

D5.3 SUSTAINABILITY STRATEGY

Initial BIPED Sustainability Strategy





Project name	BIPED: Building Intelligent Positive Energy Districts
Duration	January 2024 – December 2026
Project ID	101139060
Coordinator	Technical University of Denmark
Type of action	Innovation Action
Call ID	HORIZON-MISS-2023-CIT-01
Website	https://www.bi-ped.eu/
Document name	D5.3: Sustainability Strategy
Document status	Final Draft
Delivery date	30/04/2025
Dissemination	Public
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**Funded by
the European Union**

BIPED is funded under the EU Horizon Europe Research and Innovation programme. Grant ID: 101139060. Every effort has been made to ensure the accuracy of information provided in this document, which reflects only the authors' views. The European Commission is not responsible for any use that may be made of the information contained herein. Credits: cover image from [Adobe Stock](#).

Document history

Version	Date	Contributor	Description
0.1	20.02.2025	John Sheils, Anna Yankulova (KPMG FA)	First draft
0.2	11.04.2025	John Sheils, Anna Yankulova (KPMG FA)	Draft for Internal Review
0.3	16.04.2025	Pavel Kogut	Internal Review
0.4	22.04.2025	Arne Schilling (VCS)	Internal Review
0.5	25.04.2025	Ivy Yang (OASC)	Internal Review
0.6	28.04.2025	John Sheils, Anna Yankulova (KPMG FA)	Second Draft incorporating feedback from internal reviewers
1.0	30.04.2025	John Sheils, Anna Yankulova (KPMG FA), Arne Schilling (VCS), Ivy Yang (OASC), Pavel Kogut (DRI)	Submitted to Coordinator for Upload

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List of Abbreviations

Abbreviation	Full Term
BIPED	Building Intelligent Positive Energy Districts
EPO	European Patent Office
EUIPO	European Union Intellectual Property Office
FP	Framework Programme
HRB	Horizon Results Booster
IP	Intellectual Property
IPR	Intellectual Property Rights
KER(s)	Key Exploitable Result(s)
M&E	Monitoring and Evaluation
MIMs	Minimum Interoperability Mechanisms
MOU	Memorandum of Understanding
OUP	Open Urban Platform

PEDs	Positive Energy Districts
SaaS	Software as a Service
SCC	Smart Cities and Communities
TG	Task Group
TRL	Technological Readiness Level
UVP	Unique Value Proposition

Executive summary

This deliverable presents the initial iteration of BIPED's sustainability strategy, offering a preliminary description of the project's Key Exploitable Results (KERs), their prospective exploitation pathways, with a particular emphasis on replicability, scalability, and initial intellectual property rights (IPR) considerations. The document is structured into seven main chapters.

The first and second sections provide an overview of the exploitation and sustainability of BIPED's KERs, detailing the methodology behind the strategy and its building blocks. Section three sets the context of the current Digital Twin landscape, exploring the future potential and applications of the BIPED Digital Twin, particularly within the energy and mobility sectors, which are pivotal for the digital twin models.

Section four highlights the exploitable foreground, delving into the contextualisation of the digital twin solution and outlining the approaches BIPED will employ. Section five discusses the technology readiness level (TRL) of the digital twin models, identifying the necessary steps for their replicability and scalability. This effort will be further substantiated over the coming months through the Horizon Results Booster (HRB) initiative, which commenced in March 2025.

The anticipated impact of BIPED's digital twin is detailed in section six, which outlines the pathway to exploitation, emphasising the expected benefits and transformative effects. This section provides a roadmap for scaling and replicating the technology, demonstrating how the digital twin can drive innovation, enhance operational efficiency, and contribute to sustainable development across various sectors. It also identifies key stakeholders and end users, as identified by WP4, in conjunction with the pilot work conducted by WP3 (AAKS) in Aarhus, through ongoing stakeholder mapping and the establishment of the Positive Energy District (PED) community. These engagement methods ensure integrated feedback, facilitating a replicable and scalable digital twin.

The final section of the deliverable covers the conclusion and next steps of the project, which involve refining the sustainability strategy, engaging further with the Horizon Results Booster initiative, and gathering feedback from stakeholders and end users. These actions will collectively ensure the successful uptake and impact of BIPED's digital twin solution, driving innovation and sustainable development beyond the city of Aarhus.

1. Introduction

This deliverable presents the first iteration of BIPED's Sustainability Strategy, focusing on three KERs: the BIPED Digital Twin Solution, the BIPED Impact Assessment Roadmap, and the BIPED Handbook with Recommendations for Transition. These KERs have been discussed as part of the Horizon Results Booster initiative, which aims to ensure their sustainability and uptake beyond the project's lifespan. The strategy outlines potential opportunities for commercial, political, scientific, educational, and societal exploitation of the KERs, and identifies methods to maximise the project's impact across key end user groups. It incorporates the latest market, policy trends, and EU initiatives, detailing multiple pathways to sustainability. While the three KERs will be the focal point of the sustainability strategy, other results and their impact will also be considered in the final iteration as part of the BIPED legacy.

The deliverable provides an initial plan for the exploitation of the KERs, including an introduction to the current landscape for digital twins, which BIPED ultimately aims to contribute to. This strategy will be further developed throughout the project's lifespan, culminating in D5.8 in month 36 of the project. As of M16 of the project, the strategy faces several limitations including the uncertainties around the models development and their expected TRLs, in-depth considerations around their deployment through the open source data hub (managed by DKSR), and overall IPR associated with this effort. These will be the main development points to be carried out through T5.3 and T5.4 over the next months, ensuring that the strategy evolves to meet the project's goals and maximise the impact of the digital twin solution.

To maximise the impact and adoption of BIPED's digital twin solution, various tactics will continue to be employed by the BIPED consortium, including showcasing demonstrations at conferences and community centres, conducting hands-on workshops, offering interactive webinars as part of an online course. Additionally, proof-of-concept virtual PEDs will be developed for cities aiming to manage energy transitions using digital twins. These pathways will cover commercial and policy-oriented approaches, societal and technical strategies, as well as scientific and standards-oriented methods, such as Minimum Interoperability Mechanisms (MIMs). By utilising these diverse tactics, BIPED aims to ensure a comprehensive and effective exploitation strategy that fosters innovation and sustainable development across various sectors.

The strategy ensures a coordinated approach that contributes to the sustainability and uptake of the BIPED Digital Twin Solution, the Impact Assessment Roadmap, and the Recommendations Handbook. BIPED's core objective is to build an extended digital twin that explores properties describing PEDs in a holistic manner (environmental, social, and economic) for Brabrand. The BIPED digital twin will provide a virtual urban space to simulate and model real-time data and scenarios, aiding in evidence-based decision-making and creating district development pathways with a clear timeline for associated transformation actions.

Sustainability activities have commenced with the Horizon Results Booster engagement, which has assisted BIPED in identifying appropriate KERs, both commercial and non-commercial, for exploitation. Further engagement with the Horizon Results Booster will involve the Go to Market Module and Unique Value Proposition & Key Exploitable Results, which will help BIPED showcase its unique value to stakeholders and end users, and assist in developing an exploitation strategy for model owners. Ultimately, this will conclude with the module focusing on Intellectual Assets Management, guiding BIPED partners on how best to protect and manage their intellectual property.

In parallel, as the project develops and KERs progress, BIPED will receive feedback from identified end users of the digital twin regarding developments in the relevant landscape and sectors. This will enable a deeper market analysis of trends in digital twins in the next

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iteration of the deliverable. The results of this effort will be reflected in the next iteration of this deliverable, due towards the end of the project (month 36).

2. Sustainability Strategy Framework

BIPED's Sustainability Strategy is based on the successful transfer of project results to identified stakeholders, end users, and potential consumers linked to each of the KERs.

