, to account for the common aspects and the interlinked indicators;
- Coordinate with the business model characterization activities carried out in WP6 and WP1.

All these activities will be carried out following a close cooperation among WP5-WP6-WP1 partners.



## 7 References

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## Annex A1. Economic objectives for all actions

MAtchUP actions	Objectives of the actions	Measurable evaluation objectives	Project indicators
Building/District City infrastructure Mobility Urban and ICT actions Non-technical actions	O1: Implement cost-effective smart and sustainable solutions  O2: Reduce the energy bills and operational costs of city governments, citizens and companies  O3: Reduce societal costs due to climate change, air pollution and other externalities	OE1: Quantify the economic benefits and efficiency gains obtained through the adoption of cost-effective smart and sustainable solutions <ul style="list-style-type: none"> <li>- OE1.1: Evaluate cost savings in the energy bills due to energy savings achieved and/or the use of a cheaper fuel and/or increased efficiency</li> <li>- OE1.2: Evaluate the cost-effectiveness of the solution (implementation and maintenance)</li> <li>- OE1.3: Evaluate the market dimension of innovative smart solutions implemented in the project</li> <li>- OE1.4: Quantify the variation of property values achieved through the implementation of smart interventions</li> </ul>	EC2. Investment per unit EC3. Operation & Maintenance costs variation (Efficiency Gain) EC8. Energy consumption reduction cost EC9. CO <sub>2</sub> emissions reduction cost EC13. Financial benefit for the end-user EC21. Market orientation EC22. Market demand EC12. Property value variation
		OE2: Evaluate the profitability and the return of the investment of smart solutions <ul style="list-style-type: none"> <li>- OE2.1: Return of the investment made in energy solutions by residents</li> <li>- OE2.2: Return of the investment made in energy solutions by companies</li> <li>- OE2.3: Return of the investment made in energy solutions by municipalities</li> </ul>	EC1. Funding sources EC2. Investment per unit EC3. Operation & Maintenance costs variation (Efficiency Gain) EC4. Revenues variation EC5. Net Present Value (NPV) EC6. Internal rate of return (IRR) EC7. Payback period
		OE3: Quantify in monetary terms the benefits/avoided costs for society achieved through the implementation of smart solutions	EC10. Benefit from air pollution reduction EC11. Benefit from avoided CO <sub>2</sub> emissions EC14. Increased safety (crime) EC15. Value of Travel Time Savings



	<p>O4: Boost local economies through investment in smart solutions</p>	<p>OE4: Quantify the economic improvements of the interventions in the urban areas</p> <ul style="list-style-type: none"> <li>- OE4.1: Job creation due to smart interventions</li> <li>- OE4.2: Number of local companies involved in the intervention (large, SME, start-ups)</li> <li>- OE4.3: New companies created for the execution of the intervention (spin-offs, start-ups).</li> <li>- OE4.4: Number of companies involved in the intervention introducing innovations to the market (large, SME, start-ups)</li> <li>- OE4.5: Expenditure in local economy for the execution of the interventions</li> <li>- OE4.6: Public and private financing and investment mobilized due to the interventions</li> </ul> <p>OE5: Quantify public and private financing and investment mobilized after interventions</p>	<p>EC17. Local job creation</p> <p>EC16. Increased use of local workforce</p> <p>EC18. Certified companies involved in the project</p> <p>EC19. New business registered</p> <p>EC16. Increase in job/tourism local attractiveness</p> <p>EC23. Patents</p> <p>EC24. Green public procurement</p> <p>EC1. Funding sources</p> <p>EC2. Investment per unit</p>
	<p>O5: Support companies and in special SME and start ups by involving them in the execution of large investment projects and emergent business</p>	<p>OE6: Quantify the economic benefits of the interventions in the companies</p>	<p>EC4. Revenues variation</p> <p>EC17. Local job creation</p> <p>EC19. New business registered</p>



