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atelier
Positive Energy Districts

AmsTErdam BiLbao cItizen drivEn smaRt cities

Deliverable 6.2: Replication and Upscaling strategy

WP6, Task 6.2

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Document History

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Work Package Lead	CARTIF		
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DoA	In order to foster high replication potential of validated solutions in other conditions, a replication strategy will be developed making use of the generated knowledge in WP3, WP4 and WP5 by means of: • Establishment of a dialogue among LH and FC to identify commonalities and differences among the urban scenarios as an open discussion among PED Innovation Ateliers of each city. • Cross-cutting activity to benchmark existing urban strategies and city priorities of FC and LH and detect potential barriers for replication and upscaling. • First identification of the adaptation needs of the validated solutions for PED to foster an early replication. • Development of a general strategy to facilitate early replication and upscaling of the validated solutions in other European application scenarios.		
Date	**Version**	**Author**	**Comment**
20/10/2020	1	CARTIF	Table of content. First draft of deliverable
09/02/2020	2	CARTIF	1st draft of Section 4
11/02/2021	3	CARTIF	2nd draft of Section 4
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Table of contents

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 864374.

Table of Tables

Table of Figures

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 864374.

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Abbreviations and Acronyms

Acronym	Description
ABS	Asset Backed Security
AHP	Analytic Hierarchy Process
BM	Business model
CEF	Connecting Europe Facility
DHN	District heating network
DHW	Domestic hot water
DoA	Description of Action
EC	European Commission
ECSP	European Crowdfunding Service Providers
EE	Energy Efficiency
EEPR	European Energy Programme for Recovery
EERA	European Energy Research Alliance
EIB	European Investment Bank
EFSI	European Fund for Strategic Investments
EMA	Energy and Managing Authorities Network
EPC	Energy Performance Contract
EPBD	Energy performance of buildings directive
EPM	Ecosystem Pie Model
ERDF	European Regional Development Fund
ESCO	Energy services company
ESE	Energy Services Enterprise
EU	European Union
FC	Fellow city
GA	Grant agreement
GDP	Gross Domestic Product
GIS	Geographical information system
IEA	International Energy Agency
JPI	Joint Programming Initiative
JRC	Join Research Centre
KPI	Key performance indicators
LED	Light-emitting diode
LH	Lighthouse city
MOP	Method of procurement
PED	Positive Energy District
PESTLE	Political, Economic, Social, Technological, Legal and Environmental
PV	Photovoltaic
PVT	Photovoltaic thermal
RER	Renewable Energy Ratio
RES	Renewable Energy Sources
RFP	Request for Proposals
SCPGs	Smart City Planning Groups
SDG	Sustainable Development Goal
SET	Strategic Energy Technology
SME	Small and medium enterprise
SWOT	Strengths, weaknesses, opportunities and threats
VPP	Virtual power plant
WP	Work Package
ZED	Zero Energy Districts

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Executive Summary

The main objective of ATELIER project is to realise Positive Energy District in Amsterdam and Bilbao, to demonstrate how integrated smart urban (technical, financial, legal, social) solutions can support the deployment of PEDs, and to support the replication of these solutions in 6 Fellow cities: Bratislava, Budapest Copenhagen, Krakow, Matosinhos and Riga.

The aim of this deliverable is to develop a Replicable and Upscaling strategy to foster high replication potential of the validated solutions in the Lighthouse cities of ATELIER project (i.e. Bilbao and Amsterdam) as on the PED concept.

The ATELIER replication and upscaling approach is understood as the strategy to ensure the growing path of the ATELIER PED concept by supporting Bilbao and Amsterdam PEDs in upscaling their initial district, in adding new buildings and projects, or in the replication in other cities (or districts in same city). This replication and upscaling strategy is part of WP6 “PED replication and upscaling” and related to Task 6.2 “Development of a replication and upscaling strategy”.

This document first presents the guidelines, tools, methods and models that have been developed to support the PED replication and upscaling. These are the result of the dialogues established between Lighthouse and Fellows cities during the task duration, putting their experience and knowledge acquiring when implementing the demonstration activities, in the centre of the replication and upscaling strategy definition.

The main pillars of this replication and upscaling strategy are:

1) **ATELIER enablers of PED concept replication and upscaling:**
    a. The creation of the <u>Innovation Ateliers</u> to coordinate city council departments, integrate strategies and engage stakeholders from the PED innovation ecosystem.
    b. The definition of a <u>new governance model structure</u> to ensure the alignment of the PED replication and upscaling strategy with energy transition planning in the Bold City Vision.
    c. The definition of <u>a strong citizen engagement strategy</u> to ensure that the design and implementation of PEDs as part of the energy transition should be participative and citizen-driven.
    d. The deployment of a <u>continuous capacity building strategy</u>.

2) **ATELIER decision supporting tools, methods and guidelines:**
    a. An easy-to-use tool for PED technologies pre-selection
    b. A step-by-step methodology for PED calculation
    c. A catalogue of replicable smart urban solutions validated in the Lighthouse cities
    d. A set of guidelines for a PED Upscaling and replication strategy definition

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1. Introduction

WP6 aims at the creation of the required knowledge, methods or procedures to foster the replication of ATELIER PED concept in other cities that are willing to implement innovative smart solutions combined to 'classic' ones in order to support their energy transformation process and increase quality of life for citizens.

To achieve this target, three main activities will be outlined: 1) provide a standard definition of ATELIER PED concept considering the outcomes of ATELIER LH cities (WP4-5), 2) guide the adaptation of the validated solutions in the LHs to other scenarios considering the results of the Innovation Ateliers in WP3, and; 3) exchange the knowledge from LHs to FCs, when dealing with regulatory or financial barriers when designing the PEDs.

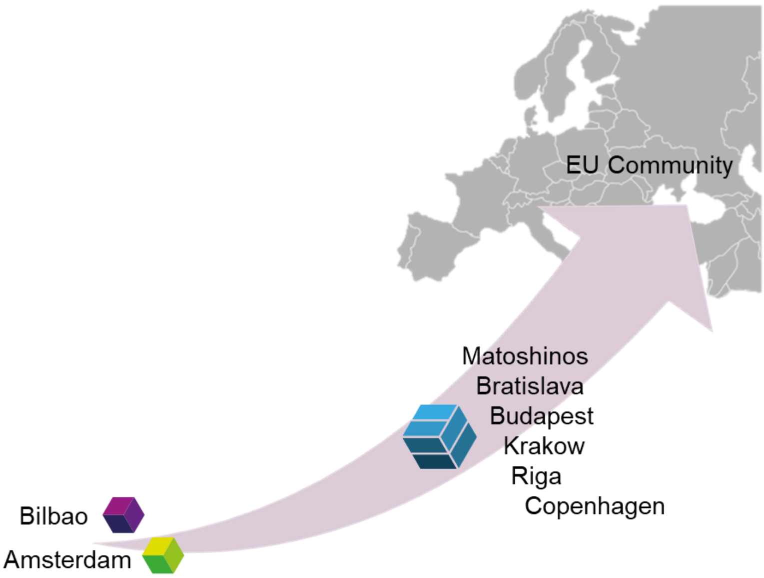

Figure 1. Replication and Upscaling process

In the context of the ATELIER project, PEDs are define as an **urban delimited area with an annual positive primary energy balance and local renewable energy** production where only building energy usage is considered. This open definition aims to facilitate each fellow city in the adaptation of this concept to the local specificities and to their specific needs and goals. At the same time, this deliverable will provide an overview of potential alternative EU PED definitions together with some indications (which elements can be included, different archetypes, how to deal with different energy flows, etc.) and resources (guidelines, self-evaluation tool, etc.) that can be used by the cities to replicate and upscale the concept, but without putting too many restrictions.

Therefore, one of the main objectives of this work package is to assist cities, in particular Fellow cities, in identifying suitable areas and smart solutions to meet the PED concept requirements, and in addressing the local challenges on an affordable manner without running into social rejection.

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1.1. Purpose and Target Group

Europe's endeavour to become the world's first climate neutral continent by 2050, in line with the climate ambitions of the Paris Agreement[2], comprise a huge challenge for cities' transformation throughout Europe. Cities need to orchestrate this decarbonisation transformation in a holistic way, bringing a wide range of opportunities and synergies together, and rely on new technologies, ways of working and management[3].

Despite the huge potential to develop and deploy innovations for climate mitigation, cities are facing many challenges related to the lack of cross-sectorial integration between city domains and departments, lack of adequate governance and finance structures to support the technical solutions, and lack of citizens support and acceptance of smart urban solutions.

The realization of Positive Energy Districts in cities fit within the ambition of becoming climate-neutral cities, as these districts deliver more energy than they use. The European Strategic Energy Technology Plan (SET Plan) guides the development and deployment of low-carbon energy technologies. A recent SET-Plan publication about the realization of PED-districts states the reasons that the development of Positive Energy Districts requires an open innovation model to support the planning, deployment and replication, and to foster the cooperation within the city among different types of stakeholders, from industry, service providers and investors, to citizens[4] [5].

ATELIER Replication and Upscaling Strategy will support cities in replicating PED projects, and/ or in testing pilot interventions in the context of the ATELIER project.

The deliverable reports on upscaling and replication approach and methodologies used in the ATELIER project, so that other cities could benefit from the lessons learned.

