# D4.1 Evaluation Action Plan and Reports

*This deliverable specifies the monitoring and evaluation framework for the project.*

| | |
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# List of Abbreviations/Glossary

| Abbreviation | Definition |
|---|---|
| AEF | Activity Evaluation Form |
| BEF | BIPED Evaluation Forum |
| BEST | Building Estimate Specification Table |
| BIPED | Building Intelligent Positive Energy Districts |
| CAPEX | Capital expenditures |
| DMP | Data Management Plan |
| ESG | Economic Social Governance |
| FoA | Field of Action |
| GA | Grant Agreement |
| GHG | Greenhouse Gas |
| KPI | Key Performance Indicator(s) |
| LDT | Local Digital Twin |
| M&E | Monitoring and Evaluation |
| OPEX | Operational Costs |
| PED | Positive Energy District(s) |
| SCIS | Smart Cities Information System |
| SCM | Smart Cities Marketplace |
| SDG | Sustainable Development Goals |
| SMART | Specific, Measurable, Achievable, Relevant, Time-bound |
| SRT | Self Reporting Tool |
| WP | Work Package |

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# Executive Summary

This report presents Deliverable 4.1 - Evaluation Action Plan and Reports of Work Package (WP) 4 of the Building Intelligent Positive Energy Districts (BIPED) project. This deliverable reports on Task 4.1, which focuses on the creation of a methodology plan to cover testing cycles and project validation. The framework is expanded in this deliverable to include the methodology, tools and scenarios to be tested from the solution developed. In addition to the stakeholder/end-user activities in WP4, the key stakeholders,end-users, and broader data space communities identified in WP2 and WP3 will also be engaged in the Monitoring and Evaluation (M&E) actions through questionnaires, workshops and focus group discussions, as prescribed through the framework.

D4.1 outlines the development of a comprehensive M&E framework tailored for BIPED. The framework integrates both qualitative and quantitative data collection methodologies to ensure a holistic understanding of project performance and impact. Central to the M&E framework will be monthly workshops and forums designed to gather both qualitative and quantitative data by engaging members of the project consortium and Key Performance Indicator (KPI) owners. Quantitative data will be documented using KPI Sheets, offering a structured approach to measuring project metrics and performance indicators. These sheets provide a clear overview of project progress and enable data assessment and evaluation.

Qualitative data, crucial for understanding the nuanced aspects of project implementation and community engagement, will be gathered through Activity Evaluation Forms (AEF). These forms capture insights, feedback, and perceptions from stakeholders involved in the project, offering valuable qualitative inputs to compliment quantitative data.

This integration of qualitative and quantitative data will be in line with BIPED's Data Management Plan (DMP) which will be a living document that presents the consortium's plan on handling data during and after the end of the project. The DMP and BIPED's M&E Framework works together to identify what data will be collected, processed and/or generated, which methodology and standards will be applied (such as anonymisation), what can be included as Open Data and how data will be preserved.

The M&E framework establishes a systematic approach to assessing project effectiveness, identifying areas for improvement, and ensuring alignment with project goals and objectives. BIPED M&E Framework was adapted to the area of Aarhus to provide definitions of a spatial scale (City Level and Sub-City District Level) in order to provide a clear boundary of where project interventions will take place and the baseline from which data will be evaluated from. The Sub-City District Level is broken down into three areas of priority for the projects which are demonstration sites, demonstration areas and demonstration districts. This is discussed further in Section 2.4.1.

As part of WP4s work with WP2 and their Deliverable D2.1, KPMG worked with AIT in developing KPI requirements and data points which will be incorporated into the Digital Twin's design and implementation and ensures that the development of the Digital Twin was in sync between Work Packages in order to achieve BIPED project goals. This synchronisation will ensure the design of a data collection architecture for the Digital Twin

which will create a scalable and replicable architecture for PEDs and Digital Twins in Europe and add value to the existing Digital Twin market.

By integrating qualitative and quantitative data collection methods, the framework enables a comprehensive evaluation of the smart city project's impact, facilitating informed decision-making and allows WP4 to populate the Smart City Information System's Self Reporting Tool which will reflect the collection of KPI data throughout the lifespan of the project.

This M&E framework will provide the scope and direction for the assessment framework. The Assessment Framework will implement a series of testing cycles, which will occur every six months. The identification of both local and external stakeholders and end users allows for the solution to be tested in different environments and ensure the compliance and alignment with BIPED's KPIs. The testing cycles will be developed with partners within the consortium and follow best practice in the M&E and assessment procedures.

# 1. Introduction

## 1.1. SMART Cities, Horizon Europe and Monitoring & Evaluation

As part of the BIPED project, the M&E framework will ensure the project outcomes remain relevant and impactful to the identified relevant stakeholders and the wider smart city development in Europe. A set of KPIs will be employed to monitor the project's progress and success. Through the continuous assessment of performance, action will be taken to ensure resources are optimised, risks are managed, and necessary adaptations are implemented to promote the overall success of the digital twin city initiative as part of the BIPED project.

Positive Energy Districts (PEDs) are a key building block in the future energy paradigm for carbon-neutral cities and communities. With the rise of modern technology, PED development is evolving towards a more agile arrangement in which decisions are first tested and fine-tuned in virtual environments before they are deployed on the ground. A key enabler of this virtual prototyping is the Local Digital Twin (LDT) technology. Traditionally, LDTs create digital representations of a functional territory by combining low- and high-velocity data with dynamic models of energy, traffic, buildings and natural environment.

However, focusing narrowly on these domains means that digital twins of PEDs can lack representation of other elements that make up the urban fabric. LDTs that omit social, economic and cultural properties will only provide a partial representation of an area they are designed to model.

This shortcoming in LDT-PED modelling, which can be caused by limited data availability and siloed systems design, can lead to suboptimal decisions, impacting negatively ambitious efforts of sustainable development in cities and communities.

BIPED's ambition is to unlock a spectrum of data-driven decision making, covering both short-term city operations and long-term policy planning, to guide AI-supported optimisation of PED development. Funded under the Horizon Europe scheme (Grant ID: 101139060), the BIPED project strives to further efforts towards achieving Sustainable Development Goals (SDG) through the promotion of digital twin models. The strategy of deploying digital twin models relates to using modern technology to develop digital representations of a specific functional territory through the collection and various data forms[1]. In this way, BIPED works to recognise the role digital twin models can play to overcome the complexities associated with PED development as well as providing information for the adoption and optimisation of existing systems[2].

1 (BIPED Proposal, 2023)

2 (European Commission, 2022)

The central focus of the BIPED project is to further establish the effective role of digital twin models in the development of PEDs in cities across Europe. This will be aided by an M&E framework which acts as an essential feedback loop to guide the project's trajectory.

## 1.2. Importance of M&E in BIPED

In the context of the leading technological developments comprising the BIPED project, M&E acts as a comprehensive framework crucial for the assessment of the initiative's performance against the predetermined project objectives and KPIs. In this way, stakeholders are equipped with relevant information cultivated through the continuous monitoring of real-time progress. This places stakeholders in the advantaged position of being able to make informed decisions and implement timely interventions. Additionally, M&E works as a vital mechanism in the assessment of risk which ensures a project's success is adequately safeguarded against unforeseen challenges. This highlights the role of M&E in navigating the inherently complex nature of urban development and ensures the resilience of the BIPED project and its associated digital twin models.

In order to further emphasise the importance of M&E to the BIPED Project's success, the beneficial roll such frameworks played in past EU funded projects will be outlined:

*"Enable the impacts of the project to become relevant to the wider policy and innovation community"* [3].

Monitoring and evaluation of data in BIPED will be vital in ensuring its success and continued effectiveness during and beyond the end of the project. By continually monitoring data, the BIPED consortium can identify trends, patterns and potential challenges allowing for adjustments of project KPIs, interventions and allow for a collaborative decision making process. BIPED's M&E will provide valuable insights into the project's performance against its objectives, helping stakeholders understand what worked well and what needs improvement. The monitoring and evaluation will ensure the outcomes can be employed within and beyond the context of the project so as to work towards cultivating sustainable cities across Europe.

The BIPED Project presents a prime opportunity to explore and develop the most efficient manner to roll-out digital twin models across European cities. In order to ensure this opportunity is capitalised on to maximum efficiency, WP4 provides an M&E framework that works towards providing an overarching and iterative process that showcases the learning and lessons from the project, both for the project during its runtime and future development. BIPED will allow space for stakeholders to explore and adapt the digital twin initiative to ensure knowledge is efficiently circulated so as to assist with the creation of sustainable smart urban areas.

3 (European Commission, 2019)

## 1.3. Principles for the Development of a M&E Framework

A robust M&E framework requires a distinct understanding among stakeholders regarding the purpose and objectives of the project at hand. It is paramount to the project's success that all key actors hold a clear understanding of the goals they wish to achieve throughout the course of the project. Such goals should be clear, defined and measurable whilst also in alignment with the central vision of the project. In this way, communication with stakeholders should be a priority during the framework's development phase.

The M&E framework should maintain a form that allows for flexibility and adaptability to accommodate contextual changes that may arise throughout the project's lifespan. In this way, M&E is seen to facilitate the continuous improvement and refinement of the project whilst also showing a commitment to an approach characterised by integrity. The following sections outline the M&E approach for the BIPED Project, including an overview of KPIs.

# 2. Overall Framework

## 2.1. What is a Framework

A M&E Framework is both a planning process and a written product designed to provide guidance on the conduct of monitoring and evaluation functions over the life span of a program or other initiative (Markiewicz, 2016)[4]. A framework acts as a tool which informs the project consortium decision-making processes, such as definition of KPIs, timing of interventions, data collection methodology and analysis, and reporting of data. This is to further understand the impact, successes, and challenges faced, and what insights, guidelines, and recommendations can be drawn from the evaluation of activities that would improve future application and replication of such activities. The development of a framework for evaluation provides a guideline that project partners can reference and follow in order to efficiently and effectively report on data related to their project activities. The reporting of data will, in turn, inform the creation of other guidelines for the implementation and replication of interventions.

## 2.2. Rationale

A data M&E framework serves as the backbone for effective decision-making, performance assessment, and optimisation of products and/or services for a smart city and digital twin development project . At its core, this framework defines the systematic process of collecting, analysing, and interpreting data generated by various tools embedded within the city of Aarhus' infrastructure. It encompasses a structured approach to monitoring the project's performance across different domains such as transportation, energy, and environment.