## Annex A2. Action card template in WP5

Action name A.0 XYZ		
City	Sub-category (Based on DoA Part B)	Responsible partner(s) (Acronym(s) of partner(s), name(s) of contact person(s))
Valencia	Electric vehicles	
Dresden	Charging stations	
Antalya	Demand management - EV to grid and grid to EV	
Herzliya	Urban freight	
Oostende	Multi-modality	
Skopje	Intelligent Transport System I.T.S.	
Kerava		
<b>Objectives of the action</b> (What do you want to achieve - reduced energy demand/costs/peak loads/emissions, energy/cost efficiency, increased use of renewables/local energy sources/public transportation, increased air quality/comfort/safety/innovation capacity/competitiveness/investments/public acceptance, new market opportunities/jobs/start-ups, replicability of action, etc.?)		
<b>Technical objectives</b>		
<b>Economic objectives</b>		
<b>Social objectives</b>		
<b>Other</b>		
<b>How to measure the progress?</b> (Already measured, your preferences etc.)		<b>Data availability</b> (Data source, format (machine readable, manual input, etc.), frequency in data collection)
<b>Technical objectives</b>		
<b>Economic objectives</b>		
<b>Social objectives</b>		
<b>Other</b>		





## Annex A3. Preliminary economic evaluation action bundles identified for the three Lighthouse Cities

### Economic evaluation action bundles for Valencia

Zone	Business Model ID	Business Model Name	MATCHUP Pillar	Actions	Lead
Cabanyal	VAL_BM-01	Reconstruction of private residential building	Energy	V1 (Reconstruction of 16 houses (13 private + 3 public) V2 (223 kW PV integration), V3 (1100 kWh electrical storage for self-consumption model integration), V4 (400 Smart meters for buildings), V5 (Next generation of 150 smart controllers at the building level), V12 (Solar thermal integration), V28 (Smart home energy management system (SHEMS))	ITE
Cabanyal	VAL_BM-02	Retrofitting of private residential buildings	Energy	V6 (Retrofitting of 548 private houses (536 private + 12 public), V4 (400 Smart meters for buildings), V5 (Next generation of 150 smart controllers at the building level) V12 (Solar thermal integration), V28 (Smart home energy management system (SHEMS)),	ITE
Cabanyal	VAL_BM-03	Reconstruction of public tertiary buildings	Energy	V9 (Civic centre for the district "Centro Cívico), V2 (223 kW PV integration), V4 (400 Smart meters for buildings), V5 (Next generation of 150 smart controllers at the building level), V29 (Smart District energy management system (SDEMS))	VAL



Cabanyal	VAL_BM-04	Retrofitting of public tertiary buildings	Energy	V10 (Retrofitting of “Mercado del Cabanyal), V11 (Retrofitting of local agency of Urban development (Agencia local de desarrollo urbano) V2 (223 kW PV integration) V4 (400 Smart meters for buildings), V5 (Next generation of 150 smart controllers at the building level), V29 (Smart District energy management system (SDEMS)	VAL
District P. Maritims	VAL_BM-05	Building integrated RES in a tertiary building (Nazaret Sport Centre)	Energy	V8 (Geothermal energy), V2 (223 kW PV integration), V14 (Sewerage energy recovery system), V29 (Smart District energy management system (SDEMS)	ITE
District P. Maritims	VAL_BM-06	Urban RES	Energy	V13 (Pilot of Wave Energy Converter (WEC) to supply public lighting)	LNV
District P. Maritims	VAL_BM-07	Smart lighting	Energy	V27 (Smart lighting – 4000 street lamps)	VAL
District P. Maritims	VAL_BM-08	Humble lampposts	Energy	V26 (10 humble lampposts)	ETRA
City level	VAL_BM-09	EV (public sector)	Mobility	V15 (101 local government eVehicles), V16 (10 fully eBuses + 8 hybrid buses), V21 (Demand management and operation of charging systems for the eBus fleet), V24 (Eco-driving patterns to optimize the performance of electric buses)	VAL, EMT
City level	VAL_BM-10	EV (private sector)	Mobility	V18 (72 EV charging points), V20 (Public charging system management),	VAL, ETRA
City level	VAL_BM-11	Demand management	Mobility	V19 (3 V2G pilots)	LNV