To ensure that a comprehensive sustainability strategy is in place for BIPED, the consortium has identified the following building blocks:

Table 1: Sustainability Strategy Framework

Identify BIPED's contribution to the Digital Twin Landscape	The digital twin landscape in Europe is rapidly evolving, driven by advancements in IoT, AI, and real-time data analytics. This technology is increasingly being adopted across various industries, including manufacturing, healthcare, and smart cities, to enhance operational efficiency and innovation. BIPED is delivering a robust approach towards creating a digital twin solution for PEDs in Brabrand, integrating energy, mobility, and cross-sectoral data to provide a holistic representation of physical reality. This project aims to deliver a strong use case by the end of its term, showcasing the potential of digital twins in urban planning and sustainable development.
Models and TRLs	As part of BIPED, 14 models are under development, divided into 3 categories: mobility, energy and cross-sectoral with TRLs varying between 6 and 9.
Key Exploitable Results	BIPED has identified 3 key exploitable results - the BIPED digital twin solution, the BIPED Impact Assessment Roadmap, and the BIPED Recommendations' Handbook.
The CIVORA Platform	BIPED aims to harness the strengths of both digital twins and data hubs to create a powerful tool for organisations. By combining these technologies, the project seeks to improve efficiency by streamlining operations and reducing downtime, and to enhance decision-making through the provision of real-time data and insights. Centralised data management ensures that all data is stored and managed in one place, which in turn improves data quality by enhancing accuracy and reliability. Increased data accessibility makes it easier for users to access and utilise data. This approach can help organisations gain a deeper understanding of their assets, optimise their operations, and foster innovation. Using a data hub to house the 3D twin while maintaining a centralised user experience seems like a strategic decision that allows for future scalability and development. To fulfil this requirement, we use the flexible smart city data hub and governance tool from DKSR called CIVORA. The 14 models which are under development are all being added to the CIVORA platform as open source/ protected by IPR.
Target Groups and Impact	The involvement of end users and key stakeholders is critical for the development of the digital twin and its sustainability and eventual uptake by end users and key stakeholders. Whereas a balanced stakeholder engagement is needed, end-users are the focal point to secure sustainability of project results.

Exploitation Pathways and IPR

BIPED has identified five exploitation pathways for the project's results: socio-cultural, technological and standards, policy, scientific, and economic. The BIPED Digital Solution will deliver across all five categories due to its versatility and comprehensive approach.

The socio-cultural pathway focuses on the societal impact of the digital twin solution, aiming to enhance community engagement and improve quality of life. By integrating real-time data and predictive analytics, the solution can address various social challenges and promote sustainable urban development.

The technological and standards pathway ensures that the digital twin solution ensures interoperability on a local, national and EU level. This pathway involves continuous innovation and the adoption of best practices to maintain the solution's technological edge.

The policy pathway involves influencing and aligning with regulatory frameworks to support the implementation and scalability of the digital twins Solution. By engaging with policymakers and stakeholders, BIPED aims to create a conducive environment for the widespread adoption of its solutions.

The scientific pathway focuses on advancing research and development in the field of digital twins. By collaborating with academic institutions and research organisations, BIPED aims to contribute to the body of knowledge and drive innovation in this emerging area.

The economic pathway aims to create sustainable business models and commercialisation strategies for the digital twin Solution. By identifying market opportunities and establishing partnerships, BIPED seeks to ensure the economic viability and long-term success of its solutions.

By addressing these five exploitation pathways, BIPED is well-positioned to maximise the impact and reach of its digital twin Solution, driving innovation and delivering value across multiple sectors.

Knowledge production in BIPED is driven by the principles of Open Source, Open Access, and Open Innovation. These three principles, when combined, provide the best opportunities for project results to be discovered and reused by key stakeholders. Any background intellectual property (IP) used in the components of the BIPED digital twin solution—such as the platform, database engine, models, and map viewer—and any other IP generated throughout the life of the project will be closely monitored and addressed to avoid any infringement. This effort will be substantiated through the Horizon Results Booster, ensuring compliance and safeguarding the project's innovations.

These will be analysed in detail in the next sections of the report.

3. Digital Twin Landscape

The BIPED digital twin aims to enhance digital twin development and seeks to boost the replication of PED solutions for climate-neutral cities, supporting decision-making at all levels, including national and EU through its test bed LDT in Aarhus, Denmark. To create a digital twin, cities need solid technical foundations, quality data, and practical use case applications. Robust technical foundations involve defining roles, resources, core processes, and a technology enablement backbone to accelerate adoption. Quality data must be accurate, standardised, up-to-date, and accessible, requiring regular sharing and enhancement. Practical use case applications should be selected for ease of implementation to translate strategy into actions, test technical capabilities, understand stakeholder requirements, engage industry leaders, and form a coalition of public and private stakeholders.

Digital twins can greatly enhance the development and management of smart cities by providing a virtual replica of physical assets and systems. Here are some key ways they support smart cities:

- **Improved Urban Planning:** Digital twins allow city planners to simulate and analyse various scenarios, aiding informed decisions about infrastructure development and urban design.
- **Efficient Resource Management:** By continuously monitoring real-time data from various sources, digital twins help optimise the use of resources such as energy, water, and transportation.
- **Predictive Maintenance:** Digital twins enable predictive maintenance of city infrastructure by identifying potential issues before they become critical, thus reducing downtime and maintenance costs.
- **Enhanced Public Services:** They facilitate better management of public services like waste collection, traffic control, and emergency response by providing real-time insights and enabling quick adjustments.
- **Citizen Engagement:** Digital twins can improve citizen engagement by providing transparent and accessible information about city operations and development projects.

BIPED's goal is to connect digital tools for long-term city planning with short-term management using local digital twin technology. The project aims to create a self-learning digital twin using data from various sources like energy, traffic, and weather. These methods will use future city network specifications and real-time data from urban spaces and stakeholders.

3.1 Digital Twin and the Energy Landscape

Digital twins have the potential to change the way energy is used in buildings and industry by means of creating more efficient, resilient and sustainable methods. By creating digital representations of physical objects, digital twins can allow individuals, companies and governments to monitor, maintain, and optimise.

3.1.1 How DTs are being used in the Energy Sector

In the energy sector, the adoption of digital twins is driven by the requirements to address challenges such as ageing critical infrastructure, increasing demand for energy and the transition to renewable energy. The energy landscape is rapidly evolving with a growing emphasis on sustainability, efficiency and resilience, digital twins offer a powerful tool to

navigate the energy landscape by providing insights into the performance and condition of energy assets, enabling efficient maintenance and optimising operations.

The global market for digital twins in the energy sector is predicted to grow in the coming years. According to reports, the market is expected to reach \$48.2B by 2026¹. This reflects the increased emphasis on digital twins as a component of transformation in the energy industry particularly when it comes to meeting regulatory requirements on a national and European scale.

Digital twins are currently being used in the energy sector to optimise the performance of assets such as wind farms, power plants and energy grids. For example, General Electric employs Digital twins to manage wind farms more efficiently while another example is companies such as Shell leveraging Digital twins to enhance the management of their operations. Digital twins enable operators in the energy industry to simulate various scenarios and assess the impact of operational strategies and identify potential risks. This capability is crucial for ensuring the safe and efficient operation of energy assets and extending their operational lifetime.

3.1.2 Future potential/use of Digital Twins in the Energy Sector

Looking ahead, the potential applications of digital twins in the energy sector are vast and varied. One promising area is the integration of digital twins with artificial intelligence and machine learning technologies. By combining these capabilities, digital twins can provide even more accurate predictions and insights, enabling more effective optimisation of energy systems. For example, AI-powered digital twins could be used to optimise the operation of renewable energy sources, such as solar and wind farms, by predicting weather patterns and adjusting operations².

In the energy sector, BIPED's digital twin can enhance grid management by predicting demand, optimising energy distribution and integrating renewable energy sources. It can facilitate proactive maintenance of infrastructure, reducing downtime and operational costs. Additionally, the digital twin can support the development and maintenance of energy grids which can enable more adaptive systems that can meet the needs of consumers.

3.2 Digital Twins and the Mobility Landscape

In the mobility and transport sector, the adoption of digital twins is driven by the need to address challenges such as traffic congestion, aging infrastructure, and the transition to smart cities. The transport landscape is evolving rapidly, with a growing emphasis on sustainability, efficiency, and resilience. Digital twins offer a powerful tool to navigate this complex environment by providing insights into the performance and condition of transport assets, enabling proactive maintenance, and optimising operations.

3.2.1 How DTs are being used in the mobility sector

Digital twins are currently being used in the transport sector to optimise the performance of various assets, including vehicles, traffic systems, and infrastructure. For instance, digital twins are employed to manage traffic conditions in real-time, helping to reduce congestion and improve traffic flow. By creating virtual models of traffic networks, cities can simulate different scenarios and implement measures to enhance mobility and safety.

A notable application of digital twins is in the management of transport infrastructure, such as bridges, tunnels, and railways. By creating detailed virtual replicas of these assets, operators can simulate various scenarios, assess the impact of different operational strategies, and identify potential risks³. This capability is crucial for ensuring the safe and efficient operation of transport infrastructure, as well as for extending their operational

¹ [How Digital Twins Can Revamp An Aging And Disconnected Energy Sector](#)

² [Digital Twin in the Energy Sector: Benefits, Use Cases, and Examples](#)

³ [Mobility & Transportation](#)

lifetimes. Overall, digital twins are proving to be invaluable tools for enhancing the performance and reliability of transport assets.