The main purpose of this deliverable is to develop a Replication and Upscaling strategy to foster the replication potential of the smart solutions validated in the LHs by promoting Positive Energy Districts as a tool for decarbonising cities. PEDs export more energy than what is consumed and help to balance the external grids. The report is structured along the following lines:

1. **General introduction on the upscaling and replication approach for PED's in the Atelier project** (section 2), including a brief description of the necessary conditions for upscaling and replication, such as citizen involvement and political support and commitment
2. **Detailed description of the main methods** (section 3) aimed at upscaling and replication applied in the project and different tools (technical and non- technical) that can be used in upscaling and replication. The methods and tools will be illustrated throughout the report with examples from the Atelier project.
3. **Step-by-step methodology** (section 4) to guide a city along the process of a PED project design, starting from understanding the city context, to continue with the City diagnosis and district level to select potential areas of the city to become a PED, to

[2] European Commission, European Green Deal, 11.12.2019 COM(2019) 640 final, Brussels, 2019
[3] European Commission Final Report of the High-Level Panel of the European Decarbonisation Pathways Initiative; Brussels, 2018
[4] Europe to become a global role model in integrated, innovative solutions for the planning, deployment, and replication of Positive Energy Districts, SET-Plan ACTION n°3.2, Implementation Plan, June 2018
[5] Bogers, M., Chesborough, H. and Moedas, C.; Open Innovation: Research, Practices and Policy, in California Management Review, Vol 60, Issue 2, 2018; https://doi.org/10.1177/0008125617745086

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finalise with a detailed design of potential scenarios and their prioritization and final selection,

The target group of this document embraces a wide range of potential future cities aiming to replicate PED concept: starting from ATELIER Fellow and Lighthouse cities, to other 'external' cities interested in replicating the demonstrated solutions. This document will guide FCs on what is a PED, how to design and replicate it within the city. Moreover, this document will guide LHs on how to upscale the concept to achieve a higher impact.

Other potential target groups will be city administration professionals, city planners, financial players, intermediaries, local fund raiser experts and, even the final end-beneficiaries of PED projects/programmes themselves: the citizens to whom this document is also publicly available.

1.2. Contributions of Partners

The following Table 1 depicts the main contributions from project partners in the development of this deliverable.

Table 1. Contributions of Partners

Partner short name	Contributions
CARTIF	Main contributor: coordinates the development and definition of the whole replication and upscaling strategy of the ATELIER PED concept. Develop a procedure for guiding the early replication and upscaling of the validated solutions to other scenarios
TNO	Support fellow cities and the strategy by means of the Innovation ATELIERS (link WP3). Identification of stakeholders and non-technological barriers devoted to the local context. Contributes to the guide by identifying how to adapt solutions to other scenarios
Tecnalia	WP2 link: how to align the replication and upscaling strategy of the PED concept with the City Vision 2050
Waag Society	Co-design and city engagement strategies for replication and upscaling of PEDs
AUAS	Capacity building and financing support
MunBud	Validate the defined strategy to support cities in leading their own replication plan definition. Adaptation needs identification of the Lighthouse Cities smart urban solutions
Matoshinos	
Riga EnAg	
COP	
Bratislava city	
City of Krakow	
Amsterdam	Transfer their knowledge and experience when designing and implementing their PEDs and validate the strategy defined to ensure that any city could replicate their smart solutions.
Bilbao	

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2. Upscaling and replication approach

The replication and upscaling approach within ATELIER project is understood as the strategy to ensure ATELIER PED concept growing path by adding value to Bilbao and Amsterdam PEDs ensuring their upscaling in extending the initial district by adding new buildings and projects, or replication in other cities (or districts in same city).

- **Upscaling** refers to extending the initial PED by adding buildings, energy production facilities and other components. The upscaling of PEDs is important to enable the integration of renewable energy sources and expansion of smart energy solutions. The initial design of a PED can influence success factors for upscaling, (e.g. the selection of off-site renewable energy in one PED limits the options for the next PED). For a demonstration pilot, a certain area needs to be chosen, but the growth path should ideally already be present as part of the plan. In ATELIER, upscaling is relevant for the Lighthouse cities and the PED demos.
- **Replication** refers to implementing a proven PED concept (including technologies, business models and governance) in the city or in another city without a direct connection to the initial PED. PED solutions can be replicated by adapting the original idea to a new context, creating a comparable project in another location. Assessing the feasibility of replicability includes determining parts of the PED that can be transferred directly, and which need to be adapted. Replicability should also consider the local context, geographical and regional differences as well as differences in political, planning and ownership structures. In ATELIER, replication is relevant for the Fellow Cities as well as for the Lighthouse cities (replication in other areas of the city).

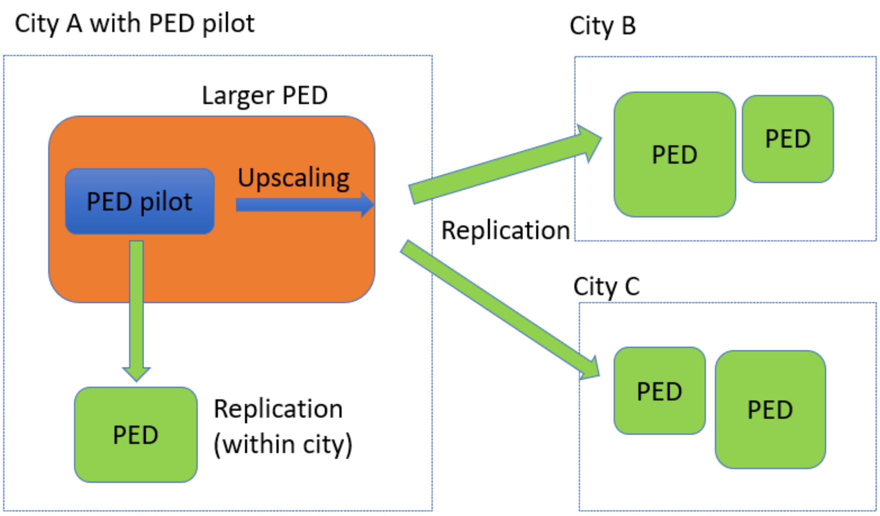

Figure 2. ATELIER Replication and Upscaling approach

Therefore, Bilbao and Amsterdam Lighthouse cities experiences have been key in the definition process of the ATELIER PED Replication and Upscaling strategy. This is because, the strategy is targeted at replicating the implemented solutions from the Lighthouse cities in other cities ‘districts, and more specifically during the project, in the Fellow cities and in the metropolitan regions around the Lighthouse cities.

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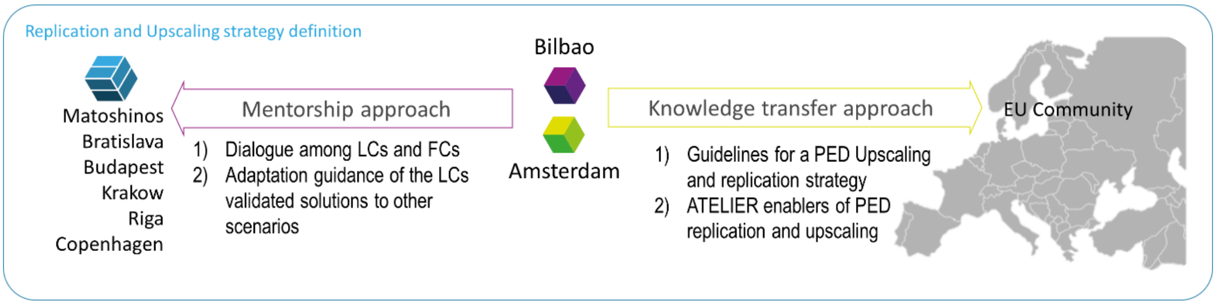

Figure 3. ATELIER PED Replication and Upscaling strategy definition approach

(Source: own elaboration)

As it can be seen in the Figure 3, a **Knowledge transfer approach** to the EU Community will be pursued by means of delivering a set of Guidelines for a PED Upscaling and Replication, complemented with the enablers (methods, strategies and tools) that are supporting Bilbao and Amsterdam during the PED design and implementation.

A **Mentorship approach** will be also performed. The goal is to support a continuous dialogue between the Lighthouse and the Fellows cities, promote knowledge exchange, and guide them in the adaptation of the validated solutions to the local cultural, social, economic and legal contexts.

2.1. Necessary conditions for upscaling and replication

ATELIER project accounts with around three years of experience implementing PED technologies (WP4 & 5), working on methods and tools for addressing the city climate challenges (WP2) and overcoming the barriers that appear during the PED design and implementation process (WP3 &7). Based on ATELIER project findings, this are the main identified conditions for upscaling and replication:

Political support and commitment

Large-scale transformations are necessarily complex processes. For this sufficient human resources, budget, collaboration, and coordination between several departments in the local administration are required. As a result, strong political commitment is crucial for a successful transformation in the city.

It is important to note that, within the EU Missions initiative, six out of the eight ATELIER cities (Amsterdam, Bratislava, Budapest, Copenhagen, Krakow and Riga) are now part of the 100 climate-neutral and smart cities by 2030. The decision of applying to be part of this initiative shows by itself the political commitment of ATELIER cities in putting efforts to accelerate the achievement of decarbonization.