District P. Maritims	VAL_BM-12	Logistics	Mobility	V17 (2 e-bikes for disabled mobility and 3 e-bikes last mile logistics), V22 (Last mile logistics based on eBikes)	LNV, VAL
City level	VAL_BM-13	Multimodality	Mobility	V23 (2 multimodal hubs)	VAL
City level	VAL_BM-14	ITS for parking management	Mobility	V25 (Management of EV parking places)	ETRA
City level	VAL_BM-15	Use of open data for new business	ICT	V30 (Open Data management), V31 (Open APIs)	UPV
City level	VAL_BM-16	Inputs and Outputs of Urban platform	ICT	V32 (IoT devices integration with the VLCi smart city platform), V33 (IoT & Big Data analysis (KPI dashboard))	UPV
District P. Maritims	VAL_BM-17	Employment initiatives	Non-Technical Actions	V35 (MAchUP employment initiative), V37 (Social and local entrepreneurship program), V38 (Promote business opportunities for district inhabitants),	KVEL
District P. Maritims	VAL_BM-18	50/50 Programmes	Non-Technical Actions	V36 (50/50 Programmes)	LNV
City level	VAL_BM-19	Shared private-public investment models for sustainable energy consumption and circular economy	Non-Technical Actions	V39 (Shared private-public investment models for sustainable energy consumption and circular economy)	KVEL
District P. Maritims	VAL_BM-20	Prosumer Energy Cooperatives	Non-Technical Actions	V40 (Prosumer Energy Cooperatives)	LNV
District P. Maritims	VAL_BM-21	District refurbishment local investment fund (financial instrument)	Non-Technical Actions	V41 (District refurbishment local investment fund (financial instrument))	LNV



## Economic evaluation action bundles for Dresden

Zone	Business Model ID	Business Model Name	MATCHUP Pillar	Actions	Lead
District Johannstadt	DRE_BM-01	Smart tenant existing building	Energy	A1 (Smart tenant), A4 (PV on existing building)	DWG
District Johannstadt	DRE_BM-02	Smart tenant new building (District Future House)	Energy	A9 (District future house), A41 (8.7 kWp PV system), A42 (Power storage)	DWG
District Johannstadt	DRE_BM-03	Energetic transformation of the real estate	Energy	A7 (Retrofitting project Pfothenhauer Str.), A38 (Energy-efficient design real estate)	VON
District Johannstadt	DRE_BM-05	Smart controls (Building control center)	Energy	A2 (Building control center)	DRE
District Johannstadt	DRE_BM-07	Smart public lighting	Energy	A15 (Optimization actions in public lighting)	DRE
City level	DRE_BM-08	EV for the public sector	Mobility	A19 (public sector)	FHG
District Johannstadt	DRE_BM-09	EV for housing sector	Mobility	A40 (housing sector)	DWG
District Johannstadt	DRE_BM-10	Expansion charging infrastructure	Mobility	A22 (Charging points + fast-chargers)	DWG
District Johannstadt	DRE_BM-11	Intermodal mobility hub	Mobility	A26 (1 IMMh)	DVB
City level	DRE_BM-12	Smart charging	Mobility	A11 (Smart meters), A24 (Smart management e-mobility), A37 (Business model for charging stations)	DWG
				A23 (Optimal use charging infrastructure), A54 (Reducing impact of charging stations on the grid)	FHG



## Economic evaluation action bundles for Antalya

Zone	Business Model ID	Business Model Name	MATCHUP Pillar	Actions	Lead
Kepez Satral	ANT_BM-01	New construction of residential building	Energy	A1: Residential blocks (B Energy Rating) A4: Solar thermal collectors installation for residential building A6: Smart control and domotics	ANP
Kepez Satral	ANT_BM-02	New construction of high performance public building	Energy	A2: New construction of public tertiary buildings A3: PV installation for public building A5: Electrical storage for building and charging station	ANP
Kepez Satral	ANT_BM-03	Smart public lighting	Energy	A8: Led public lighting A9: Smart control of public lighting	ANP
City Level	ANT_BM-04	Solar power plant with storage	Energy	A10: PV system with a total capacity 5MWp A12: Integration of district electricity storage	ANT
City Level	ANT_BM-05	LFG Utilization	Energy	A11: LFG and electricity generation	ANT
City Level	ANT_BM-06	E-bus	Mobility	A13: 2 e-bus A23: 2 e-bus charging stations A22: Management of e-fleet	ANT
City Level	ANT_BM-07	E-car	Mobility	A14: 20 e-vehicle for municipality fleet A6: 5 e-vehicle charging points	ANT
City Level	ANT_BM-08	E-bike	Mobility	A15: 30 e-bike A17: 5 e-bike charging stations	ANT
City Level	ANT_BM-09	Multimodal hubs	Mobility	A19: 2 multimodal hubs	ANT
City Level	ANT_BM-10	Intelegant transport system	Mobility	A20: Integrating existing light rail with ebike station and bus terminal A21: Applying last mile mobility for citizens via integration of e-bike station with the light rail stations.	ANT