BIPED's M&E framework will act as a plan for undertaking M&E throughout the project and will provide project partners with a guide on how to apply M&E to its own interventions and initiatives. The BIPED project explores the possibilities associated with building intelligent PEDs to assist cities with the decarbonisation efforts. In this way, the establishment of a standardised M&E approach acts as a means through which each intervention can be monitored and evaluated against other EU and world projects, to maximise efficiency and translate the project to other EU cities and contexts.

Such a framework entails establishing clear objectives and targets aligned with the overarching goals of the BIPED project. It involves selecting relevant metrics and indicators that reflect the desired outcomes, alongside defining data collection methodologies, frequency, and sources. Furthermore, the framework outlines mechanisms for data aggregation, processing, and visualisation to derive replicable recommendations and actions for stakeholders. Continuous evaluation and feedback loops are integral, allowing for adjustments and improvements in KPI interventions based on real-time or near-real-time data analysis.This framework will serve as a vital instrument in fostering sustainability, resilience, and replicability within BIPED and externally.

4 (Markiewicz & Patrick, Developing Monitoring and Evaluation Frameworks, 2015)

## 2.3. Co-Creation Principles of the BIPED M&E framework

Co-creation is the joint, collaborative, concurrent, peer-like process of producing new value, both materially and symbolically[5] (Galvagno, 2014). At the heart of the BIPED co-creation principles that underpin the framework is the recognition that effective solutions emerge from the multiple and varied perspectives of the project consortium and the stakeholders involved across the wider project. In the landscape of smart city and digital twin development, the principles of co-creation stand as pillars of collaborative innovation and stakeholder engagement. In developing the M&E framework, KPMG have worked extensively with WP2 and WP3 leaders to create documents and methodologies which will be at the core of M&E, KPI data collection and stakeholder engagement. The creation of the KPI data collection sheets, which was created in a collaborative and iterative process with WP2, is shown in full form in Annex 2. The data collection sheet will be refined in the next iteration of this Deliverable 4.3. To complement the KPI data collection sheet, KPMG has developed Activity Evaluation Forms (AEFs) in collaboration with WP2 and is shown in full in Annex 1. This will be used to evaluate project interventions and activities.

Central to BIPED's co-creation principles are planned periodic meetings, where stakeholders convene to discuss and analyse both qualitative and quantitative data collected through project interventions. These meetings will serve as focal points for dialogue, reflection, and joint decision-making, fostering transparency and accountability within the framework. By intertwining data-driven insights with participatory processes, the co-creation principles ensure that the resulting urban interventions are not only technologically robust but also socially and environmentally sustainable, resonating with the needs and aspirations of the communities they serve.

As part of the evaluation process, partners will provide feedback on project interventions applied in Aarhus such as, how the activity/intervention has performed and the key lessons learnt. The reporting on interventions can be viewed in conjunction with the quantitative data captured via the data collection sheets as the captured data validates the results reported on. Through a structured process of periodic engagement, partners will be requested to provide feedback on the various types of interventions implemented according to the aims of the project. Through long-term monitoring and evaluation of the project's interventions, partners and the public will be able to view the impact that BIPED and related projects have had on Aarhus. The analysis of project data and inputs from partners will therefore be used in conjunction to inform decision making and planning of future upscaling and replication of the project's initiatives in other cities and countries.

[5] (Galvagno, 2014, Theory of value co-creation: a systematic literature review)

## 2.4. Identification of the District

Each of the interventions implemented in Aarhus will have an impact on a predefined spatial location. The following subsections define the spatial scale and discuss the identification of the district and PED within Aarhus.

As defined in BIPED's project vision, PEDs are defined as:

*..a key building block in the future energy paradigm for carbon-neutral cities and communities. With the rise of modern technology, local digital twins – the digital representations of a functional territory combining low- and high-velocity data with dynamic models enabling advanced analytics and artificial intelligence (AI) – play a significant role in PED development and the scaling of it, supporting decision makers, planners and communities in taking informed decisions towards a sustainable future*.

Identification of the district and PED within Aarhus is crucial to the M&E framework as it allows BIPED to define the system border, map local existing Renewable Energy Sources (RES). By mapping the local existing RES, the project consortium can map, analyse and decide on viable energy efficiency measures to be implemented. By defining the district, BIPED can map and analyse current digital infrastructures within Aarhus and decide on additional interventions required. This identification of the district will allow BIPED to create strategies to achieve sustainable and resilient urban communities that optimise the use of renewable energy sources and minimise greenhouse gas emissions.

### 2.4.1 Definition of Spatial Scale

### 2.4.2 City Level

The city level is the highest level of intervention scale and analyses the impact of interventions on the city of Aarhus. The city level designation will take interventions which play a significant role in development of the Digital Twin and scaling of it, supporting decision makers and planners and key project stakeholders in being able to make informed decisions towards implementing the Digital Twin solution in Aarhus. These interventions in support of the Digital Twin will also support aspects such as social, economic, and environmental properties which lack representation.

### 2.4.3 Sub-City District Level

A sub city district level refers to an area within Aarhus which will be the smallest project area showing main streets, city neighbourhoods, a single or multiple city districts. Within the sub city district level there is three areas of priority for the BIPED project which are:

| | |
|---|---|
| **Demonstration Site** | The site level will be defined as a building or street level where interventions are conducted. |

| | |
|---|---|
| **Demonstration Area** | Contains several sites where interventions are carried out. |
| **Demonstration District** | The demonstration district can contain multiple demonstration areas depending on the scope of interventions. |

Table 1: Sub City District Level Demonstrations

### 2.4.4 The progress on the Identification of the Positive Energy District (PED) in BIPED

An essential milestone in the BIPED project was the identification of the Positive Energy District (PED). All project partners were engaged in a collaborative process and four key questions were posed:

1. **Building Selection:** Which buildings should be part of the district?
2. **Connectivity:** Should the district be interconnected, or can it consist of fragmented parts within Brabrand?
3. **Size Considerations:** Is there a limit to the district's size?
4. **Additional Comments:** Partners were invited to share any further insights.

Each partner contributed with valuable feedback. Consensus emerged on several points:

- **Diverse Buildings:** The PED should include a wide variety of building types, reflecting different uses and architectural features.
- **Connectivity:** The district needed to be interconnected.
- **Scale Matters:** A larger district was preferable overall.

Based on these discussions and feedback led by AAKs, the positive energy district in BIPED was defined as the entire Brabrand area, identified by the postcode, 8220:

Figure 1: The Positive Energy District (PED) in BIPED

In the process of identifying the Positive Energy District (PED) in BIPED, two significant advances emerged; which will be key to the overall project and be discussed in more detail in subsequent and aligned deliverables.

**1)** Identifying the district served as the starting point for the Stakeholder Mapping and Community Engagement. It kick-started the process of creating the stakeholder list within Aarhus.

**2)** Gaining clarity on the specific areas from which we needed to obtain data also kick-started the Data Acquisition from both a city and project perspective.

# 3. Quantitative Methodology

## 3.1 Defining Key Performance Indicators

KPIs are a group of measurable interventions that the BIPED project will use to compare the performance and progress of the project consortium's interventions in achieving project goals over the lifespan of the project. The Central European Research Infrastructure Consortium describes KPIs as representing standard measuring values that help institutions assess their performance in a consistent and periodic way[6]. KPIs within the BIPED project will follow the SMART (Specific, Measurable, Achievable, Relevant, Time-bound) criteria model which is an internationally recognised standard for developing indicators and measures.

## 3.2 Monitoring & Evaluation Themes

As numerous interventions will be implemented across the BIPED Work Packages the project consortium has divided the project interventions into four core themes:

| **Community Engagement** |
|---|
| The KPIs which fall under the community engagement theme are focused on the long term impact of the interventions and the extent to which key stakeholders and citizens are made aware of the activities within the BIPED project and the wider potential of Digital Twin technologies being utilised on a micro and macro scale within their cities and day to day lives. |
| **Social and Economic Value of BIPED** |
| By tracking and evaluating economic and social specific KPIs, BIPED can showcase to key stakeholders and parties the value add which can be achieved in implementing the Digital Twin solution and individual BIPED interventions in their own locale or wider region |
| **Energy Consumption** |
| Energy Consumption KPIs will provide insights into the contribution of project interventions to energy efficiency and sustainability goals. These KPIs serve as benchmarks to make informed decisions to optimise energy usage within Aarhus. |
| **Digital Solutions** |
| Digital Solutions KPIs for a project will offer essential insights into the effectiveness and impact of digital technologies deployed. Analysing KPIs such as user engagement metrics, system uptime, response times, and adoption rates provides a comprehensive view of the project's digital performance. |

Table 2: M&E Themes

[6] ERIC Forum Toolkit, Key Performance Indicators

The four M&E themes listed above are changeable and may see the inclusion of potential economic KPIs pending further discussion with the wider BIPED consortium and identification of the expertise and capabilities of conducting economic KPIs within the project.

## 3.3 Data Requirements and Typologies

Data will be collected and provided by KPI leads and supporters as defined in the KPI framework. The following definitions will provide a guide as to the roles and responsibilities of the KPI and KPI technical experts and supporters. By having a clear distinction between the KPI Owner and KPI Technical Experts this will allow the project to define the responsibilities for the owner of the titles and where KPI owner may refer to KPI Technical Experts in regards to the implementation of project interventions.

### 3.3.1 KPI Owner

The KPI owner takes the lead in the implementation, testing and monitoring of the project interventions. The KPI owners use the KPI framework created for the BIPED project to ensure that interventions are recorded and made available for analysis. The KPI owner will agree to the definition, description and calculation method of the KPIs, in cooperation with WP4. The KPI owner is responsible for implementing measures which will enable data to be captured, and providing this data in a suitable and agreed upon format, for example the M&E quantitative (KPI Data Collection Sheet) and qualitative (Activity Evaluation Form), for reporting within the WP4 deliverables/updates and overall project reporting

KPI owners are responsible for the completion of the data collection sheets according to the agreed upon reporting frequencies for each KPI and the partner responsible for the management and update of the SRT. Throughout the BIPED project the KPI owners will review the accuracy of data recorded and issue recommendations to the project consortium for adjusting the KPI definition and KPI calculations.

### 3.3.2 KPI Technical Experts

KPI technical experts are parties that act as complementary partners to KPI owners. KPI technical experts are specialists in their area/sector and provide technical support, tools and data to KPI owners which will assist in implementing project interventions. This support will contribute to the achievement of the KPI as well as providing trusted information which allows KPI owners to monitor and report on the data.