In order to fulfil this ambition, cities leadership is key to be a pioneer in this transformation and the ability to bring in allies. Therefore, Cities Mission has identified the necessity of involving local authorities, citizens, business, investors as well as regional and national authorities. Being aware that the integration of all the relevant perspectives in the planning procedures is a must to increase cities chances of better coping with their urban transition challenges, the creation of a local orchestration group is proposed, following ATELIER cities experience in the context of WP2 to create the city vision. So that, **Smart City Planning Groups (SCPG)** are proposed to lead not only the long-term city strategy but also the PED replication and upscaling plans design and implementation.

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Stakeholders' involvement

The design and implementation of PEDs requires a strong cooperation of many stakeholders from the local ecosystem, varying from country to country, also depending on the national legal and regulatory context.

In essence, a PED requires that all stakeholders, including citizens, come together and collaborate to develop the best-fit solution for and by the citizens and municipalities in order to play their role in the global climate crisis. With the support of an enabling policy framework, the citizens of the communities should be able to develop their district concepts themselves[6]. Following this approach, empowered citizens and stakeholders, will take the lead in their own communities on reducing the carbon footprint of Europe.

Public participation

It is a common understanding that the successful development and implementation of Positive Energy Districts requires the support of citizens since they are seen as a key pillar of the energy transition process. Therefore, by engaging and facilitating public participation, the role of the citizen transforms from a passive consumer to an active participant in the transition[7].

Trained municipal staff on innovation management

For local governments, the implementation of any innovative strategy supporting the long-term energy transition or any other transition paths, implies a continuous process of learning so as to incorporate innovative technology in the government everyday operations. Besides considering a long-term vision, it is important to consider the human resources required for a PED project to evolve rapidly and firmly. PEDs is a novel and complex, multifaceted urban concept (Amaral et al., 2018), therefore, it is important to invest in the training of municipal staff as much as in the acquisition of technology.

Provision of finance support

The implementation of the Replication and Upscaling strategy implies financing large-scale sustainable transformations. The transformation of the existing cities into Smart Cities will not be possible without the establishment of a new economic paradigm that makes it economically feasible, even in the frame of today public expenditure constraints. The introduction of smart city innovations is hampered by a number of financial barriers. The lack of public financial capacity requires business models that are capable to attract private financing. To realise the full potential of Smart City projects, it is needed to combine public funds with private financing leveraging investments and addressing financial barriers for a broad implementation of smart interventions. Local and regional authorities face the difficult challenge of attracting investments mainly due to lack of awareness and expertise in small-scale financing.

[6] Shnapp, S., Paci, D. and Bertoldi, P., Enabling Positive Energy Districts across Europe: energy efficiency couples renewable energy, EUR 30280 EN, Publications Office of the European Union, Luxembourg, 2020, ISBN 978-92-76-21043-6, doi:10.2760/452028, JRC121405.

[7] Wahlund, M.; Palm, J. The role of energy democracy and energy citizenship for participatory energy transitions: A comprehensive review. Energy Res. Soc. Sci. **2022**, 87, 102482.

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2.2. Background: ATELIER PED concept

Aiming at understanding the background of ATELIER PED concept, a desk research was performed as it is reported in the following sections. Previous SCC-1 projects and existing initiatives were reviewed in order to stablish the starting point. Specifically, the analysis was focus on understanding: i) the state of the art of the PED framework, ii) the elements to be considered when designing PEDs, iii) the types of boundaries and iv) the types of PEDs already defined in the literature.

2.2.1. State of the art of the PED framework

Cities have grown as isolated systems, such as transport, building, industry, tourism, without considering the interdependencies between them. Beside this problem, the Mission Board for Climate-Neutral and Smart Cities emphasizes the climate neutrality need, climate change and health crisis. To overcome these problems, cities must orchestrate the transition in a holistic approach, since windows of opportunity and possible synergies are otherwise easily missed. Capacity building to change this mindset, as well as co-evolvement of technological innovations of all actors (city administrations and businesses, large-scale public and private investors, citizens) are fundamental to make this happen (European Commission, 2020).

Positive Energy Districts (PED) is a concept that goes beyond Nearly Zero and Zero emission districts (NZED and ZED, respectively), by producing more renewable energy production than what is needed in the district. Thus, this excess of energy can decarbonise parts of the city that are not economically feasible to refurbished. Furthermore, a holistic way to design district is followed in PEDs (Monti, Pesch, Ellis, & Mancarella, 2016), as it considers mixed-used districts, horizontal vector integration (heating and cooling, power and gas sector interaction, among others), and an enormous amount of flexible assets and IT management systems.

Several definitions can be found in the literature, and is being debated among different stakeholder platforms: JPI Urban Europe (JPI Urban Europe, 2019), European Energy Research Alliance (EERA) (EERA JP Smart Cities, 2019), International Energy Agency Annex 83 on PEDs (IEA EBC - Annex 83, 2020), among others. The characteristics that a PED should have are different in each platform and can be found in (Gabaldón Moreno, Vélez, Alpagut, Hernández, & Sanz Montalvillo, 2021).

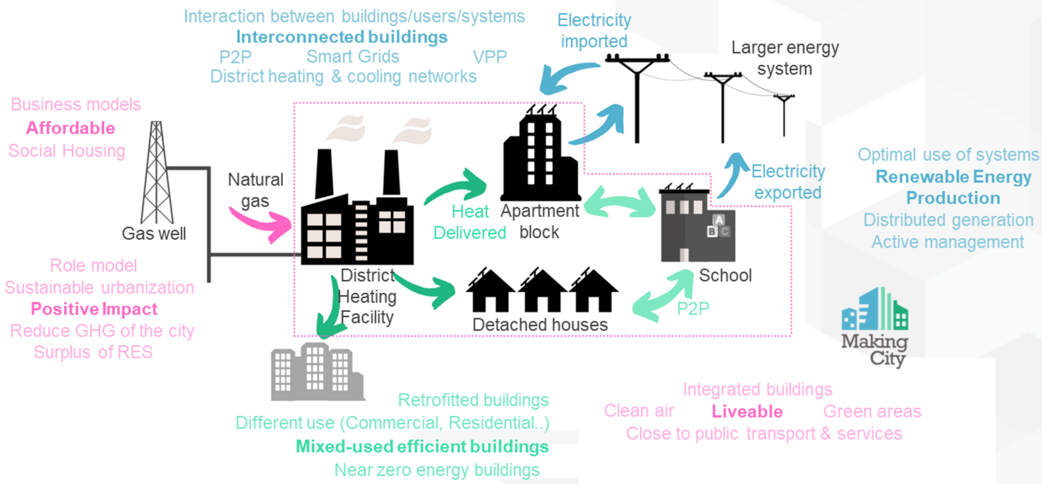

Figure 4. Characteristics of a Positive Energy Districts found in the literature

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(Gabaldón Moreno, Vélez, Alpagut, Hernández, & Sanz Montalvillo, 2021).

The SET Plan Action nº 3.2 defined "The Temporary Working Group (TWG) 3.2 has developed an integrative approach to Positive Energy Districts (PED) including technological, spatial, regulatory, financial, legal, environmental, social and economic perspectives. PEDs will be developed in an open innovation framework, driven by cities in cooperation with industry and investors, research and citizen organisations. In this context, a PED is seen as a district with annual net zero energy import and net zero CO_2 emissions, working towards an annual local surplus production of renewable energy" (SET-Plan Action 3.2 on Smart Cities and Communities). The last H2020 funding calls also mentioned that the PED should have a "positive impact" on the city and that "should actively manage their energy assets of the district" (European Commission, 2019). Furthermore, in this call a minimum area of 15,000 was required to be eligible for the funding. The Joint Programming Initiative (JPI) Urban Europe, includes other characteristics on the PED definition, such as PED should be an "added value to the user" or achieve an "affordable and high-quality living standard" (JPI Urban Europe, 2019). The IEA EBC Annex 83 on PEDs adds that "the basic principle of Positive Energy Districts (PEDs) is to create an area within the city boundaries, capable of generating more energy than consumed and agile/flexible enough to respond to the variation of the energy market because a PED should not only aim to achieving an annual surplus of net energy. Rather, it should also support minimizing the impact on the connected centralized energy networks by offering options for increasing onsite load-matching and self-consumption, technologies for short- and long-term storages, and providing energy flexibility with smart control" (IEA EBC - Annex 83, 2020). Furthermore, the Join Research Centre (JRC) included that PEDs or Zero Energy Districts (ZEDs) is "an area with defined borders that:

- is based on open and voluntary participation, is autonomous, and it is effectively controlled by its citizens.
- Its purpose is to provide environmental, economic, or social benefits to the community.
- Has an overall energy balance of zero or positive over a year?
- Has buildings with very high energy performance, complying with applicable minimum energy performance requirements and local building codes.
- Has buildings with a nearly zero or very low amount of energy demand.
- Has its building demand covered to a very significant extent, or more, by renewable energy sources.
- Where renewable sources are produced on-site or nearby"

Plus, the JRC emphasizes the importance of communities, social innovation, and the requirement for all stakeholders to collaborate (Shnapp, Paci, & Bertoldi, 2020). In MAKING-CITY project (MAKING-CITY, 2018) a methodology has been defined to the design a PED (Alpagut, Akyürek, & Mitre, 2019; Alpagut & Gabaldón, 2020), with six phases, where city characteristics (indicators, resource analysis, macro-scale analysis, etc.), boundaries (PED area identification), citizen involvement, solutions and their barriers (in form of solution cards called SPECs) and the calculation are considered.