3.2.2 Future potential/use of Digital Twins in the Mobility Sector

As digital twins become more sophisticated and widely replicable, their potential applications in transport and mobility will expand dramatically, transforming how local and national governments plan, manage, and optimise infrastructure. Future digital twins have the potential to leverage artificial intelligence, machine learning, and quantum computing to create extremely accurate simulations that can model cities, transport networks in real time. These advanced systems will enable predictive decision-making at an unprecedented scale, allowing governments to foresee disruptions—such as extreme weather events, accidents, or infrastructure failures—and take proactive measures to mitigate their impact. This will lead to more resilient transport systems.

With improvements in data collection and interoperability, digital twins will also become more accessible and scalable, making them a standard tool for urban planning and mobility management. Cities will be able to integrate digital twins across multiple transport modes—public transit, roads, rail, air, and even maritime transport—into a single cohesive system. This will enable seamless coordination between different mobility services, optimising energy consumption, reducing congestion, and enhancing passenger experiences. In the future, national governments could deploy digital twins to manage cross-border transport networks, ensuring that international logistics and travel are more efficient and environmentally sustainable.

Furthermore, as digital twins become more interactive, they will empower policymakers, businesses, and the public to engage with transport planning in new ways. Advanced interfaces will allow citizens to explore proposed infrastructure projects and provide feedback before construction begins. Governments could also use digital twins for scenario-based policymaking, testing the effects of new regulations before implementing them.

In the mobility sector, BIPED's digital twin can transform transport planning and management. It can assist in simulating traffic patterns, optimise traffic routes and improve efficiency of transport systems. By providing insights into vehicle patterns and performance and needs the digital twin can reduce emissions and operational costs. Furthermore, it can provide a solution for integrating smart transport solutions.

Beyond the mobility and energy sector, BIPED can offer benefits across sectors by providing a comprehensive virtual representation of physical systems. By fostering innovation and contextualisation via the Open Urban Platform (OUP), BIPED can ensure the benefits are realised in diverse contexts across sectors and enhances sustainability and efficiency.

3.3 Current Challenges

Adopting digital twin solutions in Europe presents several challenges that need to be addressed to fully realise their potential. Key challenges have been outlined below:

1. **Data Integration and Interoperability:** One of the primary challenges is ensuring seamless data integration and interoperability between different systems and platforms. Digital twins require harmonised communication protocols and standardised data formats to enhance data exchange and integration while ensuring data quality and security.
2. **Cybersecurity and Data Privacy:** Adherence to cybersecurity regulations is crucial, especially for the protection of sensitive operational and customer data. Establishing

a well-defined data governance model is essential to safeguard data privacy and security.

3. **High Costs and Investment:** Implementing digital twin technology can be costly, requiring significant investment in digital infrastructure, sensors, and data management systems. Policy reforms that encourage investment in digital technologies and flexibility market mechanisms are essential for the transition.
4. **Coordination Among Stakeholders:** Effective coordination among system operators, market participants, and consumers is challenging but necessary for comprehensive system planning and data exchange. Harmonisation of European regulations can reduce barriers to cross-border and cross-sector collaboration.
5. **Education and Skill Gaps:** There is a need for education and training to bridge the skill gaps in understanding and utilising digital twin technologies. This includes upskilling the workforce to handle advanced digital tools and analytics.
6. **Data Availability:** Access to suitable and high-quality data is a common challenge. Cities and organisations often struggle to gather and manage the necessary data to create accurate and functional digital twins.

Addressing these challenges requires a collaborative effort from governments, private sectors, and educational institutions to create a robust framework for digital twin adoption. By overcoming these hurdles, Europe can unlock the transformative potential of digital twins for enhanced sustainability and efficiency.

4. Exploitable Foreground

BIPED's primary Key Exploitable Result (KER) is the digital twin solution, its implementation in Aarhus, and its scalability potential across other cities committed to the Net Zero Agenda. Digital twin technology in PEDs aims to be applied to other cities to enhance sustainability and efficiency. By creating virtual models of urban areas, cities can simulate and optimise energy usage, integrate renewable energy sources, and improve resource management. For instance, cities like Helsinki and Singapore have successfully implemented digital twins to address real-world issues such as improving public services and reducing carbon footprints. These models provide real-time data and predictive analytics, enabling better decision-making and crisis preparedness.

BIPED envisions five exploitation pathways, namely socio-cultural, technical solutions and standards, policy, scientific and economic. Each of these pathways highlights the exploitation potential of the BIPED results.

Table 2: BIPED Exploitation Pathways

Socio-cultural
Use of BIPED results by citizens, local hubs, interest groups, local energy communities and NGOs to push for action on implementing the BIPED digital twin/models to improve efficiency in the realms of energy and mobility. Tactics to stimulate socio-cultural exploitation include partnerships with community centres, including community champions, visual storytelling, video guides and tutorials on how to use digital twins for community action.
Tech & Standards
Integration of BIPED results into third-party standards, tools, processes and applications with the aim of augmenting the value of the final solution. These will result in cross fertilisation within sectors for better interoperability to realise the vision of smart and connected cities. Tactics include tech meetups, releases on GitHub, GitLab, data/model repositories, conferences, live demos, hackathons, cooperation with network organisations (e.g. Living-in.eu), standards working groups e.g. the OGC, ISO and IEC
Policy
Use of BIPED results to inform policy development in the context of the European Green Deal. The use of digital twins is expected to make urban policy cycles shorter, more agile, participatory and forward-looking. Approaches to stimulate policy oriented exploitation include policy briefs, policy round tables, 'feedback to policy' sessions facilitated by REA, an impact assessment roadmap for Aarhus, and a handbook with recommendations to new cities on how to implement PEDs using digital twins
Scientific
Use of BIPED results by researchers, academics, institutes, universities and think-tanks to advance scholarly research. This exploitation is expected to add new data and insight to the growing body of knowledge about digital twins for climate-neutral cities. Tactics to stimulate scientific exploitation include open access publications, open data sets, conference appearances, workshops and seminars.

Economic

Use of BIPED results for commercial and monetisation purposes. Expected to generate additional revenue to partners who increased the TRL of their solution as a result of the project. Tactics to stimulate economic exploitation mainly focus on improving visibility of BIPED results and getting funding from potential investors to develop them further. May involve looking for funding on the Horizon Results Platform, and also dealflow.eu which has facilitated more than 1000 funding rounds over the last decade

The three core BIPED KERs that the sustainability strategy will focus on are outlined below highlighting the description, target adopters, market potential. Each KERs is also linked to the exploitation paths outlined above.

BIPED's digital twin solution is designed to deliver a district-oriented approach, integrating multi-dimensional datasets, models, and high-resolution real-time data streams to address climate neutrality considerations. The pilot project in Brabrand, Aarhus, will offer valuable insights into the deployment of digital twins at the district level. It aims to demonstrate how an optimal PED design can be replicated across local, national, and European contexts, providing a scalable and adaptable model for achieving climate neutrality in urban environments.

The technical solution will be bolstered by the BIPED Impact Assessment Roadmap and the BIPED Transition Recommendations Handbook. These resources will provide tangible insights into successfully deploying the district-oriented solution, taking into account challenges, lessons learned, functional models, and methodologies applicable to other contexts. Together, these three KERs will offer a comprehensive solution for other cities aiming to achieve net zero emissions, ensuring that the strategies and technologies developed by BIPED can be effectively replicated and scaled.

Building the BIPED Digital Twin

Within the reporting period M6 - M12, the BIPED consortium agreed that the CIVORA platform would greatly help the city of Aarhus in implementing the BIPED Digital Twin. The CIVORA platform is used as the user interface for the BIPED Digital Twin due to the fact it has the capability of integrating the VCMap⁴.

Furthermore, the BIPED consortium agreed upon the utilisation of the OGC API Processes standard⁵, which provides all BIPED modelling partners with a guideline to design their model APIs and will enable the connection of further models without the need of major customizations⁶.

Underpinning the releases of the BIPED Digital Twin is data acquisition and implementation. To date, the BIPED partners have collated variables which describe the urban and social landscape of Brabrand in a "dataset wishlist" and linked to representative datasets. This data sheet serves as living document and tool for the project team and provides an overview on datasets and the status of the dataset within the BIPED digital twin project ("available", "owner-contacted", "owner-not-contacted", "not-available") throughout the project duration.