KPI technical experts are responsible for the management of data from project interventions. KPI technical experts have the responsibility to handle data according to the Data Management Plan (DMP) and ensure that the handling of data adheres to best practice in data governance in accordance with protocols from Horizon Europe.

The collection of data will vary in line with the implementation timeline of each project intervention. Project interventions are not always carried out at the same time and run

different lengths while some data only comes online at a later stage of the project. Due to the nature of the data available regarding some KPIs, a trend in the data may only be recognisable over a prolonged period of months or years which shows the impact of the project intervention. This can be both within the project's timeline and beyond, which will be highlighted as part of the long-term impact of the project.

### 3.3.3 KPI & KPI Metadata Collection Sheet

Metadata which is defined as data relating to data, provides a summary of information about certain datasets[7]. Metadata acts as a reference to simplify searching in, working with and reutilisation of datasets. Having the relevant metadata for the project KPIs is vital to stakeholders having a full understanding of the aspects of the KPIs. Knowledge of how the KPIs have been developed will ensure solution providers and stakeholders involved to measure and record data from project interventions. The table in Annex 2 showcases an overview of the metadata which will be collected for the project KPIs during the data capturing process. The sample data collection sheet shown in Annex 2 will be finalised in the next iteration of this deliverable (D4.3).

### 3.3.4 Timeframes and Reporting Periods

The KPIs for BIPED are currently being formulated and will be written in the next iteration of this report (Deliverable 4.3). Each intervention within the projects will involve a degree of adaptation in a number of sectors and organisations across the four M&E themes (as mentioned above) and these changes will be monitored individually or as a group depending on whether the intervention is a one-off intervention or part of a group of interventions taking place across the city of Aarhus. Reporting intervals are either monthly, quarterly, bi-annually or annually.

The reporting frequency of each KPI determines when the measured performance of each intervention will be assessed, however, the data collection process will occur monthly. KPIs with a reporting frequency of bi-annually will collect six months of data to be reviewed. The date of reporting of this data will depend on when the intervention commenced.

## 3.4 Setting Baselines and Targets

### 3.4.1 Current Baselines

Multiple data points are key in assessing the impact of interventions within the project, including baseline data points, the periodic update (as per reporting periods highlighted in Section 3.3.4 and the achievement in relation to the KPI target at the conclusion of the project. The baseline data, especially used in the calculations of energy KPIs will provide a benchmark which collated data can be measured against. The use of baseline data allows for a before and after comparison after a new intervention has been commenced. As BIPED develops interventions, the baseline for KPIs, particularly the energy KPIs will need to be

7 (Computer Security Research Center, 2015)

identified or set to show the impact of the project. Some of the KPIs will have set baselines set by current/pre-project activity, whilst other KPIs will start at zero (0) to measure progress.

The target impact set for each KPI measuring interventions is a goal set for all of the KPI owners. The target impact will be based on calculations from available datasets, data best practice and similar Digital Twin/Smart City interventions. The KPI data will be compared to these data points to judge the progress of project interventions. The monitoring data will be measured against the KPI target impact over the lifespan of BIPED and by the reporting frequency of the KPI (monthly, bi annual, annual). By comparing the data to short and longer term aims, the project and stakeholders can track the progress of interventions and whether KPIs are on target, behind or ahead of schedule of expected impact.

The KPIs for BIPED are currently being formulated and the baselines for the KPIs will be reported upon within the next iteration of this report (Deliverable 4.3) in M12 (December 2024).

## 3.5 SRT submission and BEST Tables

### 3.5.1 What is the Self Reporting Tool?

The Self Reporting Tool was developed by the Smart City Information System (SCIS) which was merged into the Smart Cities Marketplace (SCM) and the objective is to provide a tool for project coordinators to report on projects' outputs and information and populate the SCM database. The Self Reporting Tool (SRT) is the link between the information and outputs from the projects within the scope of SCM and the stakeholders. The users of the SRT use this tool to upload data and provide contextual information on interventions conducted. The information grants smart city stakeholders the ability to collate and analyse this information with the aim of fostering replication[8].

8 European Commission, Self Reporting Tool Guide, 2023)

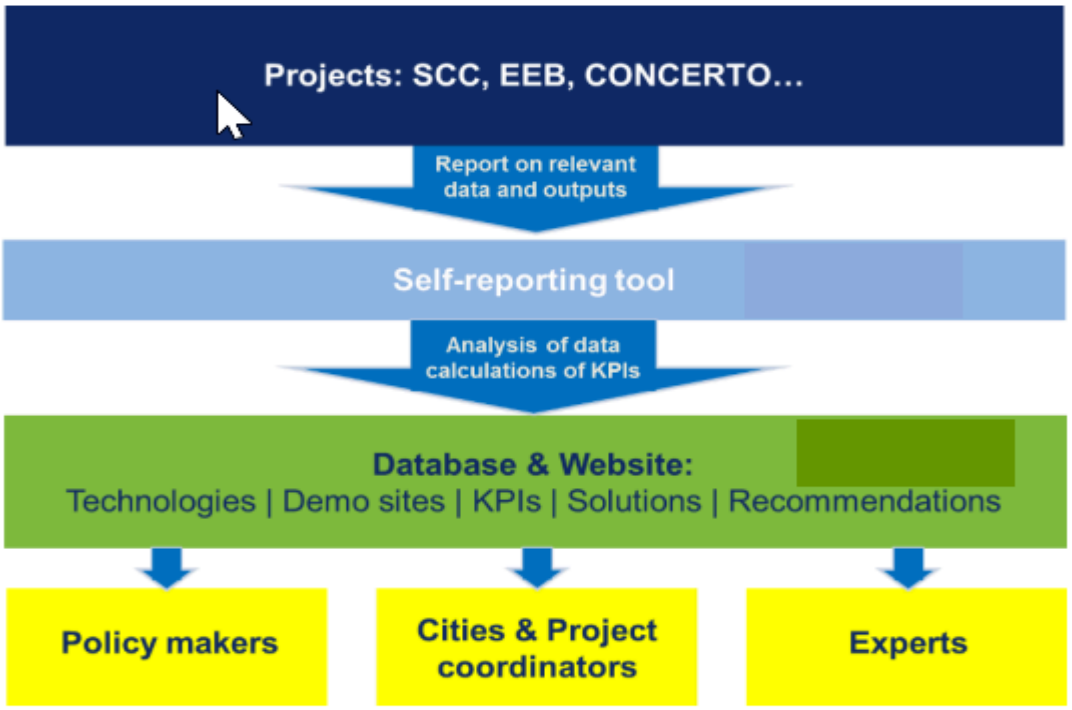


Figure 2: Stakeholder Map of SCM-SRT[9]

The SCIS developed the SRT to function as a central hub for gathering and analysing smart city project data. The primary aim of introducing this tool is to facilitate the collection, analysis and utilisation of project outputs, lessons learned and insights gained from project interventions. The SRT is designed to facilitate the uploading of project data on interventions and to establish a link between project information and key stakeholders responsible for replication purposes.

The SRT is the link between the information and outputs from the projects within the scope of SCM and the stakeholders. The information reported will provide the stakeholders with information that is monitored under real conditions, allowing them to obtain first-hand information with the aim of fostering replication[10]. KPMG will use this tool to upload the data emanating from different interventions carried out in BIPED. The information submitted to the SRT will provide external project stakeholders allowing them to access primary data with the aim of fostering replication of the Digital Twin model or interventions in creating a Digital Twin model. However, the role of the SRT and the submission of the data is reliant on infrastructure development, which is to be confirmed in the project at the submission of this deliverable.

## 3.4 Submitting Data to the SRT

The approved approach from the European Commission is to submit data to the SRT on a PED level using Building Estimate Specification Tables (BEST). This approach is recommended as it aligns with data collection and submission approaches that have been

9 European Commission, Self Reporting Tool Guide, 2023)

10 European Commission, Self Reporting Tool Guide, 2023)

established within smart city projects. Collecting and submitting data via the BEST Tables/PED helps reduce the volume of reporting due to the variety of data across projects which report on a KPI-by-KPI basis rather than individual M&E mechanisms.

KPMG will undertake engagement with data owners throughout the lifespan of the project with a view to ensuring that the project KPI data aligns with the SRT data reporting fields. Engagement with the data owners through recurring online workshops to discuss data collected and any potential refinement of the calculation of KPIs, to confirm an agreed calculation methodology of each KPI and what is required for refinement of the KPI calculation.

KPMG will work with KPI to develop and propose a KPI data reporting template that reflects data field configurations which aim to be compatible for reporting to the SRT depending on the extent of project interventions and data accessibility. These will be based upon alignment with the SRT's Field of Action (FoA) and will be reviewed and discussed with KPI owners in data workshops. If there is a differentiation in KPI data compared to the required SRT design form metrics, KPI owners will acknowledge this differentiation in their own deliverables and will be collated within future M&E deliverables.

The images below show the reporting requirements within the SCM-SRT and the data and information required to complete a SRT design form.

Image 1: General Data on Buildings within the PED

This image shows the required metrics for the buildings which will fall under the PED in Aarhus. The required information includes the building name and address, whether the building is a new build or has been retrofitted, the year of commissioning of the build or the retrofit, the use type (industrial, residential, tertiary) and the gross conditioned floor areas (m2).

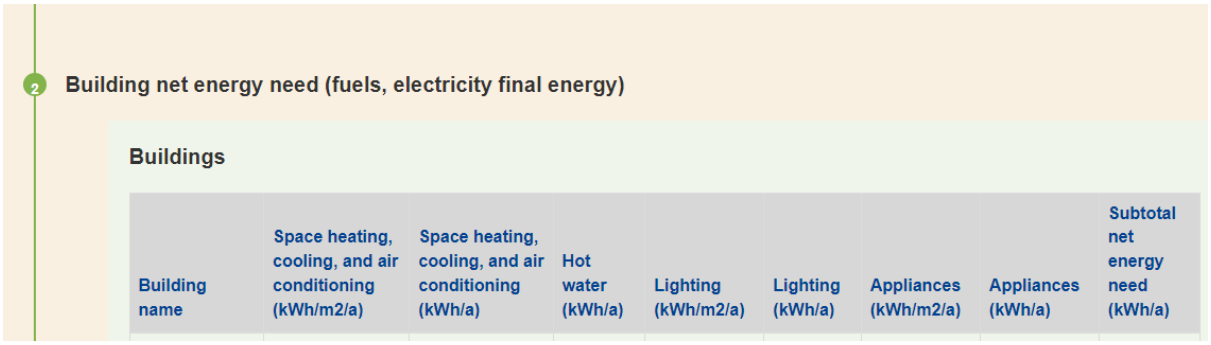


Image 2: Buildings Net Energy Needs

Image 2 shows the types of energy needs and the kWhs per annum in each building within the PED.