## Annex A4. Economic indicators feasibility checklist

WP5 TECHNICAL, SOCIAL AND ECONOMIC EVALUATION



### Economic evaluation framework (Task 5.2.) Indicators feasibility and data availability check

#### Overview of WP5 and Task 5.2.

The objective of WP5 is to setup an evaluation framework to be applied in the three lighthouse cities, with the aim to assess the effectiveness of the proposed interventions and their associated individual actions. The framework will evaluate the performances of the actions from a technical, economic and social perspective. The specific objective of **Task 5.2.** is to define the **economic evaluation framework**, as means to assess the **main economic dimensions of actions** carried out in lighthouse cities as well as evaluate the **performance of their associated financial schemes and business models**. In this perspective, it is important to evaluate the **financial performances** of project actions as well as their **environmental, social and economic benefits**.

The proposed set of indicators for the economic evaluation framework, elaborated based on desk research and interactions with project partners, was presented during a dedicated audio meeting (26 November 2018) and updated in January 2019. The set covers the following dimensions, and it is structured in core and complementary dimensions/indicators:

	Main dimensions covered:	Indicators
Core dimensions/ indicators: to be applied to all project actions	Funding/financial model	1. Funding sources
	Costs & revenue structure	2. Small city investments 3. O&M costs variation 4. Revenues variation
	Market dimension	5. Market orientation 6. Market demand
	Profitability and financial performance	7. Net Present Value (NPV) 8. Internal rate of return (IRR) 9. Payback period
Complementary dimensions/ indicators: to be applied to actions selected by partners	Efficiency	10. Energy consumption reduction cost 11. CO2 reduction cost efficiency
	Benefits for/impacts on the population/consumers	12. Property value variation - 13. Financial benefit for the end-user 14. Increased safety - 15. Value of Travel Time Savings - 16. Benefit from air pollution reduction - 17. Benefit from CO2 reduction
	Employment	18. Increased use of local workforce 19. Local job creation
	Business involvement & impact on business	20. Certified companies involved in the project 21. New business registered 22. Increase in destination local attractiveness
	Innovation	23. Patents 24. Green public procurement

The **core** indicators target key economic dimensions of actions, therefore it is recommended that they are applied and populated for all project actions – provided they are applicable and data are available.

The **complementary** indicators target interesting additional aspects and dimensions of actions, including several social and environmental benefits, that would be useful to measure/evaluate in order to have a comprehensive view of the overall impact of actions. Therefore it is recommended that Lighthouse cities take also complementary indicators into account and select a set of actions to measure these indicators.







An overview of the applicability of core/complementary indicators to the different action typologies is provided in the Excel file.

#### Indicators feasibility & Data availability check

The aim of this document is to check with Lighthouse cities:

- the data availability for each indicator, considering the accessibility of data sources, the possibility to produce directly or collect the relevant data;
- the overall feasibility to populate the proposed economic indicators, based on the availability of data and the possibility for Lighthouse Cities to collect them, also in collaboration with their technical local partners and local stakeholders. In fact, Lighthouse Cities would be in the ideal position to contact relevant organizations and subjects of their territory who own and provide access to the data.

Data will be collected (depending on the indicator):

- **before** (if it is possible to define an ex-ante baseline) **or at the beginning** of action implementation
- **during** action implementation, mainly with an annual frequency
- **at the end** of the action implementation.

For some actions, it will be necessary to retrieve data about a comparable BAU project or technology, which could represent a baseline to measure the indicators variation (e.g. for public lighting, sodium lamps vs. LEDs).