Stakeholder Engagement

The building of the digital twin is closely tied into the project's stakeholder engagement which has produced two key initiatives i) BIPED Training Programme and ii) BIPED Stakeholder Forum. The BIPED Training Programme devised by AAKS is underpinned by a community-centered approach and modular structure. The approach and content of the

⁴ VCMap: [GitHub - virtualcitySYSTEMS/map-core: vcMap Core library](https://github.com/virtualcitySYSTEMS/map-core)

⁵ OGC API Processes standard: <https://www.ogc.org/publications/standard/ogcapi-processes/>

⁶ [D2.2: Biped Digital Twin Release 1](#)

Training Programme is further detailed in D3.1⁷. This Training Programme will complement the BIPED Stakeholder Forum, the framework of which has been developed by OASC in D4.2 by OASC⁸.

Table 3: BIPED KERs Description

KER Name	BIPED Digital Twin Solution	BIPED Impact Assessment Roadmap	BIPED Handbook with Recommendations for Transition
Description	A platform for modelling PEDs using multi-dimensional datasets, models and high-resolution real-time data streams covering key areas of climate neutrality, including transport, buildings and waste management. An optimal PED design will be proposed taking into account direct emissions, indirect emissions, out-of-boundary emissions, residual emissions.	An action plan for the city of Aarhus on how to realise PED in Brabrand, and then scale it to make the whole city climate-neutral; as a member of the “100 club” Aarhus has pledged to reach this goal by 2030.	A general how-to guide for PED development. It will be based on the results of PED modelling for Brabrand and any on-the-ground measures taken by Aarhus to realise it during the project. The handbook is intended to upscale BIPED’s KERs by targeting cities with similar climate-neutrality pledges. Thus members of the ‘100 club’ will be the prime target audience for the handbook.
Target Adopters	• Aarhus (local government, councils, SMEs) • Members of the 100 climate neutral and smart cities	• Aarhus (local government, councils, SMEs)	• Members of 100 climate neutral cities in Denmark (Copenhagen, Sønderborg) and across Europe
Exploitation Pathways	• Policy oriented • Socio-cultural • Economic • Technical and standards • Scientific	• Policy oriented • Socio-cultural	• Policy oriented • Technical and standards oriented
Partners	AIR, DTU, DKSR, VCS, UWB, INNO, RT	OASC, AAKS, AIT	OASC, DRI

The table above outlines the project’s KERs and how their replicability and scalability will be secured beyond the end of the project. BIPED’s models will be facilitated through the CIVORA Data Platform, developed by DKSR, which will host all the mobility, energy and cross sectoral models and will be the demonstrator, promoting replicability and scalability. They are the starting point for the development of BIPED’s Sustainability Strategy.

⁷ [D3.1: BIPED Training Programme](#)

⁸ [D4.2: BIPED Stakeholder Forum](#)

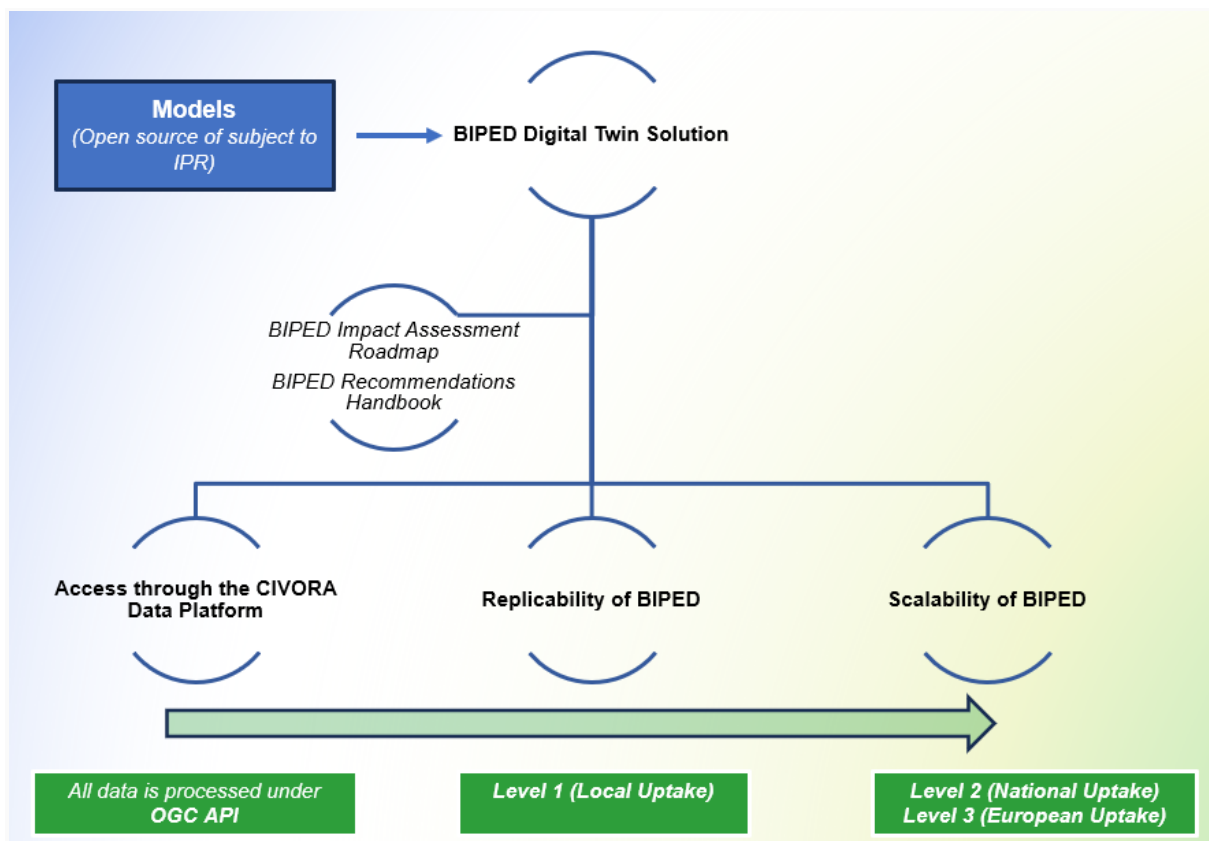


Figure 1: BIPED Digital Twin Framework

To add granularity to our analysis, the uptake has been divided into three levels: local, national, and European. Local uptake refers to Aarhus and its surroundings, suggesting replicability of the approach adopted in Braband. National uptake involves other cities in Denmark, benefiting from the same regulatory context. The third level pertains to other European cities currently pursuing the Net Zero agenda (e.g., [100 Climate -Neutral and Smart Cities by 2030](#)).

These levels are key to consider for the scalability of the digital twin solution. The BIPED Impact Assessment Roadmap and the BIPED Recommendations Handbook (alongside WP4 deliverables) will be critical in identifying regulatory, technological, and societal challenges and providing potential solutions in supporting the implementation and scalability of the digital twin.

Table 4: BIPED Implementation Plan

KERs	Level 1 - Local Uptake	Level 2 - National Uptake	Level 3 - European Uptake
BIPED Digital Twin Solution	Leveraging the approach adopted in Braband, allowing for an easy replication in the whole city of Aarhus and its surroundings. <i>No contextualisation constraints.</i>	Tailoring the approach used in Braband to support other cities in Denmark while maintaining a <i>low level of contextualisation constraints.</i>	Use the Aarhus use case to support ongoing effort through Cities Mission and to assist PED development across Europe. <i>Medium to High level of contextualisation constraints.</i>
Technological Challenges	Ensuring seamless integration of real-time data from various sources and maintaining high data quality and accuracy. Developing user-friendly interfaces for local stakeholders and addressing any technical issues that arise during implementation.	Adapting the digital twin models to different urban environments within Denmark, which may have unique characteristics and requirements. Ensuring interoperability with existing national systems and infrastructure.	Scaling the digital twin solution to accommodate diverse urban environments across Europe. Ensuring interoperability with various European data spaces and systems. Managing the complexity of integrating data from multiple countries with different standards and formats.
Regulatory Challenges	Navigating local regulations and obtaining necessary approvals for data collection and usage. Ensuring compliance with local data protection and privacy laws.	Addressing national regulations and standards, which may vary across regions. Ensuring compliance with national data protection laws and securing necessary permissions for data sharing and integration.	Navigating the complex regulatory landscape of the European Union, including compliance with the General Data Protection Regulation (GDPR) and other relevant EU directives. Addressing cross-border data sharing and privacy concerns.
Societal challenges	<u>Community Engagement:</u> Ensuring active	<u>Cultural Differences:</u> Different cities within Denmark may have	<u>Cross-Border Collaboration:</u> Facilitating

	participation and buy-in from local residents and stakeholders can be challenging. There may be resistance to change or scepticism about the benefits of digital twins. <u>Awareness and Education:</u> Raising awareness and educating the local community about the advantages and functionalities of digital twins is essential. This requires effective communication strategies and outreach efforts	varying cultural attitudes towards technology and innovation. Tailoring the approach to fit these cultural contexts is crucial. <u>Equity and Accessibility:</u> Ensuring that the benefits of digital twins are accessible to all communities, including underserved and marginalised groups, can be challenging. This requires inclusive strategies and policies	collaboration between different European cities and regions can be complex due to varying social norms, languages, and governance structures. <u>Public Trust and Acceptance:</u> Building public trust and acceptance of digital twin technologies across diverse European societies is essential. This involves addressing concerns related to privacy, data security, and the ethical use of technology.
	BIPED Impact Assessment Roadmap		
	BIPED Handbook with Recommendations		