Image 3: Total Net Energy Needs of Buildings within the PED

This image shows the total net energy needs of the buildings combined from Image 2.

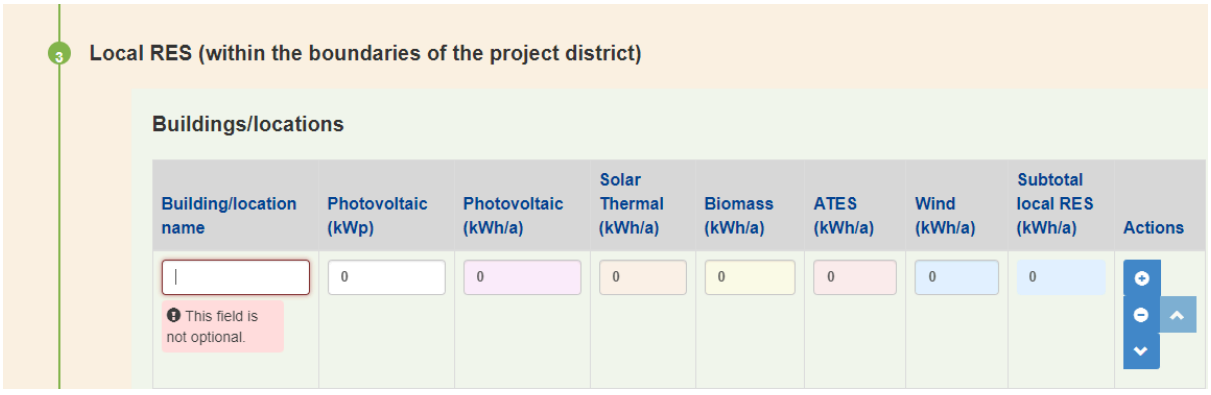


Image 4: Local RES within the Boundaries of the Project District

The SRT requests that the project records the local Renewable Energy Sources (RES) within the boundaries of the PED.

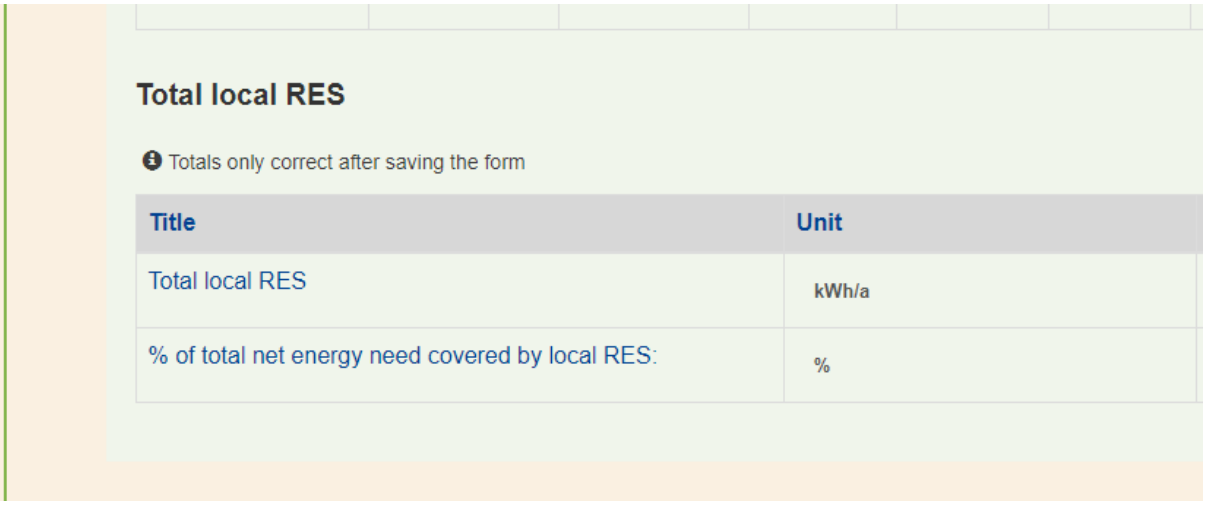


Image 5: Total local RES within the Boundaries of the Project District

The SRT requests the total local RES within the boundaries of the PED.

Image 6: Energy In/Out through District Boundaries

Image 6 shows the required fields of the energy carrier name, the energy unit which is coming in and going out of the PED.

Image 7: Total Net Incoming Energy / Building Energy Consumption related GHG emissions / Energy Management Measures

Image 7 showcases the Greenhouse Gas (GHG) emissions emitted within the district boundaries and the energy management measures within the PED and if there are any user interactions with the measures.

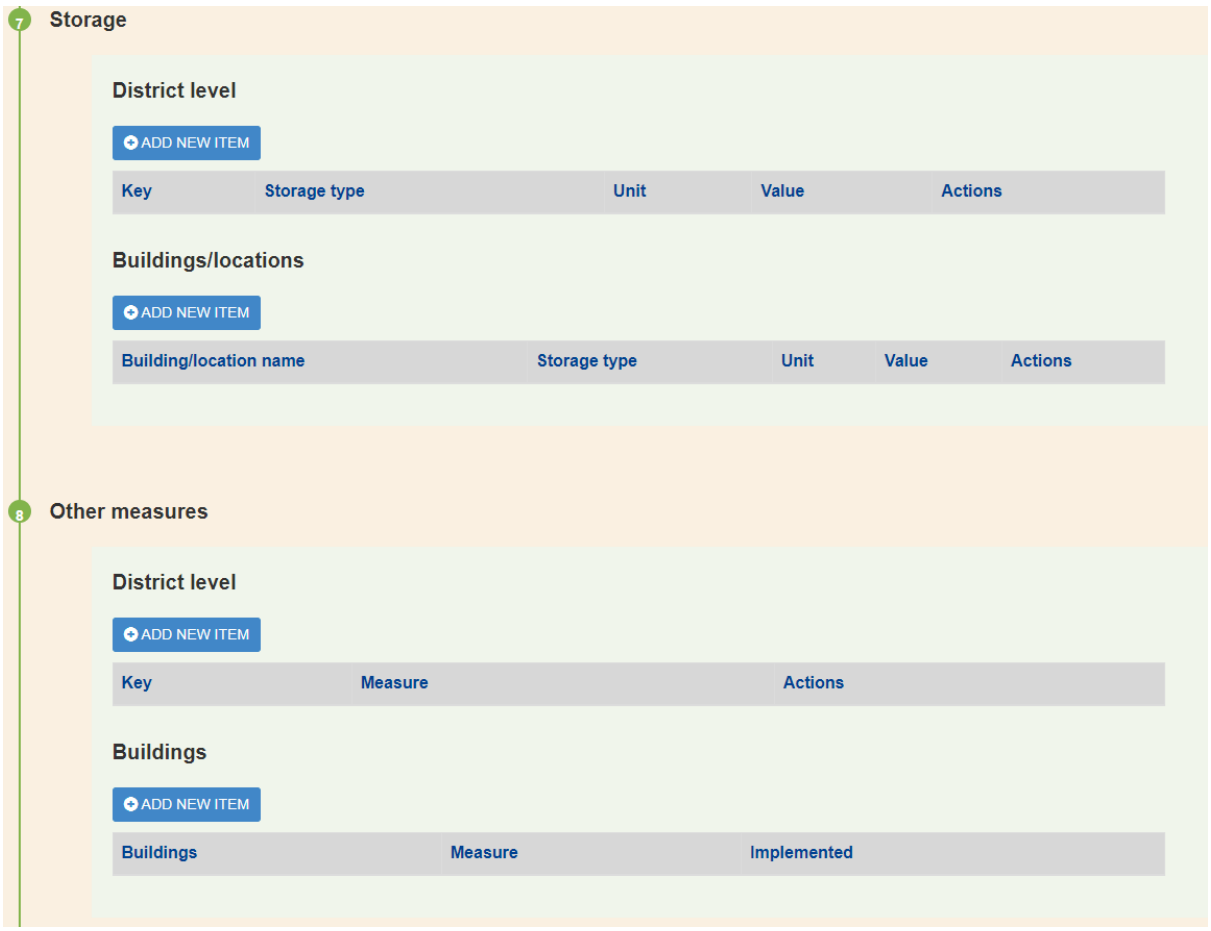


Image 8: Energy Storage (District Level & Buildings/Locations) / Other Measures (District Level / Buildings)

Section 7 shows the district level of energy storage in kWhs and the method in which it is stored. Section 8 provides a other measures section for reporting.