The main sources for the data collection will be:

- Project data/documentation (including energy bills and other types of bills)
- Surveys/interviews to the action manager
- Expert/consultant evaluations
- Existing data sources (i.a. real estate analysis, mobility surveys, tourism statistics, patent data); it will be necessary to check if these data are available at action area level (e.g. district, neighbourhood...)
- Specific data collection/production process by the action manager

Main question: to what extent are data for the **following indicators accessible?**

Please fill the Column on Accessibility according to the level of expected accessibility of data (High/ Low), and add any comment you deem convenient.

WP5 TECHNICAL, SOCIAL AND ECONOMIC EVALUATION



#	Indicator	Description	Source	Timing of measurement (referred to action implementation)	⇒PLEASE FILL: Accessibility (HIGH/LOW)
1	Funding sources (CORE)	This indicator aims to describe the typologies of funding sources (public, private) used to support the action. It comprises a qualitative description (typology and origin of funding) and a quantitative dimension (amount of funding per source).	Project data/documentation	Before/Beginning	
2	Smart city investments (CORE)	This indicator aims to measure the total smart city investments associated with the action, specifying who is investing in the action (i.e. municipality, private company, citizens, others...).	Project data/documentation	Before/Beginning During End	
3	Operation&Maintenance Costs (CORE)	This indicator aims to measure the variation of costs generated by the action, by comparing the total annual costs before and after the action implementation. The proposal is to take into account the overall O&M costs related to the action, not only the energy-related ones (i.e. energy costs, management, maintenance, components, charges, taxes), in order to capture the overall impacts on costs variation that these types of action can entail (e.g. benefits in terms of maintenance costs reduction). The indicator should be compiled specifying who incurs in the cost (i.e. municipality, company, citizens...).	Project data/documentation, energy bills, other bills, survey/Interviews to action manager	Before/Beginning During End	
4	Revenues variation (CORE)	This indicator aims to measure the variation of revenues generated by the action, by comparing the total annual revenues before and after the action implementation. The indicator should be compiled specifying who benefits from the revenues (i.e. municipality, company, citizens...).	Project data/documentation, survey/Interviews to action manager	Before/Beginning During End	
5	Market orientation (COMPLEMENTARY)	This indicator aims to measure the extent to which the project was planned on the basis of a market analysis	Expert/consultant evaluation	Before/Beginning	
6	Market demand (COMPLEMENTARY)	This indicator aims to measure the extent to which there is a general market demand for the solution	Expert/consultant evaluation	Before/Beginning During End	
7	Net Present Value (NPV) (CORE)	The Net Present Value (NPV) is a measure of financial project performance. The net present value of an investment is defined as the sum of the discounted annual incoming cash-flows related to the investment less the discounted annual outgoing cash flows over a period of time, thereby comparing the present value of money today to the present value of money in future, taking inflation and returns into account. The discount factor used should always be reported. If the benefits exceed the costs, the NPV is positive and the project is worth pursuing. It is calculated over the project lifetime.	Project data/documentation, cash-flow accounts	Before/Beginning During End	
8	Internal rate of return (IRR) (CORE)	The IRR of an investment is the discount rate at which the net present value of costs (negative cash flows) of the investment equals the net present value of the benefits (positive cash flows) of the investment. It is expressed as the interest rate at which the NPV of the investment is zero.	Project data/documentation, cash-flow accounts	Before/Beginning During End	