4.1 Ensuring Contextualisation of the Digital Twin

Contextualisation is crucial for the effective implementation of digital twins, as it ensures these models can adapt to various scales and environments, whether on a local, national or European level. By tailoring the digital twin to the specific needs and characteristics of an area, stakeholders can achieve more accurate simulations and more efficient and better decision making. This adaptability allows for the integration of diverse data sources fostering collaboration across different regions and sectors. The following sections will outline how BIPED aims to achieve this contextualisation by engaging with key stakeholders and end users to garner critical feedback on how to contextualise the digital twin to ensure replicability and scalability as outlined in the figure below:



Figure 2: BIPED Scalability

4.1.1 BIPED Stakeholder Forum

The establishment of a stakeholder and end-user Forum is a cornerstone of the BIPED project to ensure that the digital twin solution is not only robust in design, but also aligned with the diverse needs of its users. The Forum complements the stakeholder efforts at the pilot city level by supporting the identification and engagement of the target end-users for the BIPED DT solution. Most importantly, with insights from key stakeholders and potential end-users outside the pilot setting, this Forum plays a crucial role in ensuring the broader applicability of the developed LDT solution by other cities and users. It also takes a proactive stance in preparing the solution for later exploration of scalability and replicability, instilling confidence in the project's future.

Therefore, this Forum serves as an inclusive, dynamic platform that fosters continuous engagement, collaboration and feedback from a wide range of stakeholders within and mostly beyond the pilot city of Aarhus. By actively involving city representatives, infrastructure operators, technology providers, policy makers and academic experts, the Forum aims to co-create BIPED innovative solutions that directly address real-world challenges.

Through regular workshops, virtual collaborations, and targeted working groups, the stakeholders and end-user Forum will act as a vital bridge between technical development and on-the-ground BIPED application, empowering cities to lead the transition toward a smarter, more resilient, and sustainable urban platform, contributing to the iterative development of the digital twin solution.

4.1.2 Sister Project Collaboration

WP4 and OASC have successfully established contact with several sister projects focused on PEDs and relevant EU-level initiatives. These collaborations aim to foster a synergistic approach towards achieving sustainable urban development and energy efficiency. The key initiatives involved in these collaborative efforts include Cities4PEDs, ATELIER, RESPONSE, European Cities Mission Platform, Net Zero Cities, and the MI Urban Transitions Mission.

The collaboration modalities encompass various forms of engagement. Regular exchange of research findings, data, and insights among the projects enhances collective knowledge and drives innovation in PEDs. Formal agreements, such as Memorandum of Understanding (MoU), outline the terms and conditions of collaboration, ensuring structured and mutually beneficial partnerships. Coordinated efforts to host conferences, workshops, and seminars bring together stakeholders from various projects to discuss progress, challenges, and future directions. Support on social media platforms promotes the initiatives, shares updates, and engages with the broader community, thereby increasing visibility and outreach. Collaborative testing and validation of solutions and methodologies developed within the projects ensure their effectiveness and scalability.

Through these collaboration modalities, WP4 and OASC aim to create a robust network of projects and initiatives that work together towards the common goal of developing and implementing Positive Energy Districts across Europe. This integrated approach not only accelerates progress but also ensures that the solutions are well-rounded and widely applicable.

4.1.3. Scalable Cities Working Group

Scalable Cities is an initiative of the European Commission to create an innovative, sustainable and city-led community of smart and climate-neutral cities in Europe. Scalable Cities represent 142 unique cities involved in 28 Smart Cities and Communities (SCC) and Positive Energy Districts (PED) projects funded by the Horizon 2020 and [HorizonEurope](#) programmes that are working in consortia with academia, industry, associations and consultants.

Together, they have implemented more than 550 demonstrations of [technological and social innovations](#) in the areas of mobility and logistics, buildings, urban data and ICT infrastructure, citizen engagement as well as urban governance.

The wider BIPED project is part of the Scalable Cities initiative which hosts monthly meetings covering an array of topics in the sphere of digital twins and Smart Cities. The Task Group (TG) on Monitoring and Evaluation (M&E) Meeting for Scalable Cities which covers collection of practical data, monitoring and reporting processes and tools, developing impact methodologies, exchange of data collection, interfacing control systems and databases, algorithms for data set cleaning and dissemination tools. It also engages in peer-to-peer learning and in collaboration with external experts. As part of the TG on M&E, KPMG & DTU presented on BIPED's M&E Framework and how it can be replicated and utilised for scalability across projects.

By fostering cross-collaboration between stakeholders across Europe, Scalable Cities deliver tangible evidence on how smart actions can pave the way to achieve climate neutral cities. By being part of this initiative BIPED will be able to present and validate results while also implementing best practice from other PED and digital twin projects in relation to sustainability and exploitation.

4.1.4 Cities Mission

BIPED will be collaborating with the Cities Mission Platform and supporting their aims through a signed Memorandum of Understanding (MOU) – both OASC and AIT are key partners in the NetZeroCities consortium, and Aarhus is a Mission City. BIPED is specifically designed to support the wider aims of the Horizon Europe strategy to 'accelerate green & digital transition' with a strong focus on achieving the goals of the Mission: Climate neutral and smart cities.

5. Sustainability & Exploitation

5.1 Sustainability of the BIPED Digital Twin Solution

In an era where urbanisation and technological advancements are rapidly transforming cities and towns across Europe, integrating digital solutions has become essential. BIPED operates within this sphere by combining expertise from the energy and mobility sectors to develop a replicable digital twin. This digital twin will serve as an interactive model for numerous end users and stakeholders, including urban planners, policymakers, and businesses, to optimise and enhance urban environments.

The commercialisation of the digital twin is crucial for ensuring its sustainability beyond the project's lifespan. Various commercial models can be explored to achieve this goal. These include licensing and subscription models, where cities and towns pay for ongoing access to the digital twin and its updates. Consulting and customisation services can be offered to tailor the digital twin to the specific needs of different urban environments. Training and certification programmes can be developed to equip professionals with the skills needed to effectively utilise and manage the digital twin. Additionally, a Software as a Service (SaaS) model can provide scalable and flexible access to the digital twin's features. Finally, industry-specific solutions involving individual digital twin models can address the unique challenges and requirements of different sectors, ensuring the digital twin's broad applicability and impact.

By exploring these commercial models, the project aims to create a sustainable framework that supports the continued development and enhancement of the digital twin, ensuring its long-term viability and impact.

BIPED's sustainability strategy focuses on how best to position the project outcomes and move from a district-oriented solution to a scalable and replicable product that can be deployed beyond Brabant and Aarhus. A key objective at this stage of the project is developing foundational mechanics to accelerate adoption and deliver at scale, ensuring the digital twin solution's sustainability and scalability across local, national, and European levels.

Utilising the OUP provides a robust foundation for developing the essential mechanics of digital twins. This platform establishes a common language and framework, fostering market participation and creating a unified approach to engagement and information sharing. The OUP offers a tangible pathway for implementation, driving the adoption of digital twins.

The journey towards sustainability and widespread uptake of digital twins will leverage the OUP for individual models. The OUP marketplace empowers organisations to purchase tailored models that suit their specific needs, facilitating seamless integration into various operational and strategic processes. This approach not only enhances sustainability but also promotes the broader adoption of digital twins across diverse sectors.

DKSR Open Urban Platform

DKSR's Open Urban Platform which is an open source real-time platform for cross-domain data integration and match-making⁹. Real-time sensor data platform that follows the vision of OUP as expressed by the European Innovation Partnership Smart Cities and Communities¹⁰ and defined in DIN SPEC 91357. The OUP enables small and large cities and businesses to efficiently integrate new and existing data sources, process and analyse data in near real-time, and ultimately share the data with various stakeholders. Unlike many other platforms, it is cloud agnostic and can run in the cloud, in container environments

⁹ [BIPED_D2.2_BIPED Digital Twin Release 1.docx](#)

¹⁰ eu-smartcities.eu

Kubernetes or in the local data centre. Depending on the requirements, cloud-based services or open source technologies that can be used for these purposes.