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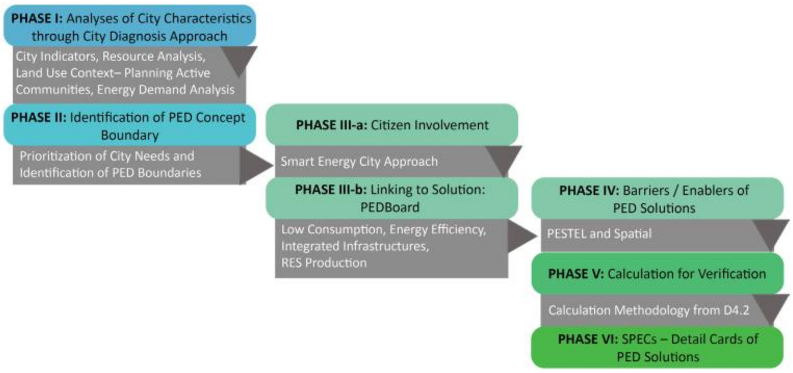

Figure 5. MAKING-CITY PED DESIGN methodology (Alpagut & Gabaldón, 2020)

As a conclusion, the literature agrees on considering PED as **a group of buildings that produce more energy than what is consumed. This can be achieved by having a low energy demand in the buildings, and by installing renewable energy technologies, which considers advanced materials, local RES, local storage, smart energy grids, demand-response, cutting edge energy management (electricity, heating and cooling), user interaction/involvement and ICT.**

2.2.2. Elements to be considered

In ATELIER, the following elements will be considered in the design of a PED:

- **Final energy consumption** of the buildings included in the PED area (or energy delivered): of all energy vectors (fuels, heat or cool from networks, electricity, etc.)
- **Energy demand** of the buildings included in the PED area. Covering EPBD of the ISO 52000 standards: domestic hot water (DHW), space heating and cooling (SH and SC, respectively), ventilation and lighting energy needs.
- **Local renewable energy production** (which means: geographical boundaries)

As Figure 6 shows, the main components of PEDs are: 1) Energy Efficiency, which tries to reduce as much as possible the building energy demand, 2) Renewable energy sources, to have local energy production and reduce the final energy consumption from sources outside the boundaries, 3) Energy flexibility, through the use of storage or smart controls that allows to reduce peak demand (thanks to load shifting), 4) Electric mobility, to decarbonise more sectors in the district.

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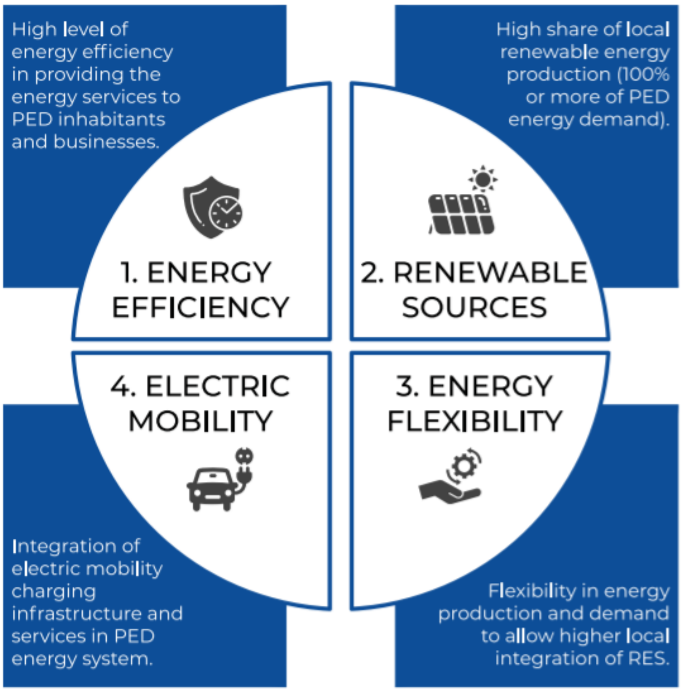

Figure 6: Main components of PEDs[8]

Besides the elements above-mentioned (final energy, energy demand and local production), mobility loads (green vehicles and charging stations), energy needs of the street infrastructures (road, street lighting, etc.), a life cycle perspective or/and circular economy perspectives (resource streams optimization, waste management, etc.) can be considered in the design but are not mandatory. The approach taken in MAKING-CITY PED calculation guidelines[9] is to allow the calculation of the PED to be adjusted for each specific case, by selecting within a checklist the different elements and boundaries to be considered for the energy balance to ensure transparency, while allowing PED concept to adapt to the different cities' characteristics. ATELIER follows the same approach, using a self-evaluation tool (Figure 7, see Annex 1).

[8] Vandevyvere, H.; Ahlers, D.; Alpagut, B.; Cerna, V.; Cimini, V.; Haxhija, S.; Hukkalainen, M.; Kuzmic, M.; Livik, K.; Padilla, M.; et al. SCIS EU Smart Cities Information System. Positive Energy Districts Solution Booklet. 2020. Available online: https://smartcities-marketplace.ec.europa.eu/insights/solutions/solution-booklet-positive-energy-districts (accessed on 1 October 2021).

[9] Alpagut, B., Gabadón, A., Annex I Guidelines for Postive Enegy district Design. MAKING-CITY G.A. n°824418. Available online: https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&cad=rja&uact=8&ved=2ahUKEwiuhcD5xv36AhVGTcAKHftGCesQFnoECBIQAQ&url=https%3A%2F%2Fmakingcity.eu%2Fwp-content%2Fuploads%2F2020%2F12%2FGuidelines-for-PED-DEsign.pdf&usg=AOvVaw1DRLPJnFd5olzD-5Awbkkc (accessed on 26 October 2022).

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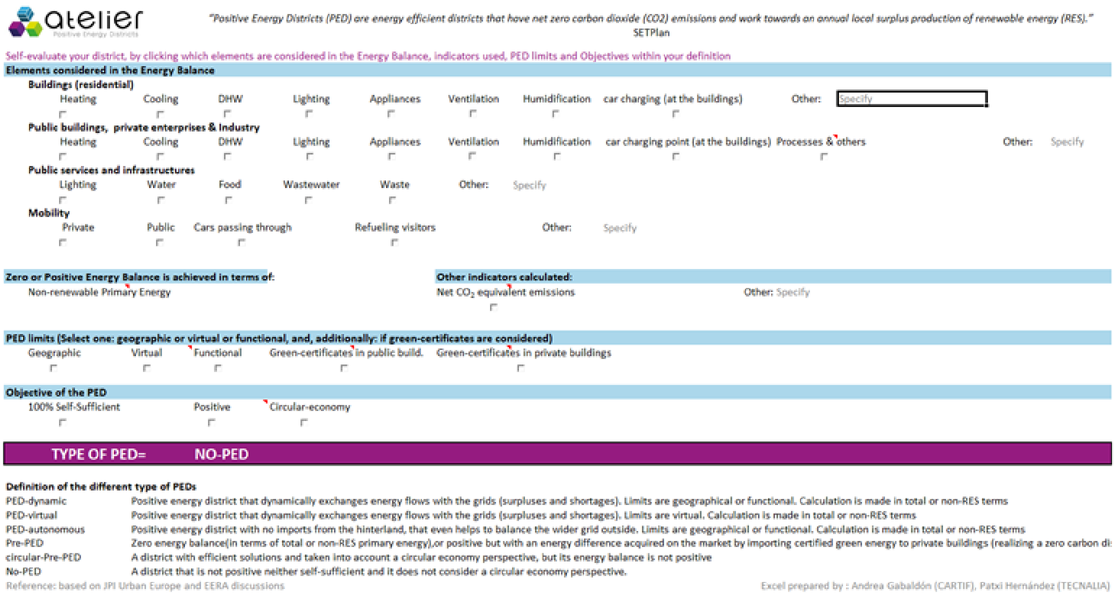
"Positive Energy Districts (PED) are energy efficient districts that have net zero carbon dioxide (CO2) emissions and work towards an annual local surplus production of renewable energy (RES)." SETPlan

Self-evaluate your district, by clicking which elements are considered in the Energy Balance, indicators used, PED limits and Objectives within your definition

Elements considered in the Energy Balance

Buildings (residential)
Heating | Cooling | DHW | Lighting | Appliances | Ventilation | Humidification | car charging (at the buildings) | Other: Specify

Public buildings, private enterprises & Industry
Heating | Cooling | DHW | Lighting | Appliances | Ventilation | Humidification | car charging point (at the buildings) | Processes & others | Other: Specify

Public services and infrastructures
Lighting | Water | Food | Wastewater | Waste | Other: Specify

Mobility
Private | Public | Cars passing through | Refueling visitors | Other: Specify

Zero or Positive Energy Balance is achieved in terms of:
Non-renewable Primary Energy

Other indicators calculated:
Net CO_2 equivalent emissions | Other: Specify

PED limits (Select one: geographic or virtual or functional, and, additionally: if green-certificates are considered)
Geographic | Virtual | Functional | Green-certificates in public build. | Green-certificates in private buildings

Objective of the PED
100% Self-Sufficient | Positive | Circular-economy

TYPE OF PED= NO-PED

Definition of the different type of PEDs

PED-dynamic	Positive energy district that dynamically exchanges energy flows with the grids (surpluses and shortages). Limits are geographical or functional. Calculation is made in total or non-RES terms
PED-virtual	Positive energy district that dynamically exchanges energy flows with the grids (surpluses and shortages). Limits are virtual. Calculation is made in total or non-RES terms
PED-autonomous	Positive energy district with no imports from the hinterland, that even helps to balance the wider grid outside. Limits are geographical or functional. Calculation is made in total or non-RES terms
Pre-PED	Zero energy balance(in terms of total or non-RES primary energy),or positive but with an energy difference acquired on the market by importing certified green energy to private buildings (realizing a zero carbon di
circular-Pre-PED	A district with efficient solutions and taken into account a circular economy perspective, but its energy balance is not positive
No-PED	A district that is not positive neither self-sufficient and it does not consider a circular economy perspective.