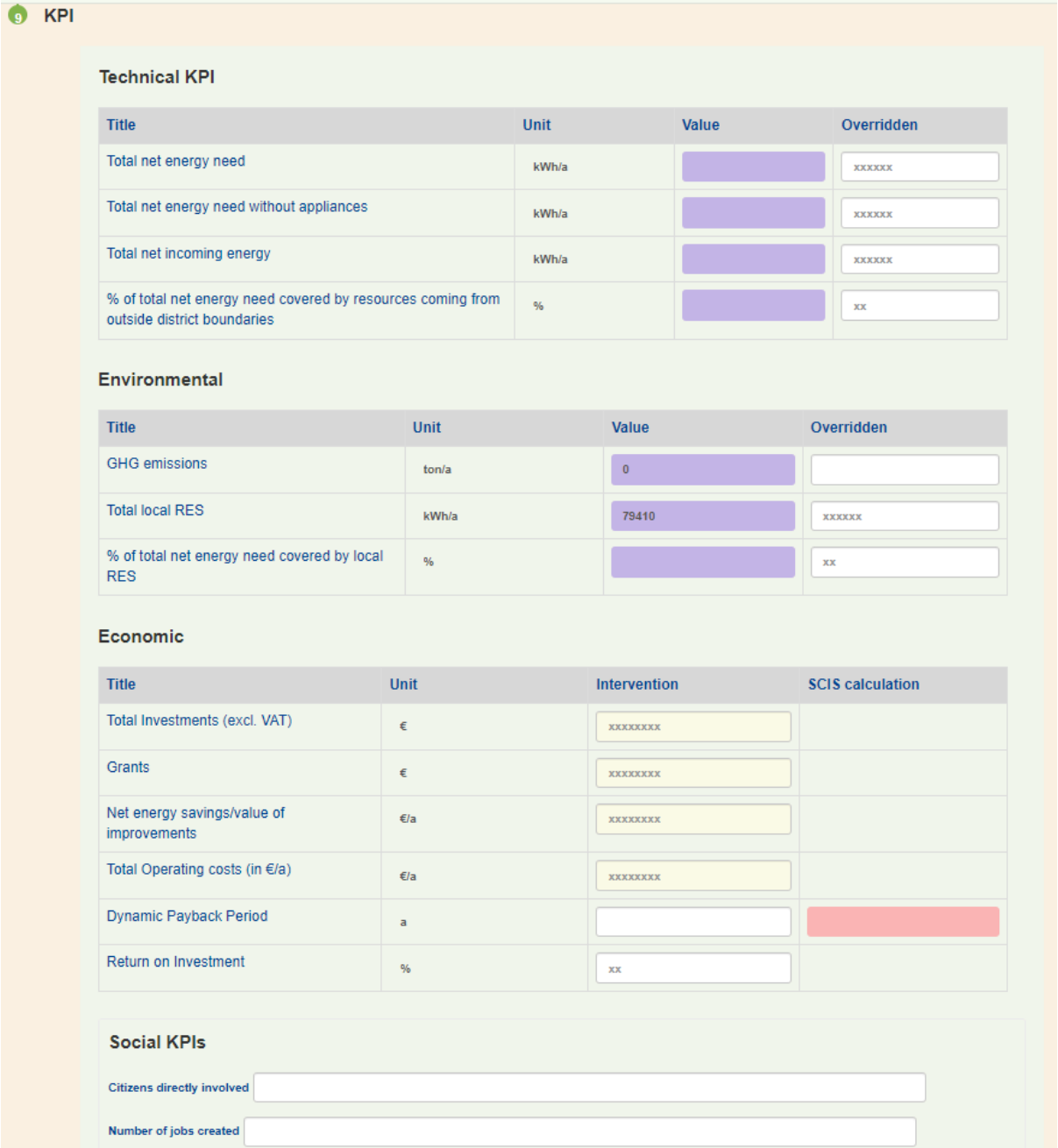


Image 9: KPIs (Technical, Environmental, Economic, Social)

## 3.5 Alignment with T2.6

***Task 2.6: Establishing an extended Positive Energy District Assessment Framework*** which will run from M13 (February 2025) to M35 (December 2026) of the project is led by AIT and supported by DTU, UWB, DKSR, VCS, RT and AAKS. The task involves the calculation of KPIs that go beyond energy and mobility measures at district scale. This includes KPIs related to social, governance, ICT and additional technical aspects related to integrated energy solutions at district scale which affect the district's energy performance, offering the monitoring and assessment of the PED throughout BIPED.

BIPED's M&E framework will work with T2.6 via a number of KPI data collection and monitoring methodologies to maintain alignment and consistency in reporting. In this regard there will be an effort to align the calculated KPIs within BIPED with selected goals of UN-SDGs like SDG 7 and SDG 11.

Along similar lines to the above, it should be noted that the extended KPI framework (T2.6) will align where possible to the development of the digital twin models in the participating cities, considerate of both the parameters established in the energy and mobility models, to comprehensively assess the energy and mobility performance of the Positive Energy District. Furthermore, subject to data availability additional KPIs are intended to be developed, capable of monitoring cross-sectoral aspects of city development (related to achieving a positive energy balance) including environmental, social and economic properties of the district. Their purpose will be to track and provide feedback to ensure that the project is on the pathway intended with respect to wider project objectives in consideration of socio-economics and the local environment.

## 3.6 Quality Control Procedures

According to the European Commission's Data Providers Guide[11], quality assurance is the process of implementing and applying quality control standards and activities to ensure high quality production of components, infrastructure and content. Quality control and assurance are directly related and will act as the process of testing to assess whether the appropriate level of quality and standards have been adhered to in the project.

It is vital that all partners involved in the BIPED project and responsible for the measurement of project interventions and utilising the project's KPI framework adhere to the standards of measurement set for each KPI. This applies whether KPIs are measured via the SCIS[12] or guidelines as established by the project consortium. The application of this methodology during the measurement of interventions and gathering of data will ensure that KPI data will be accurate, consistent and comparable across the project and within the European Commission's BEST. Adhering to this approach will increase the opportunities for upscaling and replicating BIPED's digital twin model.

Following the guidelines for monitoring, capturing and evaluating the project data will provide the opportunity for periodic reviews of the data and validation and refinement of the KPI framework and methodologies utilised. This will be conducted via a bi-annual data review meetings, beginning in M9 of the project. This review will allow partners to determine whether a KPI is still relevant for the monitoring of certain interventions and whether the data being collected is of high quality and relevant to the project's KPIs.

## 3.7 KPI Amendment Procedures

In the event of a project KPI being deemed not suitable for data collection or/and purpose, a process will be followed to amend the KPI in order to measure relevant and high quality data

11 (European Data Portal, 2018)

12 (European Commission, Smart Cities Marketplace - Smart Cities Information System)

that will help assess the performance of project interventions and likelihood of achieving related project KPIs. This procedure will be invoked after the confirmation of the KPIs is conducted. The following table shows the steps to be taken in the event that a KPI needs to be amended.

1. KPI owners to carry out an investigation as to why the KPI in question cannot be measured.
2. KPI owners will perform:
    - An analysis as to why there is a gap in the data
    - Review the existing project data capturing methodologies
    - Review quality of data currently being delivered
3. Assessment of the scope of the intervention which is to be implemented. If the intervention has been completed and won't deliver any further results, the data can be stored while a review of the status of the intervention is conducted to determine if any changes will need to be made.
4. KPI owners and KPI technical experts are to provide a report on their findings to the project consortium during the project's monthly management meeting/ or a consortium-wide especially organised session for this amendment. The report will contain information regarding the issue identified, along with all proposed changes to aspects of the KPI in order to ensure measurability and the parties responsible for enacting the identified changes as well as the timeframe required for the amendments to the KPI to take place.
5. Following this, project coordinators, KPI owners and project consortium will review the report and proposed changes and discuss options (in management and WP/task specific meetings) until an agreement is reached.
6. The project consortium will be informed of changes made to the KPI framework via the next suitable project management meeting.
7. KPI technical experts will update all data repositories accordingly.

Table 3: KPI Amendment Procedures

# 4. Qualitative Methodology

## 4.1. Role of Qualitative Evaluation in the Project

The qualitative dimension of the evaluation process will involve a comprehensive review of all engagement with partners and stakeholders regarding the evaluation of project activities and interventions, alongside insights derived from quantitative data. This encompasses the evaluation of activities and interventions as reported by partners, gathered through various channels such as feedback forms, interviews, informal discussions, and group workshops. Additionally, relevant project documentation including deliverables and meeting notes will be scrutinised. The ongoing collaboration within the BIPED Evaluation Forum (BEF) will further enhance the planning and execution of the evaluation process, ensuring its continuous refinement and application across the project.

## 4.2. Mechanisms and Process for Qualitative Assessment

| Who | What | When | How |
|---|---|---|---|
| - Key Actors<br>- Focus Groups<br>- Partners | **- What data is available?**<br><br>**- What do the partners want to highlight from each intervention?**<br><br>**- What needs to be recommended for replication?** | - Scheduling of data provision requests<br>- Data collection during workshops<br>- After action reviews (feedback forms) | **- How to gather the data that is needed**<br><br>- Questionnaires, interviews or other process to collect data<br><br>**- How will we report the results?** |
| **Primary Involvement** | **Quantitative & Qualitative Data** | **Events / Interventions** | **Evaluation Mechanisms** |
| BIPED Partners<br><br>**Second Involvement:**<br><br>Identified External Stakeholders (NGO, Academic, Public, Enterprise) | **What datasets are available to the project?**<br><br>**How is project KPI data captured?**<br><br>**Where is it stored? (Google Drive, SCM-SRT)**<br><br>Challenges, lessons learned, solutions and recommendations | Process for collection of data for the lifespan of the project<br><br>Feedback on events and activities within Aarhus<br><br>Event calendar to allow project consortium to track activities | Recurring meetings to foster collaboration within data collection meetings<br><br>Series of data collection sheets / event feedback forms<br><br>Use of information and dissemination within the project consortium (management meetings, WP specific meetings) and |

| | | | |
|---|---|---|---|
| | emerging from project initiatives | Mechanism to ensure recurring assessment of activities/initiatives | externally (project website and social media channels)<br><br>Reporting formats (flyers, reports, fact sheets) |

Table 4: Pillars of the Qualitative Data Evaluation Framework

Through the co-creation principles discussed in this deliverable, a process for assessing and evaluating qualitative data has been developed. To streamline access, relevant materials and documentation are centralised in a designated location within the project's documentation repository (Google Drive), allowing partners to refer to them prior to reporting on project activities. Subsequent subsections offer detailed descriptions of various evaluation methods proposed. Partners have the flexibility to employ any combination of these methods in their evaluation, with resulting outcomes documented and stored in the repository for future review and assessment.

## 4.3. Qualitative Workshops: BIPED Evaluation Forum (BEF)

The qualitative workshops with internal project stakeholders will serve as a vital source for consolidating perspectives and insights gathered throughout the lifespan of the project. By engaging internal project stakeholders in the qualitative data review process, KPMG will ensure a comprehensive understanding of the project's successes, challenges and areas for improvement. This collaborative approach will enhance buy-in and alignment towards the project's objectives and KPIs.

Various forms of engagement, such as interviews, learning sessions, informal discussions, and similar workshops, can serve as sources of data and information, as well as platforms for their review. The qualitative workshops will function as a tool for partners to evaluate interventions and validate or expand upon feedback received following intervention evaluations. Targeted workshops will focus on reviewing evaluation findings, allowing partners to elaborate on feedback provided, address any ambiguity, or provide additional context to project activities and reported information. The workshop will involve facilitated discussions, thematic analysis, identification of challenges and interpretation of qualitative data allowing stakeholders to identify actionable recommendations. These sessions will also provide an opportunity for partners to discuss and refine project and intervention guidelines and recommendations, ensuring clear and concise messaging that informs decision-making regarding the replication of the interventions.