Data Governance Tools

Modular Data Spaces

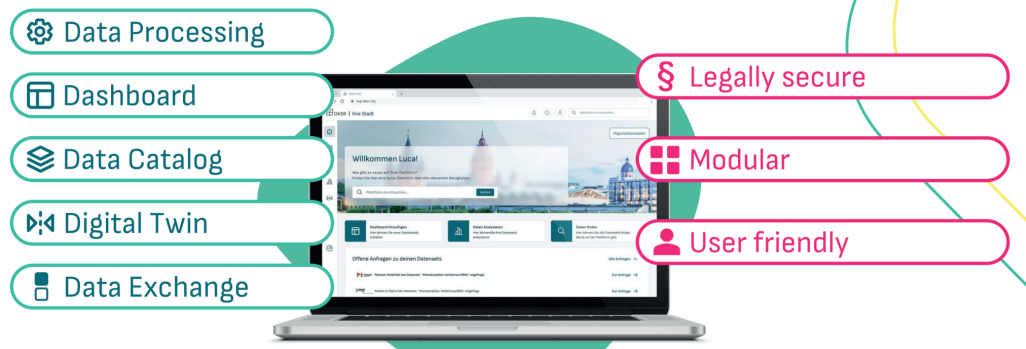


Figure 3: CIVORA Data Hub & Governance tool¹¹

Software as a Service (SaaS)

By offering the digital twin and individual digital twin models as a SaaS solution, model owners can provide several benefits to potential end users including scalability, ease of access, and reduced IT infrastructure costs. SaaS solutions can be accessed from anywhere, making it easier for end users to monitor and manage their operations remotely.

To commercialise BIPED's digital twin as a Software as a Service (SaaS), BIPED will utilise DKSR's Open Urban Platform as a marketplace for the BIPED digital twin models and operate as a central hub where organisations can browse, evaluate, and acquire digital twin solutions tailored to their specific needs. Each model will be designed to address particular aspects of urban planning, environmental management, energy optimisation, and more.

Open Source Models

Alternatively, BIPED can leverage open sourcing for its models. By making certain models that constitute the digital twin openly accessible, the project can foster a collaborative environment where developers, researchers, and stakeholders can contribute to and enhance the technology.

Open sourcing allows for continuous improvement and innovation, as the community can identify and address potential issues, suggest enhancements, and develop new features. This collaborative approach not only accelerates the development process but also ensures that the digital twin remains adaptable and relevant to evolving needs.

Furthermore, open sourcing promotes transparency and trust, as stakeholders can review the underlying code and methodologies. This openness can lead to greater acceptance and confidence in the digital twin, encouraging more organisations to adopt and implement the technology.

To facilitate this, BIPED will utilise the Open Urban Platform for sharing the open-source models, complete with documentation, tutorials, and support resources. The OUP platform can serve as a hub for collaboration, where users can access the models, share their experiences, and contribute to ongoing development. By embracing open sourcing, BIPED can create a sustainable ecosystem for the digital twin, ensuring its long-term viability and encouraging widespread uptake across various sectors.

¹¹ [BIPED_D2.2_BIPED Digital Twin Release 1.docx](#)

Table 5: BIPED Models & TRL Levels

Model	Energy	Mobility	Cross Sectoral	Expected TRL
Traffic Model		X		9
ClimateRisk		X		8
District Heating (testbed model)	X			8
CLIMIFY Indoor Climate Model	X			7-8
Traffic Enviro Analyst - Energy		X		6-7
Traffic Enviro Analyst - Emissions		X		6-7
Building Occupancy Model			X	6-7
Load Forecasting	X			8
MAPED (Model for Energy Analysis of Positive Energy District)	X			7-8
Behaviour Change Profiles			X	TBD
Urban Heat Island Model			X	TBD
Solarplanner	X			TBD
Solar Potential	X			9
Microscopic Simulation		X		TBD

Intellectual Property Rights (IPR)

In the context of the European Union, IPR are essential for protecting and managing the innovations developed within the BIPED project. Horizon Europe operates within the robust IPR framework provided by the European Union, including the European Patent Office (EPO) for patents and the European Union Intellectual Property Office (EUIPO) for trademarks and designs. This framework ensures that intellectual property is protected across all EU member states. Key IPR considerations in BIPED have been listed below:

1. **Patent Protection:** Patents can safeguard novel inventions and technological advancements within BIPED, ensuring that unique aspects of the digital twin solution are legally protected. This prevents unauthorised use by third parties and encourages further innovation.
2. **Copyrights:** Copyright protection applies to original works created during the project, such as software code, documentation, and educational materials. This ensures that BIPED retains control over the distribution and use of these creative outputs.

3. **Trade Secrets:** Proprietary information, such as algorithms, processes, and methodologies, can be protected as trade secrets. Implementing measures to keep this information confidential is crucial for maintaining a competitive edge.
4. **Trademarks:** Trademarks protect the branding and identity of the BIPED project, including logos, names, and other distinctive signs. This helps differentiate BIPED's products and services in the market.
5. **Compliance with EU Regulations:** BIPED must ensure compliance with EU regulations, such as the General Data Protection Regulation (GDPR), which governs data protection and privacy. This is particularly important for managing data from key stakeholders within the digital twin models.
6. **IPR Management:** Effective IPR management involves developing a comprehensive strategy to identify, protect, and exploit intellectual property. This includes regular audits, monitoring for potential infringements, and ensuring compliance with relevant laws and regulations.

By addressing these IPR considerations within the EU context, BIPED can safeguard its innovations, enhance its competitive edge, and ensure the long-term sustainability and impact of its digital twin solution. Knowledge production in BIPED is driven by Open Source, Open Access and Open Innovation, the three principles that, in combination, provide the best chances for project results to be discovered and reused by the key stakeholders. Background IP used in the components of the BIPED digital twin solution (e.g., platform, database engine, models, map viewer) will be closely monitored and addressed accordingly to avoid any IPR infringement.

Joint Exploitation Strategies/ IP ownership arrangements

Engagement in specialised IPR training sessions with the Horizon Results Booster will be crucial for understanding the IPR landscape in this emerging area. These sessions will provide valuable insights into the complexities of IPR, helping to develop robust strategies for protecting and managing the intellectual property associated with the digital twin solution. Ensuring compliance with IPR regulations is essential to safeguard the project's innovations and maintain its competitive edge. Furthermore, IPR workshops with project partners will be conducted to educate them on best practices and the importance of IPR. These workshops will foster collaboration among partners, enabling them to develop joint IPR strategies that maximise the impact and reach of the models constituting the digital twin solution. By addressing IPR-related challenges and establishing a comprehensive framework for ongoing IPR management, the project will be well-positioned to protect its intellectual assets and drive innovation across multiple sectors.

5.2 Horizon Results Booster

To ensure the full exploitation of the KERs, BIPED is availing of the Horizon Results Booster initiative, which is an initiative from the European Commission providing a set of services to EU-funded projects, free-of-charge, to help navigate the complexities of dissemination and exploitation. Booster is tailored for research projects funded by the European Commission under Horizon Europe, the Framework Programme (FP) for Research and Innovation 2021-2027, Horizon 2020, Framework Programme 7 (FP7) and initiatives co-funded within the European Commission's R&I Framework Programmes (Joint Undertakings, Partnerships, EIT KICs, etc.).

5.2.1 Horizon Results Booster Activities (M12 – M18 of BIPED)

The Mentors were appointed on 19/02/2025 and the Applicant was contacted on 19/02/2025. The Applicant(s) informed the Mentors that the two calls would have taken place on 11/03/2025 and on 31/03/2025.

On 11/03/2025 the first call was organised to introduce the Dissemination & Exploitation ecosystem, align expectations with Booster services, assess Key Exploitable Results (KERs), and identify involved Research Teams. Any relevant documents, such as business or exploitation plans, were also requested. On the same day, the Mentors sent all the necessary information and the “Readiness Assessment” tool to be shared with BIPED project partners and filled.