Reference: based on JPI Urban Europe and EERA discussions
Excel prepared by : Andrea Gabaldón (CARTIF), Patxi Hernández (TECNALIA)

Figure 7. Self-evaluation Excel tool

2.2.3. PED boundaries

From a technical point of view a PED is characterized by achieving a positive energy balance within a given boundary. Such boundary that depends on the urban context, can be a (JPI Urban Europe, 2019):

- **Geographical boundary**: Spatial-physical limits of the PED in terms of delineated buildings, sites and infrastructures –these may be contiguous or in a configuration of detached patches
- **Functional boundary:** Limits of the PED in terms of energy grids, e.g. the electricity grid behind a substation that can be considered as an independent functional entity serving the PED; a district heating system that can be considered as a functional part of the PED even if the former's service area is substantially larger than the heating sector of the PED in question; or a gas network in the same sense
- **Virtual boundary:** Limits of the PED in terms of contractual boundaries, e.g. including an energy production infrastructure owned by the PED occupants but situated outside the normal geographical PED boundaries (e.g. an offshore wind turbine owned through shares by the PED occupant community)

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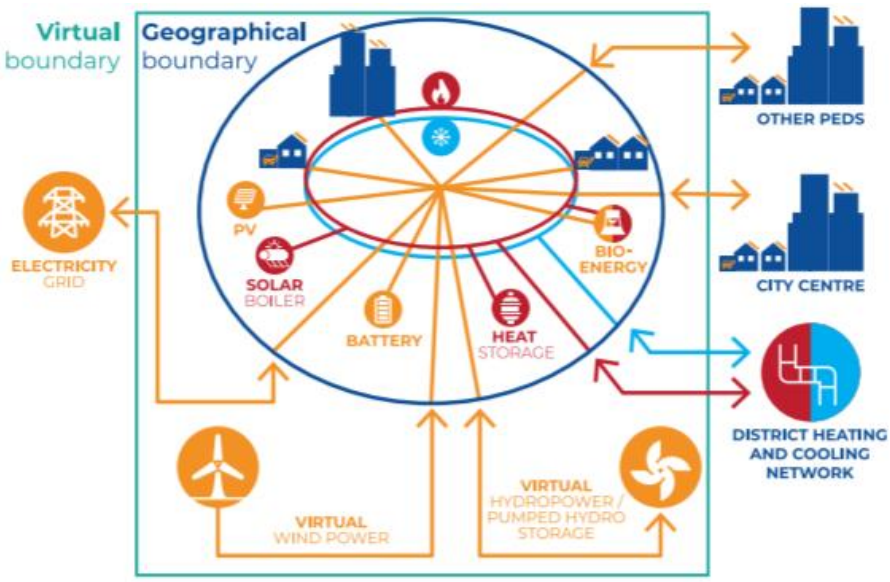

Figure 8. PED boundaries (Ahlers, et al., 2020)

Example 1: Kaukovainio and Groningen PED. City of Oulu and Groningen (MAKING-CITY project)

Kaukovainio PED consists of five buildings (four residential and one shopping mall) connected by means of a low temperature district heating network. Instead, the PED of Groningen consists of seven buildings connected that are separated in two areas (two different districts: Paddepoel and Oosterpoortwijk), but the balance is calculated as a whole considering only the buildings where an intervention is implemented. Groningen (See Figure 9) shows that the PED is form by two patches: one in the north and another one in the southeast, with 6 buildings (3 in each zone) and two solar parks located nearby the buildings (less than 4 km). The geothermal source is not longer feasible (due to environmental restrictions).

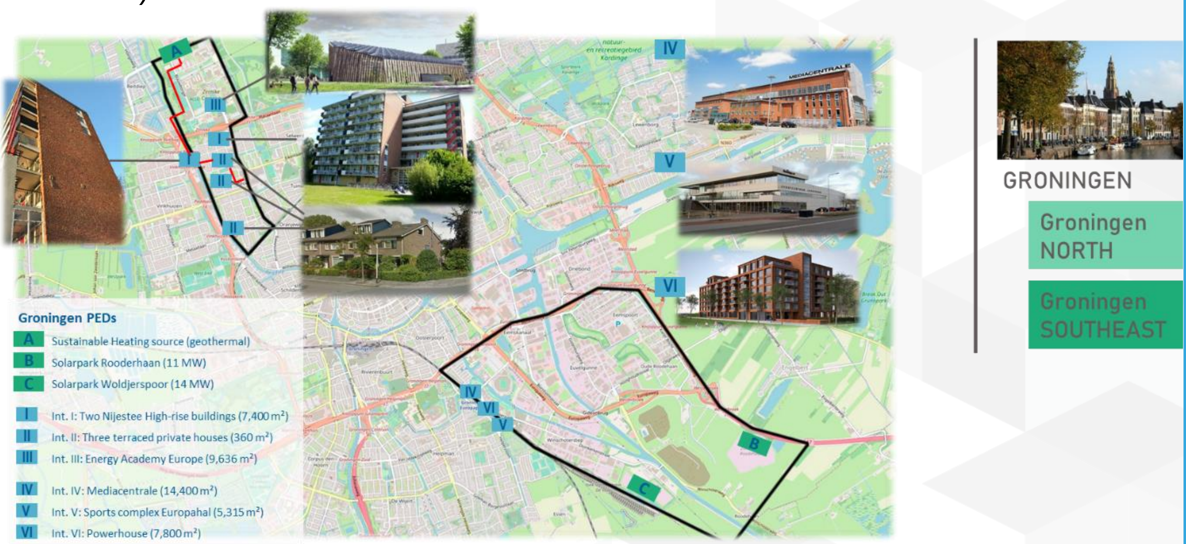

Figure 9. Groningen PED (initial plan)

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Example 2: Zorrotzaurre PED. City of Bilbao (ATELIER project)

Bilbao PED has functional boundaries since it is form by three detached areas (north, centre, south areas) connected by the geothermal ring. The 3 areas are mixed-use building and north area even includes an old industry building, and a building for multiple uses.

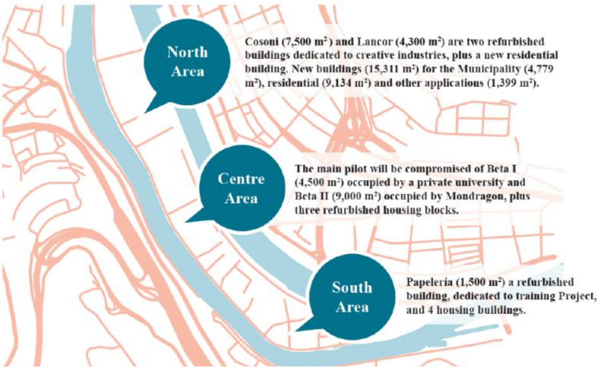

Figure 10. Zorrotzaurre PED (initial plan)

2.2.4. PED types

Lindholm, Rehman, & Reda et al. defined four types of PEDs, according to the way the energy balance is achieved, and thus provide for system flexibility and operational optimization potential:

- **Auto-PED (PEDautonomous):** 'plus-autarkic', net positive yearly energy balance within the geographical boundaries of the PED and internal energy balance at any moment in time (no imports from the hinterland) or even helping to balance the wider grid hinterland outside
- **Dynamic-PED (PEDdynamic):** net positive yearly energy balance within the geographical boundaries of the PED but dynamic exchanges with the hinterland to compensate for momentary surpluses and shortages
- **Virtual-PED (PEDvirtual):** net positive yearly energy balance within the virtual boundaries of the PED but dynamic exchanges with the hinterland to compensate for momentary surpluses and shortages
- **Candidate-PED (pre-PED):** no net positive yearly energy balance within the geographical boundaries of the PED but energy difference acquired on the market by importing certified green energy (i.e. realizing a zero-carbon district)

Example: Virtual PED projects

SPARCS project (GA No. 864242) and also +CityXchange project (GA No. 824260) are applying a virtual concept, where part of the energy technologies is located outside the geographical boundaries of the district.
In the case of +CityXchange project a tidal turbine is placed in the nearby river, which generates 0.4GWh/yr of electricity (IES, 2020).