## WP5 TECHNICAL, SOCIAL AND ECONOMIC EVALUATION



#	Indicator	Description	Source	Timing of measurement (referred to action implementation)	⇒PLEASE FILL: Accessibility (HIGH/LOW)
9	Payback period (CORE)	The number of years at which the net present value of costs (negative cash flows) of the investment equals the net present value of the benefits (positive cash flows) of the investment	Project data/documentation, cash-flow accounts	Before/Beginning During End	
10	Energy consumption reduction cost (CORE)	Costs in euro per unit of energy saved per year	Project data/documentation, energy bills	During End	
11	Cost efficiency of CO2 reduction (CORE)	Costs in euro per ton of CO2 saved per year	Project data/documentation, energy bills	During End	
12	Property value variation (COMPLEMENTARY)	Variation of the property value thanks to the project/action	Real estate data at action level	Before/Beginning During End	
13	Financial benefit for the end-user (COMPLEMENTARY)	Total cost savings in euros for end-users per household per year	Energy bills, data from survey with households at action level	Before/Beginning During End	
14	Increased safety (crime) (COMPLEMENTARY)	Monetized value of increased safety for the population/city users deriving from the action implementation.	Contingent evaluation questions to be included in surveys in the area; Literature	Before/Beginning During End	
15	Value of Travel Time Savings (COMPLEMENTARY)	Monetized value of travel time reduction for the population/city users deriving from the action implementation	Mobility survey in the action area, literature for unit costs	Before/Beginning During End	
16	Benefit from air pollution reduction (COMPLEMENTARY)	Monetization of external costs due to air pollution avoided thanks to the action	Reduction of air pollutants calculated by Technical Indicators; Literature on unit costs	Before/Beginning During End	



## WP5 TECHNICAL, SOCIAL AND ECONOMIC EVALUATION



#	Indicator	Description	Source	Timing of measurement (referred to action implementation)	⇒PLEASE FILL: Accessibility (HIGH/LOW)
17	Benefit from avoided CO2 emissions (COMPLENTARY)	Monetization of external costs due to CO2 emissions avoided thanks to the action	Reduction of CO2 emissions calculated by Technical Indicators; Literature on social cost of carbon	Before/Beginning During End	
18	Increased use of local workforce (COMPLENTARY)	Share in the total project costs that has been spent on local suppliers, contractors and service providers.	Project data/documentation, specific collection process by the action manager	Beginning During End	
19	Local job creation (COMPLENTARY)	Number of jobs created by the project	Project data/documentation, specific collection process by the action manager	Beginning During End	
20	Certified companies involved in the project (COMPLENTARY)	Share of the companies involved in the project holding an ISO 14001 certificate	Project data/documentation, specific collection process by the action manager	Beginning During End	
21	New business registered (COMPLENTARY)	Number of new businesses registered (including start-up) in a year because of the action	Project data/documentation, specific collection process by the action manager	Beginning During End	
22	Increase in job/tourism local attractiveness (COMPLENTARY)	Increase in incoming tourist/workers flow in the area thanks to the action	Official local statistics on tourism/communiting at district level, specific collection process by municipality	Beginning During End	



## WP5 TECHNICAL, SOCIAL AND ECONOMIC EVALUATION



#	Indicator	Description	Source	Timing of measurement (referred to action implementation)	⇒PLEASE FILL: Accessibility (HIGH/LOW)
23	Patents (COMPLEMENTARY)	Total number of new patents generated by the action/project, issued to residents and organizations of the city per year	Patent office data, specific collection process by action manager	End	
24	Green public procurement (COMPLEMENTARY)	The extent to which GPP criteria were taken into account for the procurement processes related to the project	Expert/consultant evaluation	During End	



## Annex A5. Reference units according to action categories

Category	Sub-category	Reference units
Buildings and district	Building integrated RES	€/m <sup>2</sup> €/kW
	Building integrated storage	€/kW
	Domotics & smart controls	€/unit (smart control)
	New buildings	€/m <sup>2</sup>
	Retrofitting	€/m <sup>2</sup>
	Building repurposing actions	€/m <sup>2</sup>
City infrastructures	District heating and cooling	€/kW
	District thermal storage	€/kW
	District electrical storage	€/kW
	Public lighting	€/unit (lamppost)
	Smart grids	€/unit (smart meter)
	Urban level RES	€/kW
Mobility actions	Charging stations	€/unit (station)
	Demand management	€/unit (station, charger, ....)
	Electric vehicles	€/vehicle
	Intelligent transport systems	€/unit
	Multimodality	€/unit (hub, ....)
	Urban freights - logistics	€/vehicle
Non-technical actions	Citizen's engagement	€/unit (programme, initiative..)
	Innovative business	€/unit (programme, initiative..)
	Policy improvement	n.a.
	Staff exchange	€/unit (programme, initiative..)



	Urban planning	n.a.
Urban platform and ICT developments	IoT	€/unit
	Urban platform	€/unit