Table 6: HRB KER Categorisation

KER	Technology	Service	Policy	Standard	Infrastructure	Other
BIPED Digital Twin Solution	X					
BIPED Impact Assessment Roadmap						Action Plan
BIPED Handbook with Recommendations for Transition						Guideline

On 31/03/2025, a second call with the Applicant was organised to review the "Readiness Assessment" tool, ensuring the project information accurately reflects BIPED's actual readiness. As an outcome of this call, the Service Roadmap was also finalised, outlining the appropriate Booster services to be provided which involves 2.3 (Go to Market) and 3.3 (Intellectual Assets Management) encapsulates the following 'Sub-Modules:

- Module A: Kick-Off
- Module B: Unique Value Proposition & Key Exploitable Result(s)
- Module C: Exploitation Strategy
- Module F: Reporting

The following Service Roadmap Timeline was also agreed upon and is reflected in Table 7 below:

Table 7: BIPED HRB Services

Booster Service(s)	Timing
2.3 Go to Market Module-A Kick Off	May 2025
2.3 Go to Market-Module B-Unique Value Proposition & Key Exploitable Results	June 2025
2.3 Go to Market-Module C Exploitation Strategy	August 2025
2.3 Go to Market-Module F-Reporting	October 2025
3.3 Intellectual Assets Management	November 2025

6. Expected Impact

6.1 BIPED Digital Twin: Pathway to Replicability

BIPED is committed to achieving replicability of its digital twin through a comprehensive approach that includes training programmes¹² ([as initially developed in D3.2](#)), stakeholder engagement, and multiple demonstrations. By implementing targeted training programs, BIPED will equip participants with the necessary skills and knowledge to effectively utilise and replicate the digital twin technology. Stakeholder engagement will be facilitated through a dedicated stakeholder forum, which will play a crucial role in informing the development of the digital twin. This forum will serve as a platform for stakeholders to provide valuable feedback and insights, ensuring that the digital twin is tailored to meet diverse needs and requirements. Additionally, multiple demonstrations of the digital twin will be conducted via the forum, showcasing its capabilities and practical applications. The detailed plan for achieving replicability through these initiatives will be outlined in the following paragraphs.

6.2 End Users and Key Stakeholders

As discussed in D4.2: Stakeholder Forum¹³, “the involvement of end users and key stakeholders is critical for the development of the digital twin and its sustainability and eventual uptake by end users and key stakeholders. Whereas a balanced stakeholder engagement is needed, end-users are the focal point. The end-users are those who will directly use the digital twin solution being developed as part of the project. While all end-users are stakeholders, not all stakeholders are end-users. Thus a necessary process which was carried out as part of WP4 in BIPED was to identify end-users from the broader set of targeted stakeholders.

As shown in the figure below, the concept of 'stakeholder' in the EU context is divided into two categories. The first category is those who influence the development of the digital twin. This refers to those with knowledge and expertise in the digital twin sphere. These stakeholders include policy makers and business actors, whose opinions will influence the adoption and implementation of the solution.

The second category is those who will be impacted by the utilisation of the BIPED digital twin solution although they do not utilise the digital twin directly. This includes 'direct users' and 'indirect beneficiaries'. A link can be made with those who are likely to adopt the digital twin into their workflow and the stakeholders who will influence the adoption of the digital twin, such as policy makers, are considered as 'indirect' end-users, who should also be prioritised by the end-user focused engagement.”¹⁴

¹² [D3.2: Training Programme](#)

¹³ [D4.2: Stakeholder Forum](#)

¹⁴ [D4.2: Stakeholder Forum](#)

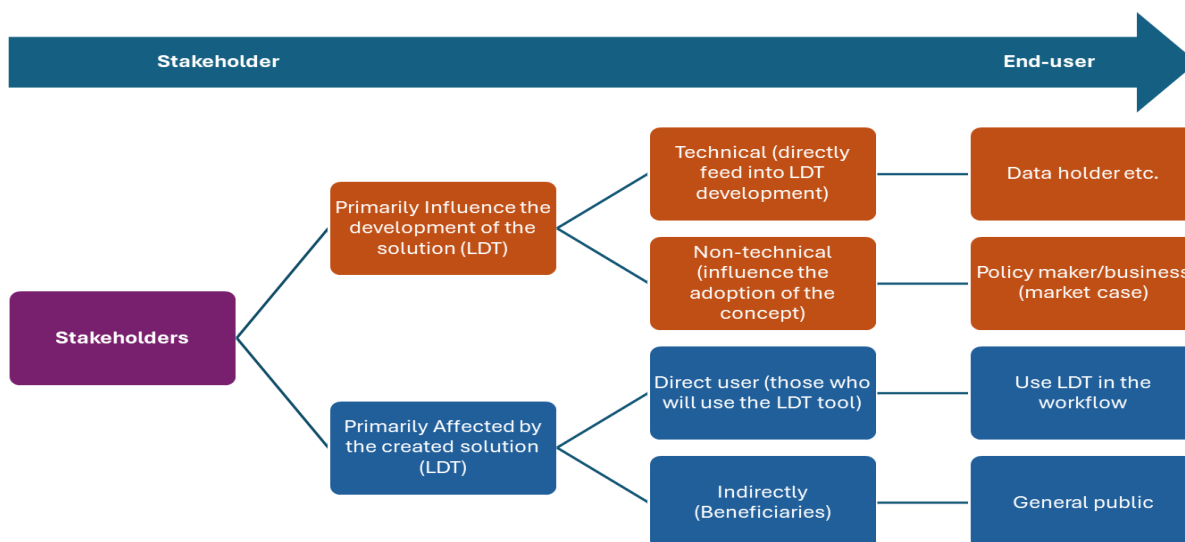


Figure 4. Deconstruction of the Concept of 'Stakeholder' to 'End-user' in the EU Context (OASC)¹⁵

6.3 BIPED Stakeholder Forum and Demonstrations

BIPED will present the digital twin to the stakeholder forum through a series of interactive sessions designed to showcase its functionalities and applications. By providing a comprehensive overview of the digital twin's capabilities, BIPED aims to encourage active participation amongst stakeholders and provide a clear understanding of how the digital twin operates.

The stakeholder forum will also act as a source of feedback, enabling stakeholders to share their insights and any concerns regarding the digital twin. BIPED will employ various methods to collect and analyse this feedback, including surveys, focus groups, and open discussions. This feedback will be reviewed and integrated into the ongoing development of the digital twin, ensuring that it evolves in alignment with stakeholder needs and expectations.

To ensure replicability, BIPED will document the feedback integration process, and the subsequent modifications made to the digital twin. This documentation will result in the BIPED Handbook with Recommendations for Transition which is one of the KERs as identified through the Horizon Results Booster. This will provide a clear roadmap for replicating the digital twin in different contexts, highlighting best practices and lessons learned. Additionally, BIPED will utilise the training programme (referenced above) and support resources to assist stakeholders in implementing and replicating the digital twin effectively.

Through these efforts, BIPED aims to create a dynamic and responsive digital twin that not only meets the immediate needs of stakeholders but also serves as a scalable and replicable model for future applications.

6.3.1 BIPED Training Programme – An outline

As initial findings from ongoing stakeholder engagement activities further suggest (D3.2¹⁶), there is also a need for a general introduction to PEDs and digital twins for both cities, communities, the broader public and professionals involved, as the technology behind it and the opportunities it offers is still to a degree unknown to most involved. Such introduction should provide a high-level overview about what a PED and a digital twin is, how it is

¹⁵ [D4.2: Stakeholder Forum](#)

¹⁶ [D3.2: Training Programme](#)

technically set up and how it represents physical properties of a city or neighbourhood, such as Brabrand and its community, what data-driven models can assess and where limitations are, and what benefits a digital twin can provide related to the stakeholder groups.

Based on these findings, BIPED offers three training modules:

Module 1: Introduction to BIPED Digital Twin (2025)

- Audience: City management, planners, citizens, researchers, software developers, local industry.
- Content: Overview of PEDs and digital twins, their benefits, and technical setup.
- Format: Online handbook and 1-3 online workshops.

Module 2: BIPED User (2026)

- Audience: Decision makers, municipalities, project managers, researchers, citizens, planners, energy and mobility planners.
- Content: Practical insights on using the BIPED digital twin, data exploration, and real-world applications.
- Format: Online handbook and workshops.

Module 3: BIPED Software Developer (2026)

- Audience: Software developers, technical professionals.
- Content: Technical details of the BIPED platform, APIs, and extending the digital twin.
- Format: Online handbook and workshops.

Further information on these modules and training can be found in D3.2¹⁷.

6.3.2 Communication and Dissemination for Sustainability

Sustainability is about ensuring BIPED continues to generate impact after the end of the project (December 2026), when it is no longer around as a consortium of 13 partners, but will exist predominantly as a collection of results created during BIPED's lifetime. Sustainability is not about simply having results 'out there' without knowing whether or not they are being used. Sustainability is achieved when results are used by those who have something to gain from their adoption.