In SPARCS project a virtual power plant (VPP) concept is introduced in the two PED projects of the lighthouse cities: in Espoo (Hukkalainen, et al., 2020) and Leipzig (City of Leipzig;Leipziger Stadtwerke;Leipzig University;Cenero Energy GmbH; seecon Ingenieure GmbH;WSL Wohnen;Service Leipzig GmbH;Fraunhofer; SUITE5, 2020). In Espoo the VPP buys CO_2 free electricity from Nordpool and locally produces energy with PV (750 kWp). Furthermore, loads (electrical equipment, HVAC, elevators, EV-chargers) are managed

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together with a stationary energy storage (2MW and 2.1 MWh). Through Virtual Power Plant in electricity reserve markets is operated by Fingrid.

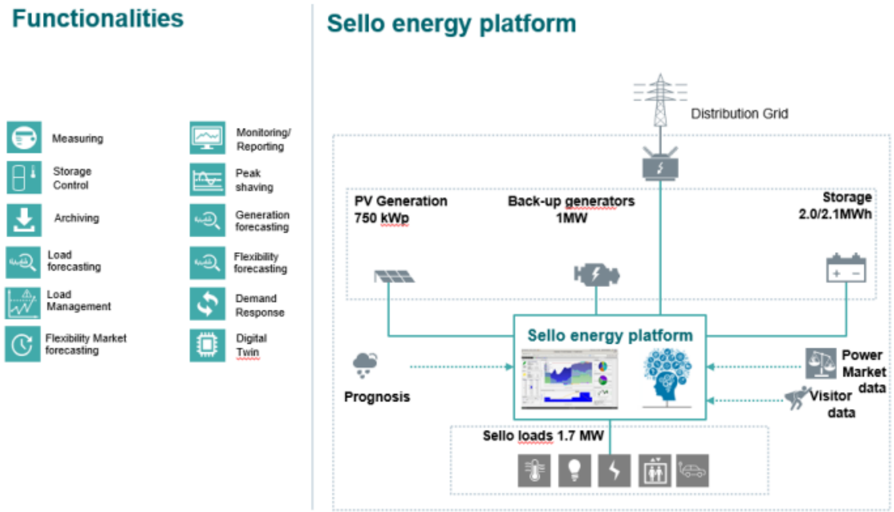

Figure 11. Espoo virtual power plant (Siemens – Sello's smart energy system[10])

In Leipzig, the virtual district consists of the VPP, where a wide variety of assets are connected to create an optimised energy management system with real-time data, for example, by selling energy from the VPP when demand is exceeded in the microgrid. PV (1.53MW) and batteries (10 MW) are used. A geothermal, HVAC systems and a combined-heat and power unit are integrated to balance the network.

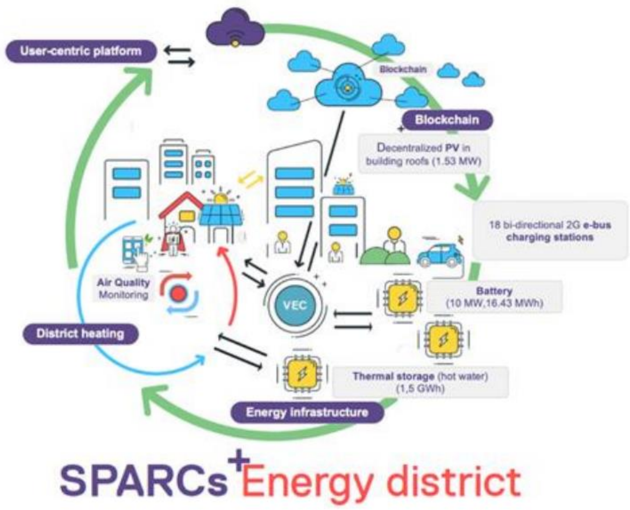

Figure 12. SPARCS energy district[11]

[10] D3.3 – Implemented demonstration solutions for energy positive blocks in Espoo https://www.sparcs.info/sites/default/files/2022-10/D3.3_Implemented%20demonstrations%20of%20solutions%20for%20energy%20positive%20blocks%20in%20Espoo.pdf
[11] D4.3 Implemented demonstration solutions for energy positive blocks in Leipzig https://www.sparcs.info/sites/default/files/2022-10/D4.3_Implemented%20demonstrations%20of%20solutions%20for%20energy%20positive%20blocks%20in%20Leipzig.pdf

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3. ATELIER enablers of PED replication and upscaling

Based on ATELIER lighthouse cities experiences, several "enablers" by means of models, tools and strategies have been collected in this section. The goal is to support the implementation of PEDs (WP4-5) but also, due to their successful impact, the replication and upscaling of ATELIER PED concept not only in Bilbao and Amsterdam but also in other potential urban scenarios (WP6).

Included in the Replication and upscaling strategy, the potential users (policy makers, public authorities, investors, producers (energy companies), NGOs, citizens, academia) are provided by a variety of practical instruments and approaches for easing the decision-making process. These enablers are not mutually exclusive and can be easily combined to produce synergies and enhance effectiveness.

The following figure shows the models, strategies and tools explained in this section, and the application phases over the Replication and Upscaling strategy:

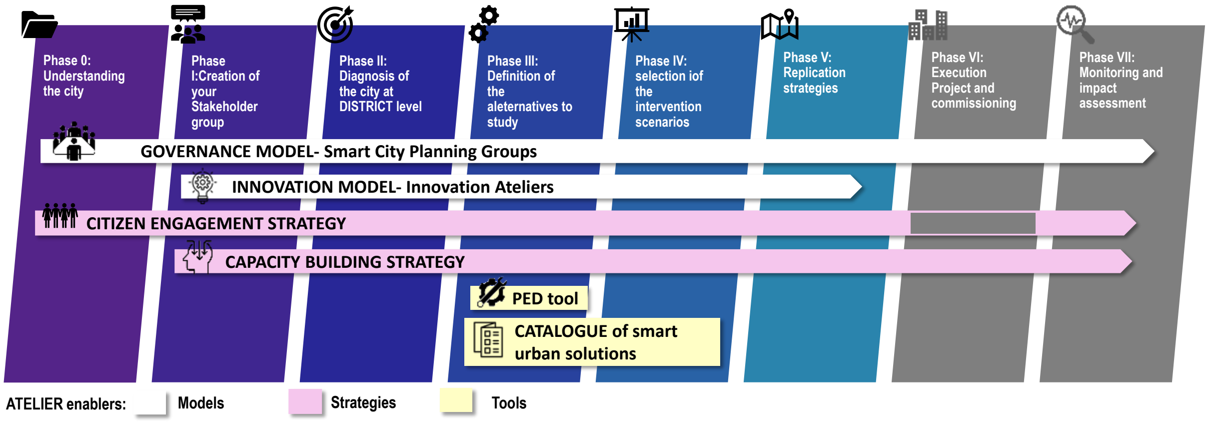

Figure 13. Proposed enablers for PED replication and upscaling

3.1. Governance model- Smart City Planning Groups

As it was already mentioned, cities have a huge potential to develop and deploy innovations for climate mitigation (and adaptation), but face many challenges such as the cross-sectorial integration between separate domains and departments in the city, having adequate governance and finance structures available to support the technical solutions, and seeking support of citizens for the smart urban solutions.

Within the first "*Step 1.Engage"* of the Cities4ZERO methodology for City Vision creation (Urrutia et al, 2020), Smart City Planning Groups (SCPGs) were proposed as a governance model within each city's organization to enable the energy perspective integration in existing urban planning dynamics and Smart City planning structures. SCPG is a dynamic, flexible, and adaptable governance model created for steering the urban energy transition journey within municipalities.

Energy transition governance models need to harness existing interactions between governance levels and actors in the city, that is to say that the **governance model should be multi-scale** to support the collaboration across administrative levels.

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On the other hand, **the governance model should be multi-actor** (considering the quadruple helix principles) so as to support the collaboration among local governments and with civil society, and between business associations, municipalities and trade union to ensure the capacity to coordinate three main planning dynamics inherent to the energy transition process in cities:

- The planning process itself, ensuring an integrated approach
- The engagement of key local stakeholders and partnership building in the process
- A suitable access to the information and data required.

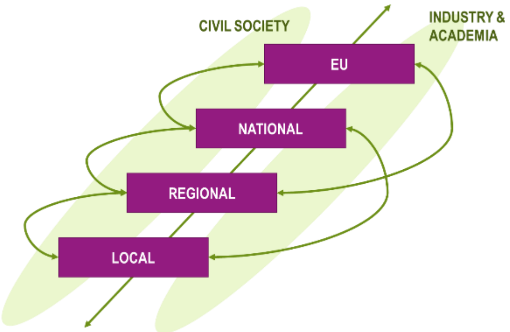

Figure 14. Multi-level and multi-actor approach.
Source: own elaboration adapted from Tentacle (2017)

The governance model proposed by ATELIER should be tailored to the needs of the city and evolve over time, so the process to build the right governance model starts with the 1) **understanding of the existing governance structures** as the framework of rules, procedures, roles and responsibilities that constitute decision making processes and project management; 2) **legitimising and making it transparent,** which means to engage a broad range of stakeholders by a sound engagement strategy definition from the very beginning of the project; 3) **allocating responsibilities for key decisions and building partnerships,** 4) **identifying levers of influence and windows of opportunity,** 4) **reflecting and adjusting** over time[12].