## 4.4 Activity Evaluation Form

WP4 aims to assist partners in recording qualitative data from project interventions and activities. In order to record this data, Activity Evaluation Forms (AEFs) have been created by KPMG (Annex 1) which will be used by all partners when evaluating activities and

interventions within the project. The role of the form is to gather information from primary sources before a one-to-one discussion with partner/s responsible for the activity/intervention to obtain a greater understanding of the finer details of the intervention, how it was conducted, lessons learned, unforeseen challenges which arose and the future sustainability of the intervention. Following on from the one-to-one discussion, the feedback form and findings will be presented in the wider BEF. This will also allow for feedback and suggestions from the BIPED consortium for potential improvements on how the interventions are being implemented and how to tackle existing challenges.

The feedback form, co-created with WP3, sets out a format for intervention reporting under four headings: *i) Title and abstract, ii) Methods, iii) Results/Findings and iv) Discussion*. The form has been refined within Work Package specific meetings (WP3 and WP4) to adapt to the partners needs and requirements in their attempts to capture and effectively report data from interventions and activities. The form offers a streamlined structure for partners to input information on project activities across four categories: Title, Methods, Results and Findings, and Discussions. These headings provide clarity and guidance on the type of feedback expected from partners responsible for interventions. The headings assist in identifying the activity or intervention being evaluated (Title), how partners assessed the activity (Methods), and the key insights and findings (Results and Findings, and Discussions). Notably, the Results and Findings, and Discussions sections prompt feedback on highlighted findings, successes, challenges, solutions, and recommendations. While some project activities already have reporting structures, meeting minutes, or learning sessions, the aim of the Feedback Form is to offer partners an optional format for easily transferring information from other reports. Further refinement of the Feedback Form is expected through collaboration with the project partners as activities/interventions progress.

## 4.5 Interaction between Qualitative and Quantitative Data for Evaluation

The evaluation process encompasses an analysis of both qualitative and quantitative data. The examination of both quantitative and qualitative data will identify potential gaps in the understanding and project data for evaluation purposes. Quantitative data within the KPI framework is compiled by KPI owners through the implementation of project interventions and, in certain instances, derived from extensive sets of raw measurement data. This quantitative dataset offers a measure of the performance of interventions and the overall progress achieved. This quantitative perspective on progress is complemented by qualitative data provided by partners. The alignment of KPIs with the qualitative evaluation process ensures that qualitative data received during evaluation offers contextual insights into the reported quantitative figures.

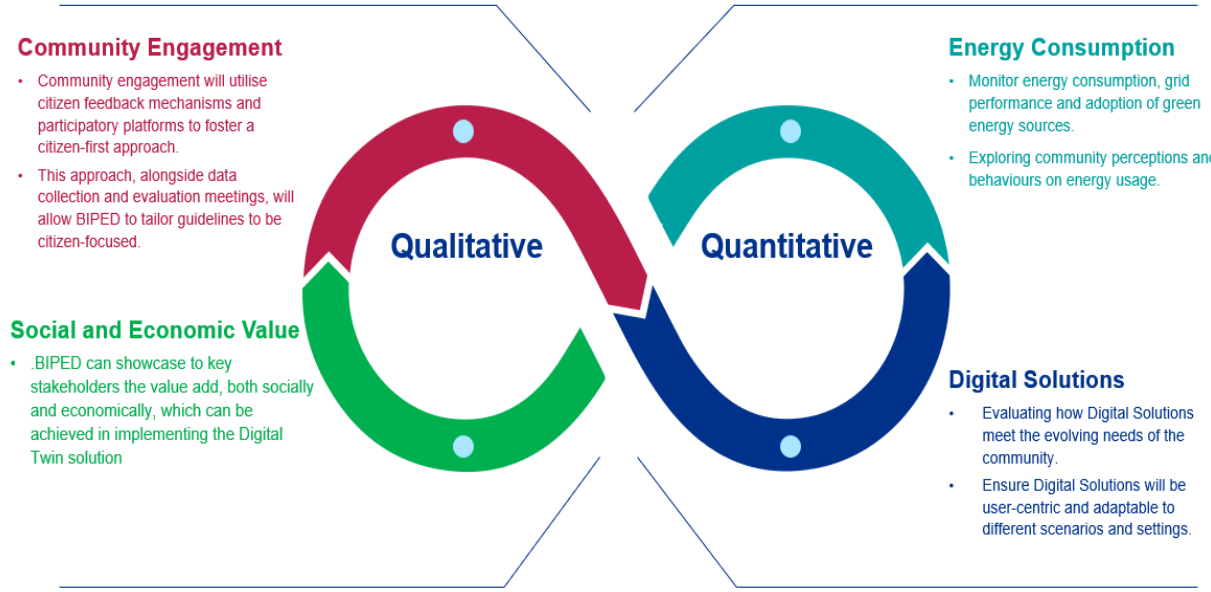


Figure 3: Themed KPIs Interaction

The themed KPI approach (Community Engagement, Social and Economic Value, Energy Consumption and Digital Solutions), used in the qualitative and quantitative strands will evaluate the effectiveness of project interventions, as well as performance and impact. The interaction between the qualitative and quantitative aspects of the M&E, tasks which will be undertaken in BIPED involving citizen interaction, stakeholder engagement and the effects of the project's interventions on people's daily lives and their acceptance and participation will be considered.

# 5. Project KPIs

## 5.1 Developing the Project KPIs

The BIPED KPIs were developed by KPMG in collaboration with subject experts and Work Package leads. In relation to the Community Engagement and Policy Context themed KPIs, these KPIs were developed in collaboration with WP3 (AAKS). For the digital solutions and energy consumption KPIs, these KPIs are currently being developed in collaboration with WP2 (AIT), specifically the pending outputs of T2.6 and related T2.2-T2.4 and the final description, targets and calculations will be confirmed in the next iteration of this deliverable (D4.3). The KPIs have been developed in order to identify the extent of and responsibility of individual task responsibilities within the BIPED project and Work Packages.

## 5.2 KPI Data Management

Data collation is described as the process of assembling and summarising data points from a single or multiple data sources over a period of time (Macueve, 2007).

As discussed in Section Three, the KPI data will be summarised according to the KPI type as defined in the M&E themes. This summarisation will group monitoring data from the KPIs into themes as defined for the project.

- Community Engagement
- Policy Context
- Energy Consumption
- Digital Solutions

Community engagement will utilise citizen feedback mechanisms and participatory platforms to foster a citizen-first approach. This approach, alongside the BEF, will allow BIPED to tailor guidelines to be citizen-focused. As part of M&E, we will track local, national and EU level policy developments in collaboration with partners. BIPED will assess current and upcoming regulatory frameworks and evaluate their role in the development of smart cities. KPIs under the energy consumption theme will monitor energy consumption, grid performance and adoption of renewable energy sources. Exploring community perceptions and behaviours on energy usage. Digital Solutions KPIs will evaluate how Digital Solutions meet the evolving needs of the community. The M&E of these KPIs will ensure Digital Solutions will be user-centric and adaptable to different scenarios and settings.

## 5.3 FAIR Data Handling

Through the utilisation of a DMP for BIPED the European Commission states that project data should be handled in a Findable, Accessible, Interoperable and Reusable (FAIR) manner (EC, 2016). In The FAIR Guiding Principles for scientific data management and stewardship, Wilkinson et. al 2016 described FAIR principles as follows:

| | |
|---|---|
| Findable | ● Data is registered in a repository where it can be accessed and given unique identifiers.<br>● Metadata will be captured for each KPI.<br>● The metadata will describe the unique identifiers, for example, KPI technical experts, which will identify the data points captured. |
| Accessible | ● Data should be made accessible via a free and open mechanism.<br>● The protocol must include authentication procedures where certain data should be available only through controlled access (e.g. subscription/registration). |
| Interoperable | ● Data should be presented in a format that has multiple functions<br>● Data can be downloaded in suitable formats. This can ensure further processing and analysis within other platforms. |
| Reusable | ● The data that is shared should be checked to guarantee accuracy and as well as adherence to universal standards.<br>● The use of data should be clearly licensed and indicate user permissions as agreed upon by the project consortium.<br>● Creative Commons licences are applied to allow the use of data and creation of products/services, while prescribing the necessary acknowledgement of such use. |

Table 5: FAIR Data Principles

## 5.4 KPI Outlines

| KPI No. | Name | Description | KPI Group | Target | Reporting Frequency |
|---|---|---|---|---|---|
| 1 | Number of community participation events organised/coordinated | The role of community participation events is to enable local communities to have a greater understanding of the Digital Twin solution. Community participation events refer to events such as learning workshops, joint exhibitions or event participation and other events promoting the project and its outcomes. By tracking the community participation events and evaluating their outcomes, you can gauge the level of community engagement within the project and make informed decisions to enhance participation and collaboration. | Community Engagement | 10 | Quarterly |
| 2 | Number of Co-Creation & Training Workshops | BIPED will conduct a number of co-creation & training workshops which will involve key stakeholders identified by AAKS. The co-creation workshops Co-will focus on collaborating with key stakeholders to guide the design process of the Digital Twin solution and other BIPED interventions. The training workshops will be commenced upon completion of the Digital Twin solution and will involve the same key stakeholders and train them in the use of the Digital Twin solution. | Community Engagement | 3 | Bi-Annual |