For people to start using results, they first need to discover them. BIPED's promotional tactics include blogs, social media posts, videos, presentations, mentions on third-party platforms, networking, podcasts (from May 2025), training (from January 2026), and publications. The latter have a linked target of 10 peer-reviewed publications - that's how many papers BIPED needs to publish by the end of the project.

At the time of writing this deliverable, two peer-reviewed articles have been published in the ERCIM News magazine. Two more papers (one focusing on digital twins, another on stakeholder engagement) will be published by a PhD student working at the Aarhus Municipality. The remaining six publications will be delivered as journal articles, conference papers or manuscripts on Open Research Europe.

The ORE route is especially appealing. It offers many of the benefits of traditional publishing (peer review, indexing, open access) but at zero cost to the project (there are no article processing charges for open access), plus the whole publication process happens more quickly thanks to rapid publishing.

Several forthcoming deliverables are suitable for a publication on ORE. Potentially, policy briefs (D5.4, D5.5, D5.8) can be turned into white-paper style articles in which PED related results will be presented to a broad community of researchers, policy makers and

¹⁷ [BIPED_D3.2_BIPED Training Programme.docx](#)

practitioners. In addition, a consultation with partners will take place to determine which deliverables from WP2, WP3 and WP4 lend themselves to the ORE route, perhaps not as Open Letters but as Case Studies, Case Reports, Brief Reports, or Research Articles.

6.4 Sustainability Strategy and Expected Impact

The sustainability strategy aims to ensure long-term viability and maximise positive impacts across environmental, social, and economic dimensions. The digital twin is designed for scalability and replicability, allowing its benefits to extend across various contexts and sectors. The table below outlines the key outcomes and their expected impacts.

Table 8: Expected Outcomes

Outcome	Expected Impact
Increase the number of city planning actions for PEDs using the (proto-) PED design	The extended BIPED digital twin will allow city governments, urban planners and decision makers to take informed action on PED development by including various variables defining the urban environment. BIPED's sustainability strategy will focus on ensuring the longevity and adaptability of the digital twin by embedding it within the European data space environment. To ensure this outcome is reached BIPED and the consortium will engage with end users and key stakeholders by conducting workshops and training sessions via the Stakeholder Forum to educate city governments, urban planners and key decision makers on how to use the digital twin effectively in their sphere/sector. This ties in with KPI 24 (Number of Aarhus City Council Staff Trained to use the digital twin) as shown in D4.3: BIPED's approach to the use of open standards and MIMs aims to guarantee interoperability and ease of integration with other systems across Europe to ensure replicability. The objective is to ensure that sources for data representing included properties will be open source and available on a large European scale. Furthermore, BIPED will utilise our communication and dissemination work package (WP5) to share the project's outcomes, best practices and success stories with other cities via the Stakeholder Forum which will encourage end users and key stakeholders to adopt the digital twin solution.
Enhance data gathering approaches representing multiple variables	To enhance data gathering approaches, the strategy will focus on creating a robust and scalable data collection framework BIPED will work with initiatives like the smart communities data space Destination Earth as well as smart city/digital twin sister projects to integrate their data into the project. BIPED introduces a holistic view on PEDs using an extended digital twin representation of the testbed (Aarhus / Denmark) and hence, includes variables defining the urban environment (i.e. social, economic & environmental properties). This inclusion of variables will guarantee capacity for collecting and managing different data types and formats on a large scale. The specific needs of the stakeholders/end users are

	identified to define a list of relevant data-sets with the support of the Stakeholders Forum and the local end users, for the decision making processes that need to be undertaken. The definition and usage of MIMs and data shared models will allow for an open architecture and a replicable solution.
Introduce novel quantitative data gathering approaches to collect “soft data” that has been difficult to collect on a large scale.	Collected “soft data” through the project will complement more discrete data, such as energy consumption or mobility patterns, adding to the holistic picture of a PED. The extension of the BIPED digital twin goes beyond the inclusion of variables quantifiable by discrete numbers by introducing innovative methodologies to gather less easily quantifiable “soft data”. BIPED’s sustainability strategy will be developed through the interlinkages of WP2, WP3 and WP4 and utilise the data gathering approach by technical partners in WP2. This will be complimented alongside stakeholder engagement conducted as part of WP3 and WP4. This will foster better communication and collaboration between the public and policymakers, enhancing the inclusivity of decision-making processes and continuously refine approaches by regularly reviewing and improving data collection methods to ensure best practice and ensure impact during and after the lifespan of the project. This will be done through bi-weekly Technical Team meetings on the project which provides updates on the individual models which make up the digital twin and WP4 monthly meetings which provide a broader overview of end user and stakeholder engagements and supported by the ‘Event Feedback Form’ which is utilised by KPMG FA as part of the M&E lead in WP4.
Include data from various urban scales and levels, such as from building, district and city level:	The developed digital twin will include data from a variety of sources. At its base, it will include energy and mobility data, from small scale management systems (on building level for instance) to district and urban scale.
Increase the number of city planning departments, using data-driven digital twins by explaining methods, processes and results in workshops and drawing interpretations from them.	The strategy will emphasise knowledge sharing and capacity building to increase the adoption of data-driven digital twins. In order to ensure knowledge sharing with end users and key stakeholders via the Stakeholder Forum, BIPED will conduct workshops and training to explain the methods, processes, and results of the digital twin to city planning departments and other stakeholders. Through this training BIPED partners will facilitate action implementation in supporting end users and stakeholders in interpreting the results of the application of the digital twin and implementing actions based on these interpretations. This ties in with KPI(s) 1 (Number of community participation events organised/coordinated) and 2 (Number of Co-Creation & Training Workshops).

	WP4 will continuously monitor the implemented actions by users of the digital twin and evaluate their impact on PED development, providing feedback to improve future actions and the success in achieving project KPIs. Furthermore, this M&E action will also allow BIPED to share success stories and best practices via the project social media channels to encourage other cities to adopt the best practice approaches developed as part of BIPED and highlight the replicability of the digital twin.
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7. Conclusion and Next Steps

The BIPED digital twin solution provides a robust framework for real-time data integration, predictive analytics, and decision support, making it an invaluable tool for various industries. All data models that constitute the digital twin will be demonstrated through DKSR's CIVORA Platform, enabling end users to deploy BIPED solutions and share their data on the platform. While some models will be open source, others may be protected by intellectual property rights. The overall monetisation of the platform is currently under discussion.

The digital twin solution will be supported by the BIPED Impact Assessment Report and the Transition Recommendations Handbook, offering comprehensive guidelines and best practices for transitioning to and implementing digital twin technology, ensuring stakeholders can effectively harness its potential.

Over the first 16 months of the project, the consortium has built a robust framework for the development and deployment of the models that will constitute the digital twin solutions. Additionally, BIPED has established a comprehensive KPI framework to ensure all project objectives are met by month 36. The focus over the next months will be on properly implementing all solutions under the district-oriented lens and developing a business plan, culminating in the final version of the sustainability strategy in month 36.

To support this effort and to ensure the replicability and scalability of the BIPED's solutions, the consortium is availing of the Horizon Results Booster initiative, expected to commence shortly. These will be instrumental in substantiating the final BIPED Sustainability strategy due in M36. The following five modules have been selected:

Table 9: Horizon Results Booster Services

Booster Service(s)	Timing
2.3 Go to Market Module-A Kick Off	May 2025
2.3 Go to Market-Module B-Unique Value Proposition & Key Exploitable Results	June 2025
2.3 Go to Market-Module C Exploitation Strategy	August 2025
2.3 Go to Market-Module F-Reporting	October 2025
3.3 Intellectual Assets Management	November 2025

Workshops with project partners will be organised to discuss how each partner plans to utilise the KERs. These interactive sessions will facilitate knowledge sharing and collaboration, enhancing the collective understanding and application of the Digital Twin and Handbook. Feedback gathered during these workshops will be invaluable in continuously improving the KERs and their implementation strategies.

Engagement in specialised IPR training sessions with the Horizon Results Booster will be crucial for understanding the IPR landscape in this emerging area. These sessions will help in developing strategies to protect and manage the IPR associated with the digital twin solution, ensuring compliance with IPR regulations to safeguard the project's innovations. Furthermore, IPR workshops with project partners will be conducted to educate them on IPR best practices and their importance. These workshops will foster collaboration on developing joint IPR strategies to maximise the impact and reach of the models that constitute the digital twin solution.

By following these next steps, the project will be well-positioned to achieve its sustainability goals, ensuring that the BIPED results allow for replicability and scalability of the digital twin and deliver lasting value, driving innovation across multiple sectors.

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