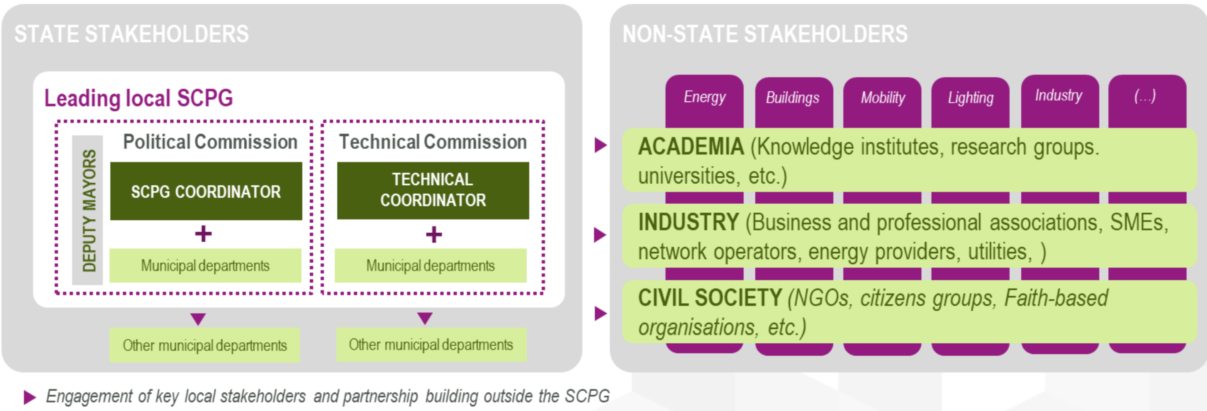

Figure 15. Main elements of the governance model. Conceptual structure

The structure of the administrations and political cultures can vary from country to country or even from region to region within the same country. So that ATELIER proposed a conceptual structure of the SCPG as reference for any future city divided into two main elements: 1) the **Political Commission**, impersonated by the SCPG coordinator and formed by the deputy mayors of the different departments to be involved (e.g. energy department, urban planning department, mobility and transport, etc); and 2) the **Technical Commission** impersonated by the Technical coordinator and formed by the technicians of the different departments to be

[12] Governance of transitions toolkit. Maria Yetano Roche, Wuppertal Institute

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involved. The local authority should decide how to adapt it to ensure not only the political commitment taking into account its organizational culture, but also the coordination of the planning dynamics already mentioned.

Example:

The Mobility and Sustainability Commission is the representation of the city council in the SCPG and both a technical and a political sector take part from it. The technical part is responsible for direct communication with stakeholders to address both energy and urban planning issues, and to promote innovative solutions. It also gathers and stores data in an efficient way so that they can be processed in the future.

Political management focuses on regulatory and administrative decisions. Some of the leaders of the departments are still to be decided which may imply some modifications during the process, showing the flexibility of the governance model proposed to create the city vision in WP2.

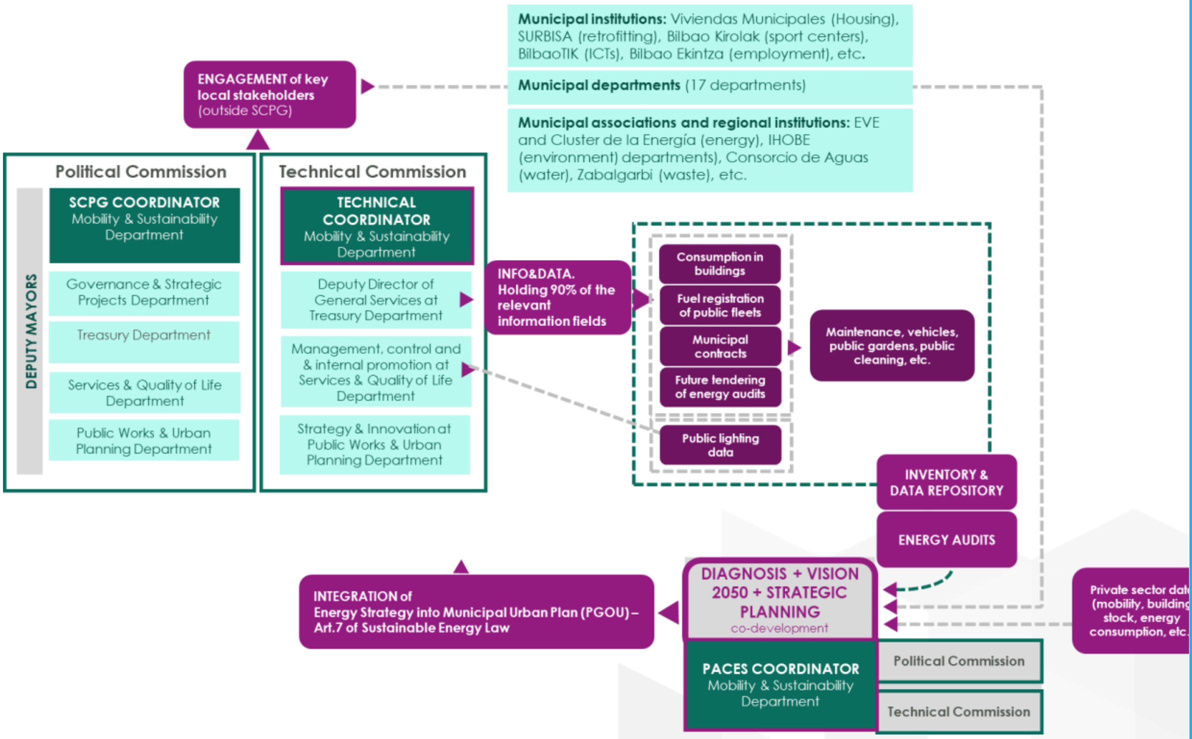

Figure 16. Bilbao SCPG

More information in *D.2.2 Report on Smart City Planning Groups (SCPGs)* submitted in January 2021.

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The governance model is at the heart of every stage in the policy planning cycle, from strategy development to design, implementation, evaluation and optimisation of implemented projects. The existence of this consolidated and active governance model in ATELIER, supports the replication and upscaling of the PEDs, its design and implementation, as Key projects that contribute to the strategic objectives and targets established at city level within the City Vision 2050.

SCPGs will participate in the "Design stage" which could imply the enlargement of SCPGs current structure by engaging new stakeholders from the city system to both integrate them into public competences and to foster private implication from public support.

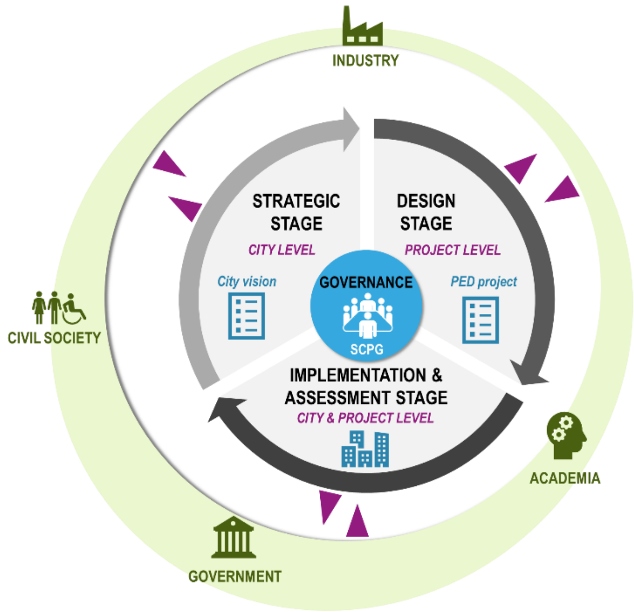

Figure 17. Policy planning cycle.

Source: own elaboration

Therefore, the governance model that will drive the PED replication and upscaling activities could be adapted to the specific needs of the PED replication and upscaling activities to ensure the correct integration of the PED projects into city strategic planning, with core-city strategic axes and even aligned with regional and national strategies (multi-level approach), depending on their level of influence.

How can SCPG support the replication and upscaling?

SCPGs as newly governance structures support the PED concept replication and upscaling by proposing systemic changes within ATELIER cities governance models, in particular:

- Transforming the municipal organization by means of promoting a common agenda across municipal departments (shared vision).
- Enhancing the participation and co-creation with citizens (citizen- driven innovation) to build trust and sense of belonging.
- Nudging collaboration between public and private partners, securing finance and procurement by investor confidence building or investor risk mitigation.

A key role will be played in Phase 0 and Phase I, as driver of the multi-scale and multi-actor governance model created, coordinating the stakeholder involvement and partnership activities. In brief, this local orchestration group can support the PED replication and upscaling Phase I in: 1) Identifying and involving local stakeholders that should be part of the local innovation group driving the replication and upscaling process considering the profiles identified in Table 17 and ensuring that the different perspectives are present and considered in the process. 2) Ensuring an open, transparent and well-designed stakeholder involvement process. 3) Recognising / officialising this group as the responsible of the PED replication and upscaling strategy.