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| | | | | | |
|---|---|---|---|---|---|
| 3 | Workshop participants | By systematically measuring stakeholder engagement through workshops and evaluating participation levels, engagement, and outcomes, you can assess the effectiveness of your engagement efforts and ensure that stakeholder perspectives are considered in project decision-making and implementation. | Community Engagement | 400 | Quarterly |
| 4 | Networks/Associations Targeted | Through engagement with smart city networks such as SCC1 Monitoring & Evaluation Task Group, BIPED can engage with networks and associations focusing on smart city and digital twin projects which share common goals and objectives. Engaging with these networks/associations will give BIPED expertise into digital twin/smart city experiences which will help the project navigate potential challenges. | Community Engagement | 30 | Quarterly |
| 5 | EU Cities Engaged | BIPED will showcase the digital solution and engage with 100 cities via the Net Zero Cities project supporting the EU's Mission of "100 Climate-Neutral and Smart Cities by 2030" newly-launched as part of the Horizon Europe programme. The project works as a service-oriented platform supported by world-class practitioners. It helps European cities by providing them with the support and solutions they need to achieve their Net Zero goals. | Community Engagement | 100 | Bi-Annual |

| | | | | | |
|---|---|---|---|---|---|
| 6 | Joint Actions with 'Sister Projects' | Through participation in smart city networks such as SCC1 Monitoring & Evaluation Task Group, BIPED can engage with 'sister projects' in the digital twin/smart city sphere. Through this network, BIPED can carry out joint actions with 'sister projects' for the digital twin solution By systematically measuring joint actions with other projects, BIPED can evaluate collaboration in terms of alignment, impact, benefits, challenges, and lessons learned when implementing a digital twin solution across different environments/settings. | Community Engagement | 3 | Bi-Annual |
| 7 | Increased Citizen Understanding and Awareness of the potential of Digital Twin projects | This KPI aims to measure the initial citizen awareness of digital twins and the nature of how they operate. Through the lifecycle of the project, BIPED will aim to raise this awareness through bi-annual workshops, focus groups and questionnaires with citizens and track the potential increase in awareness via BIPED's efforts and the wider digital twin landscape and awareness of the potential socio-economic impacts of the digital twin solution. | Community Engagement | 3 (On Likert Scale 1-5) | Bi-Annual |
| 8 | Policy Results Downloads | This will involve monitoring the volume of downloads of policy documents and project deliverables which are accessible to the public from the BIPED website. | Community Engagement | 500 | Bi-Annual |

| | | | | | |
|---|---|---|---|---|---|
| 9 | Media Coverage (News Articles, News Videos) of BIPED Project | KPI Nine assesses the frequency and breadth of media attention, reflecting the project's visibility and public awareness, vital for garnering support and replicability of the Digital Twin solution | Community Engagement | 10 | Bi-Annual |
| 10 | Usability of the Digital Twin Solution for End Users | The extent to which the solution is perceived as difficult to understand and use for potential end-users. It is presumed that a smart city solution that is easy to use and understand will be more likely adopted than a difficult solution. | Community Engagement | TBD | Bi-Annual/Annual |
| 11 | Number of Aarhus City Council Staff Trained to use the Digital Twin | This KPI tracks the training of the developed digital twin through the number of city council staff that have received training for the tool. The staff trained will be able to operate the digital twin and its functions to assist with analysis of and reporting on project implementation, baseline development feasibility studies and general use. | Energy Consumption | 40 | Annual |
| 12 | Tonnes of $CO_2$-equivalent emissions reduction per year via utilisation of the Digital Twin solution | The indicator measures the reduction in $CO_2$-equivalent emissions as a result of the use of the Digital Twin Solution developed by the BIPED project. The reduction is based on the $CO_2$-equivalent emission baseline compared to the reduced emission through the Digital Twin. The reduction is based on the $CO_2$-equivalent emissions calculated through measurements and models for the different constituent components as detailed in the BEST tables. | Energy Consumption | TBD | Annual |
| 13 | Number of stakeholders/buildings/assets | This KPI tracks the uptake of the market by the number of stakeholders/buildings which are able | Energy Consumption | TBD | Bi-Annual |

| | | | | | |
|---|---|---|---|---|---|
| | utilising the Digital Twin Solution | and technically equipped to adopt the digital twin solution. | | | |
| 14 | Progress towards development of a PED | In collaboration with WP2, KPMG will develop a methodology for measuring the progress towards development of a PED. This KPI will be updated in the next iteration of this deliverable. | Energy Consumption | TBD | Annual |
| 15 | Energy Savings for Key Stakeholders via Implementation/Uptake of the Digital Twin Solution | The reduction of the energy consumption to reach the same services (e.g., comfort levels) after the implementation/uptake of the Digital Twin solution, taking into consideration the energy consumption from a reference period. | Energy Consumption | TBD | Bi-Annual |
| 16 | Improved Interoperability of the Digital Twin Solution | Interoperability is the ability of a system (or product) to work with other systems by providing services to and accepting services from other systems and to use the services so exchanged to enable them to operate together (ISO/TS 37151). The indicator assesses the improvement in interoperability in a qualitative manner. | Energy Consumption | TBD | Bi-Annual |
| 17 | Increase in Local Renewable Energy Generation via implementation of the Digital Twin Solution | The share of Renewable Energy production in itself gives an idea of the rate of self-consumption of locally produced energy, which is an indicator of the flexibility potential of the local energy system. The indicator accounts for the increase of renewable energy generation due to the intervention. | Energy Consumption | TBD | Quarterly |
| 18 | Demonstrations of the Digital Twin Solution/Platform | By systematically measuring demonstrations held of the Digital Twin and evaluating feedback and impact, you can assess the effectiveness of the | ICT Digital Solutions | TBD | Quarterly |

| | | | | | |
|---|---|---|---|---|---|
| | | solution and refine the solution to ensure an interoperable solution. | | | |
| 19 | Datasets Published | Publication of open datasets for use by third parties. | ICT Digital Solutions | 5 | Bi-Annual |
| 20 | Models Linked to PED Published | Publication of models for use by third parties. | ICT Digital Solutions | 3 | Bi-Annual |
| 21 | Usage of Open Source Software and Solutions | The use of open source software and solutions means less possibilities of vendor lock-in and more space for communities to develop smart city solutions. It also lowers the software costs. | ICT Digital Solutions | TBD | Quarterly |
| 22 | Quality of Open Data | Percentage of data that uses DCAT standards. The quality of open data is better if standardised. Processes get easier when data standards are applied. The DCAT standard allows municipal employees to produce data in a standardised way. | ICT Digital Solutions | TBD | Quarterly |
| 23 | Soft Datasets Integrated | Capture and integrate soft (intangible) data into the BIPED Digital Twin platform which goes beyond tangible energy and mobility sources to better understand how spaces and policies affect people's behaviours etc. | ICT Digital Solutions | TBD | Quarterly |

Table 6: BIPED Key Performance Indicators

This section will be updated in D4.3 to reflect energy based and ICT Digital Solution KPIs which are currently being developed in collaboration with AIT as part of WP2.

## 5.5 KPI Data Collation and Reporting

KPMG, working in collaboration with AAKS and AIT, KPI owners and KPI technical experts will determine which deliverables can be reviewed to gather qualitative and quantitative information in regards to the KPIs and lessons learned and evaluated activities. KPMG will also engage on a monthly basis with partners via the data collection meeting on the development and improvement of the M&E framework and methodology which will lead to a greater collation and evaluation process based on the co-creation principles of the M&E framework. The insights gained from the review of deliverables will be presented to partners in the data collection meeting and wider management meeting to allow partners to discuss the process behind the interventions, the lessons learned and challenges experienced in greater detail.

The qualitative data evaluation process will commence with the beginning of the first project interventions and activities related to KPIs, which will provide an initial outlook on qualitative data sourcing and collation. Further refinement will continue throughout the lifetime of the project. Reporting on this refinement will be highlighted in the next iteration of this deliverable D4.3. Paired with the quantitative data, qualitative insights from the M&E process will be reviewed to provide insight and recommendations from interventions within BIPED.

# 6. Conclusion

Deliverable 4.1 provides a co-created M&E framework and associated reports, forming a critical component of WP4 for BIPED. The deliverable concentrates on Task 4.1, which is pivotal for devising a robust M&E plan encompassing qualitative and quantitative data collection and comprehensive project data validation. D4.1 articulates the formulation of a M&E framework, specifically tailored to meet the unique needs of the BIPED project. This framework integrates both qualitative and quantitative data collection methodologies, thereby ensuring a holistic perspective on project performance and impact. A cornerstone of this framework is the monthly workshops and forums which serve as a platform for collecting diverse data inputs from project consortium members and KPI owners. The documentation of quantitative data through KPI Sheets ensures a systematic and clear overview of project metrics and performance indicators, thereby facilitating precise data assessment and evaluation. Simultaneously, qualitative data, which will capture the project implementation and stakeholder engagement, is collected through the AEF. These forms are instrumental in capturing insights, feedback, and perceptions from various stakeholders, thereby enriching the quantitative data with qualitative depth and context.

The systematic approach established by the M&E framework is designed to continuously assess project effectiveness, identify areas for improvement, and ensure that project activities remain aligned with the overarching goals and objectives of BIPED. By leveraging a comprehensive evaluation strategy that combines both qualitative and quantitative methods, the framework supports informed decision-making and effective project management. This dual approach also facilitates the population of the Smart City Information System's Self Reporting Tool, ensuring accurate and consistent collection of KPI data throughout the project's duration.

Furthermore, the M&E framework provides the foundational scope and direction necessary for the Assessment Framework. This framework operationalises a series of testing cycles conducted every six months, designed to rigorously evaluate the solutions in various environments. Based on this bi-annual assessment project KPIs, KPI descriptions and calculations will be evaluated and assessed. Based on this assessment, KPIs may be adjusted in order to adapt to ensure greater data collection and actionable insight. The inclusion of both local and external stakeholders and end-users in these testing cycles ensures that the solutions are comprehensively assessed for compliance and alignment with BIPED's KPIs. By collaborating with consortium partners and adhering to best practices in M&E and assessment procedures, the testing cycles are poised to deliver reliable and actionable insights.

Building on this deliverable in M12 of the project, D4.3 will showcase the development of the M&E Framework and KPIs in establishing a number of metrics and parameters that need to be monitored which fall under the theme of Social and Economic Value Add. These metrics will explore potential KPIS on capital expenditure (CAPEX), operational costs (OPEX), expected and substantiated reductions of energy, CO2 etc and the returning derivatives; price of energy reduction per volume, price of CO2 reduction per volume, energy forgone for other uses, i.e. shadow investment need introduced from computing needs of the LDTs, local democratic and social returns and integration of Economic, Social, Governance (ESG)

targets. Upon defining the metrics and parameters baseline and design data will be fully defined for M&E purposes.

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# 8. Annex

## Annex 1: Activity Evaluation Form (AEF)

| Number | Topic | Item | Answer |
|---|---|---|---|
| Title & Abstract | | | |
| S1 | Project Activity Title | Name of Activity | |
| S2 | Activity Description | Brief Description of the Project Activity | |
| S3 | Motivation and Rationale | Purpose of the intervention, issues addressed by the intervention | |
| S4 | Project partners and WP involved | List of all partners involved in the activity | |
| S5 | Relevant KPI | KPI Number | |
| S6 | Attendance Numbers (if applicable) | | |
| Methods | | | |
| S7 | Data Collection | Description of instruments (e.g. interview guides questionnaires, minutes) | |
| S8 | Quantitative Data Collection | Any data captured for KPI or monitoring purposes and provide link if available | |
| S9 | Qualitative Data Collection | Any descriptive data/information captured with regards to the project activity - challenges, solutions, experience etc. | |

| | | | |
|---|---|---|---|
| | | (Provide link if available) | |
| S10 | Data Processing | Methods for processing data prior to and during analysis, including transcription, data entry, data management - where is the data captured/stored? How can it be accessed for M&E purposes? | |
| S11 | Opportunities (Methods) | Did any method or practise you employed led to a better outcome, or caused any difficulties? | |
| Results/Findings | | | |
| S12 | Challenges Faced | Brief description of challenges / stumbling blocks / unforeseen issues | |
| S13 | Solutions developed (or under development) | Brief description of how the above mentioned were addressed | |
| Discussion | | | |
| S14 | Key insights highlighted | Summarised (qualitative) evaluation of the activity/event. What were the key insights highlighted? Key questions/issues raised? Key solutions developed? | |
| S15 | Key recommendations for replication of activity | How can things be improved for future activities of the same kind? Apart from this activity, how can other | |

| | | | |
|---|---|---|---|
| | | activities under the same theme benefit from the key insights highlighted? | |
| S16 | Next Steps | What still needs to be addressed, and how would it contribute to the success of the activity/intervention? | |
| S17 | Relevant documentation / deliverable | Has this project been explained/described in a document/deliverable? | |
| S18 | Sustainability | Is this activity something you are planning to continue after BIPED finishes? And why? | |

# Annex 2: KPI Data Collection Sheet

| Classification & KPI Information | Example Input Fields |
|---|---|
| Theme | |
| KPI Number | |
| Definition | |
| KPI Owner | |
| KPI technical expert | |
| Data Type and Format | |
| Data Source/Provenance | Existing data - third party provided / Existing data owned by BIPED partner / New data to be collected by a BIPED partner |
| Unit of Measurement | |
| Scope | |
| Year of Data | |
| Considerations | |
| Expected Impact / Target | |
| KPI Share | |
| Size | |
| Data utility outside BIPED | |
| Quality and Validity | |
| Statistics Data | |
| ISO Applied | |
| Lineage | |
| Disclosure Control Methods (e.g. GDPR) | |
| Quality Issues | |
| KPI Owner / Organisation | |
| Organisation Name | |

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| | |
|---|---|
| Email Address | |
| Responsible Party Role | |
| Telephone Number | |
| Resource Locator | |
| KPI Owner Approval | |
| Data Owner / Organisation | |
| Organisation Name | |
| Email Address | |
| Responsible Party Role | |
| Telephone Number | |
| Resource Locator | |
| Where stored | |
| Additional Solutions Providers / KPI technical experts | |
| Organisation Name | |
| Email Address | |
| Responsible Party Role | |
| Telephone Number | |
| Resource Locator | |
| Temporal | |
| Temporal Extent | |
| Frequency of Update | |
| Frequency of SCIS Update | |
| Dataset Reference Date | |
| Planned Date of Implementation | |
| Actual Date of Implementation | |
| Monitoring Start Date | |
| Geographic | |

| | |
|---|---|
| Geography / Spatial Scale | |
| Spatial Reference System | |
| Location | |
| Data Provider and Constraints | |
| Limitations on Public Access | |
| Use Constraints | |
| Licence Type | |
| Data Provider Name | |
| Email Address | |
| Telephone Number | |
| Resource Locator | |
| Where stored | |
| Conformity | |
| Conformity | |
| Metadata | |
| Metadata Date | |
| Metadata Language | |
| Metadata Point of Contact | |
| Unique Resource Identifier | |
| Resource Type | |
| Dataset Language | |
| Search Keywords | |
| Interoperability Best Practice | |
| Vocabularies / Ontologies | |
| GDPR | |
| Personal Data | Yes/No |
| Special categories of personal data | (personal data revealing racial or ethnic origin, political opinions, religious or philosophical beliefs, or trade union membership, and the processing of genetic data, biometric data for the purpose of uniquely identifying a |

| | |
|---|---|
| | natural person, data concerning health or data concerning a natural person's sex life or sexual orientation) |
| Mixed data | (personal and non-personal data in one dataset) |
| Anonymisation/ pseudonymisation | (personal and non-personal data in one dataset) |
| Artificial Intelligence | |
| AI elements in the model/tool | yes/no, describe |
| Data used to train a model | yes/no, describe |
| Ethical | |
| Ethical considerations/limitations | |
| Envisaged combination with other data/sets/models | |

# Annex 3: KPI Data Dictionary

| Term | Definition |
|---|---|
| Scope | The extent of the area or subject matter that something deals with. |
| Theme | The relevant project theme |
| KPI Number | A unique identifier for a specific Key Performance Indicator (KPI). |
| Definition | A clear and precise description of the KPI. |
| KPI Owner | The KPI owner takes the lead in the implementation, testing and monitoring of the project interventions. The KPI owners use the KPI framework created for the BIPED project to ensure that interventions are recorded and made available for analysis. The KPI owner will agree to the definition, description and calculation method of the KPIs, in cooperation with WP4. The KPI owner is responsible for implementing measures which will enable data to be captured, and providing this data in a suitable and agreed upon format, for example the M&E quantitative and qualitative data collection sheets, for reporting within the WP4 deliverables/updates and overall project reporting<br><br>KPI owners are responsible for the completion of the data collection sheets according to the agreed upon reporting frequencies for each KPI and the partner responsible for the management and update of the SRT. Throughout the BIPED project the KPI owners will review the accuracy of data recorded and issue recommendations to the project consortium for adjusting the KPI definition and KPI calculations. |
| KPI technical experts | KPI technical experts are parties that act as complementary partners to KPI owners. KPI technical experts are specialists in their area/sector and provide technical support, tools and data to KPI owners which will assist in implementing project interventions. This support will contribute to the achievement of the KPI as well as providing trusted information which allows KPI owners to monitor and report on the data.<br><br>KPI technical experts are responsible for the management of data from project interventions. KPI technical experts have the responsibility to handle data according to the Data Management Plan (DMP) and ensure that the handling of data adheres to best practice in data governance in accordance with protocols from Horizon |

| | |
|---|---|
| | Europe. |
| Data Type and Format | the data type (e.g. number, percentage etc) and how the data is presented in a certain format (e.g. CSV) |
| Data Source/Provenance | The origin of the data or where it was obtained. |
| Unit of Measurement | The standard unit in which the KPI is measured. |
| Associated Demonstration Project | A project/event that demonstrates the KPI in action. |
| Year of Data | The year in which the data was collected |
| Considerations | Factors or aspects that should be taken into account. |
| Expected Impact / Target | The anticipated impact of the KPI and the target to be reached. |
| KPI Share | The portion or percentage of the KPI that is shared across KPI owners. |
| Size | The magnitude or extent of the KPI or data. |
| Data Utility Outside BIPED | The usefulness or applicability of the data beyond the BIPED framework. |
| Quality and Validity | The degree to which the data is accurate, reliable, and valid. |
| Statistics Data | Data that has been collected for statistical analysis. |
| ISO Applied | Whether or not International Standards Organization (ISO) standards have been applied. |
| Lineage | The history or lifecycle of the data, including where it originated and |

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|---|---|
| | how it has been altered over time. |
| Disclosure Control Methods (e.g. GDPR) | Methods used to control the disclosure of data, such as those outlined in the General Data Protection Regulation (GDPR). |
| Quality Issues | Any problems or issues related to the quality of the data. |
| KPI Owner / Organisation | The organisation that the KPI owner belongs to. |
| Organisation Name | The name of the organisation. |
| Email Address | The email address of the contact person in the organisation. |
| Responsible Party Role | The role of the person responsible for the data or KPI. |
| Telephone Number | The contact telephone number of the responsible party. |
| Resource Locator | The location where the resource can be found, often a URL. |
| KPI Owner Approval | Whether or not the KPI owner has approved the data or KPI. |
| Data Owner / Organisation | The organisation that the data owner belongs to. |
| Where Stored | The location where the data is stored. |
| Additional Solutions Providers | Any additional organisations providing solutions related to the data or KPI. |
| Temporal | Pertaining to time-related aspects of the data or KPI. |
| Temporal Extent | The time period that the data covers. |

| | |
|---|---|
| Frequency of Update | How often the data is updated. |
| Frequency of SCIS Update | How often the Smart Cities Information System (SCIS) is updated. |
| Dataset Reference Date | The date that the dataset refers to. |
| Planned Date of Implementation | The date when the implementation of the KPI or data usage is planned. |
| Actual Date of Implementation | The date when the implementation of the KPI or data usage actually occurred. |
| Monitoring Start Date | The date when monitoring of the KPI or data began. |
| Geographic | Pertaining to geographical aspects of the data or KPI. |
| Geography / Spatial Scale | The geographical area that the data covers. |
| Spatial Reference System | The coordinate system used to define geographical data. |
| Constraints | Any limitations or restrictions on the data or KPI. |
| Limitations on Public Access | Any restrictions on the public's access to the data. |
| Use Constraints | Any restrictions on how the data can be used. |
| Licence Type | The type of licence that governs the use of the data. |
| Conformity | Whether the data conforms to certain standards or expectations. |
| Metadata | Data that provides information about other data. |

| | |
|---|---|
| Metadata Date | The date when the metadata was created or last updated. |
| Metadata Language | The language in which the metadata is written. |
| Metadata Point of Contact | The person or organisation to contact for more information about the metadata. |
| Unique Resource Identifier | A unique identifier for the resource, often a URL. |
| Resource Type | The type of resource, such as a dataset, image, document, etc. |
| Dataset Language | The language in which the dataset is written. |
| Search Keywords | Keywords used to search for the data or resource. |
| Interoperability Best Practice | Best practices for ensuring that systems can work together (interoperate). |
| Vocabularies / Ontologies | Standardised vocabularies or ontologies used in the data. |
| GDPR | Pertaining to the General Data Protection Regulation, a regulation in EU law on data protection and privacy. |
| Personal Data | Data that relates to an identifiable individual. |
| Special Categories of Personal Data | Categories of personal data that are considered sensitive under the GDPR or similar. |
| Mixed Data | Data that includes a mix of different types of data. |
| Anonymisation/Pseudonymisation | The process of making data anonymous or pseudonymous to protect privacy. |
| Artificial | The use of artificial intelligence in relation to the data or KPI. |

| | |
|---|---|
| Intelligence | |
| AI Elements in the Model/Tool | Specific elements of artificial intelligence used in the model or tool. |
| Data Used to Train a Model | The data used to train a machine learning model. |
| Ethical | Pertaining to ethical considerations in relation to the data or KPI. |
| Ethical Considerations / Limitations | Any ethical considerations or limitations related to the data or KPI. |
| Envisaged Combination with Other Data/Sets/Models | Any plans to combine the data with other datasets or models. |