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- Supporting in the definition of the roles and responsibilities of each member of the local innovation group.
- Supporting and agreeing the “rules of the game” regarding the rules for entering and leaving the process, how decisions are made, how information is brought into the process etc.
- Promoting and supporting the public participation activities proposed under the PED replication and upscaling strategy. This can be done by sharing knowing channels, providing methodology and tools based on the SCPG experience, etc.
- Aligning the PED replication and upscaling strategy with energy transition planning and activities.
- Supervising and monitoring the strategy implementation.

The structure that ATELIER cities implemented was described in *D.2.2 Report on Smart City Planning Groups (SCPGs)* submitted in January 2021.

3.2. Innovation model- Innovation Ateliers

As it was already mentioned, PEDs requires **an open innovation model** for their planning, deployment and replication, and **a cooperation** within the city with different types of stakeholders, from industry, service providers and investors, to citizens.

The ATELIER Replication and Upscaling strategy supports cities in replicating PED concept and tested interventions, with specific attention to the process of **Innovation Management**. *How to ensure city authorities align the PED’s with their long-term visions on sustainability and accommodate PED’s in their urban planning?* Industries such as real estate developers, construction companies, network operators, utility companies and many others, will play a vital role as solution providers, while citizens will take on a new role as prosumers with active participation in energy trading. Knowledge institutes and “academia” will provide robust documentation, monitoring and evaluation, will develop planning tools and technology solutions for the medium-to-long term, and will secure capacity building and education of the next-generation positive energy professionals and citizens.”[13]. Moreover, it is important to consider the opportunities of innovative procurement strategies to stimulate more PED deployment for instance.

Complementing the governance model already presented, ATELIER introduces an open innovation model, materialized as **Innovation Ateliers,** which play an important role in the development, deployment and upscaling of the PED’s in cities. Setting up PED Innovation Ateliers intends to: a) stimulating open innovation in the Quadruple helix, b) co-creation of solutions and supporting measures, c) sustaining partnerships[14]. Intrinsically bringing together the relevant stakeholders and partners from Public Authorities, Private Companies, Research and Development and Citizens, creating an open innovation environment, where people are willing to learn from each other, to share experiences, results and doubts [15].

Stimulating open innovation in the Quadruple helix

Central in the concept of open innovation is to **jointly create value**. Adequate business models are then needed to divide the revenues between the cooperating actors that work on the open

[13] Europe to become a global role model in integrated, innovative solutions for the planning, deployment, and replication of Positive Energy Districts, SET-Plan ACTION n°3.2, Implementation Plan, June 2018
[14] Slob, A.F.L (2010), From Aliens to Allies: the sense and nonsense of stakeholder involvement in the science policy universe, Keynote presentation and paper for the Nordrocs 2010 Conference, 15-16 September 2010, Copenhagen, Denmark
[15] ATELIER, Deliverable 3.1: The PED Innovation Atelier Organisation Document, Den Hague, November 2020.

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innovation. Open Innovation is described as combining internal and external ideas as well as internal and external paths to market to advance the development of new technologies (Boger sea 2018). Open innovation blurs the demarcation between research and practice, and between practice and policy and requires forms of cooperation between actors that formerly did not cooperate. Especially innovations for societal challenges (wicked problems), such as climate change and other sustainability issues (cities energy transition as one of them), are thought to require open innovation models. In the local PED Innovation Ateliers, the actors from the (local) quadruple helix work together to create and implement solutions that together deliver the Positive Energy District. With this aim the following actors from the local innovation ecosystem contribute to the Innovation Atelier: city's administration, industries, businesses, SMEs, network operators, energy providers, utilities, NGO's, knowledge institutes, representatives from civic organizations, and citizens (see Figure 18) [16][17].

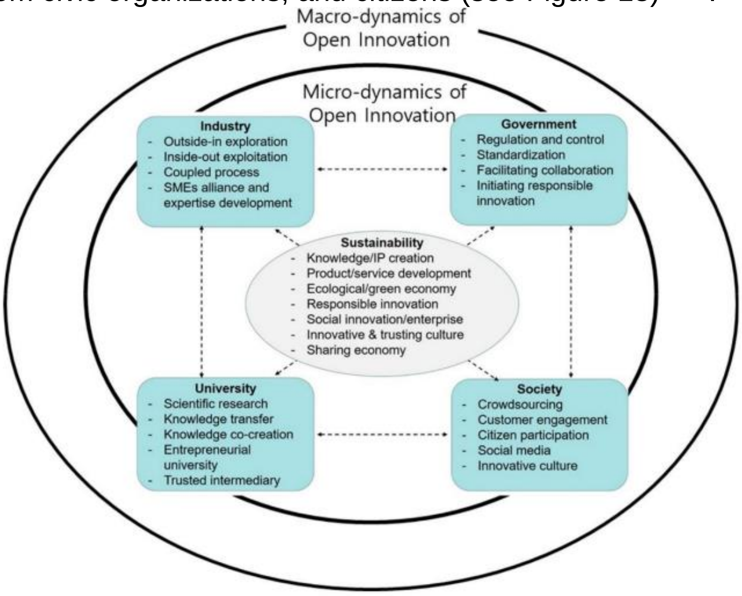

Figure 18. The Quadruple helix in an open innovation system *(Yun & Liu, 2019)*

In the Innovation Ateliers these actors jointly develop, tailor, deploy, and upscale the solutions that together will enable the Positive Energy District. The development and deployment of different technical solutions together with implementation of measures to support these is not a mere straightforward exercise. It will require a good cooperation among all contributing actors, a dedicated processes for PED-solutions co-creation, and the adaptation to the local situation and circumstances. In the Innovation Atelier the local PED innovation ecosystem works together in the joint development, assessment and review of technical and non-technical solutions. **The Innovation Atelier aims to develop and review supportive measures, and to remove obstacles becoming apparent from "old structures" that are in competition with the development of an innovative PED (solution).** The Innovation Atelier has an important task in developing and reviewing new institutional arrangements, new forms of cooperation and governance, new business models, new financing schemes and funding opportunities that support the technical solutions. The Innovation Atelier, furthermore, researches and reviews (potential) obstacles, such as old regulations, funding mechanisms, etc. with the aim to (develop proposals how) to remove and/or adapt these. Finally, the PED

[16] Yun, J. J., & Liu, Z. (2019). Micro- and Macro-Dynamics of Open Innovation with a Quadruple-Helix Model. Sustainability, 11(12), 3301. https://doi.org/10.3390/su11123301
[17] Gerrits, L., & Edelenbos, J. (2004). Management of sediments through stakeholder involvement. Journal of Soils and Sediments, 4(4), 239–246. https://doi.org/10.1007/bf02991120

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 864374.

Innovation-Ateliers monitor the applied solutions to check whether any new obstacles appear and whether the deployment and implementation of solutions are developing according to plan. The co-creation of innovations extends, thus, beyond the technical domain and is integrated with innovations of institutions, financial instruments, and policy.

3.2.1. Innovation Ateliers methodology supporting replication and upscaling of PEDs

The central concept of open innovation is **jointly creating value**. This value is created in supporting the PED, by stimulating open innovation, co-creating solutions and -measures and sustaining partnership. Value is created, not only by knowledge development and creation, but also by knowledge sharing; education and dissemination. Activities contributing to the latter are about upscaling and replication.

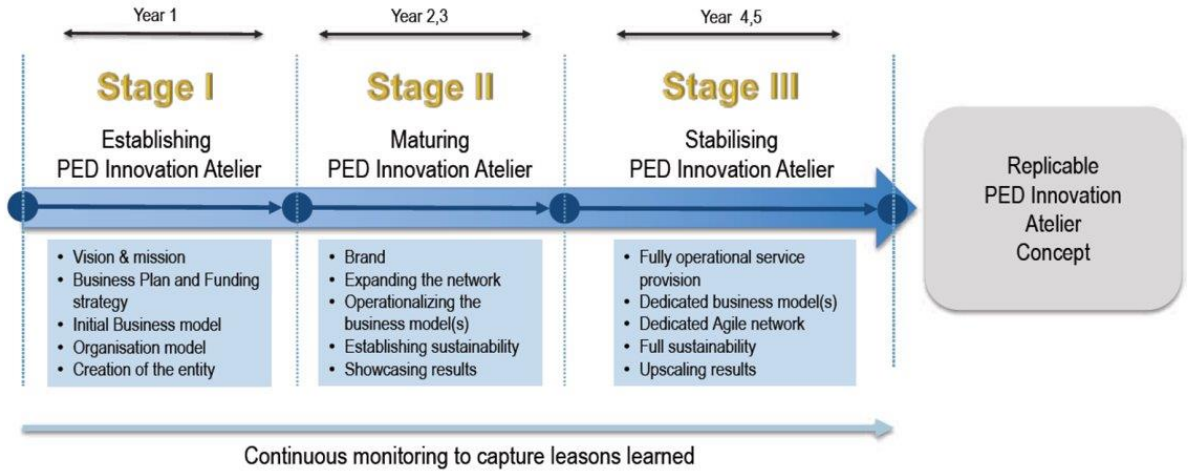

Figure 19. Stages of the Innovation Atelier development

The development of an Innovation Atelier involves different stages, from the first establishing stage (see Figure 19**¡Error! No se encuentra el origen de la referencia.**) to the final stabilizing stage, in which the Innovation Atelier is a steady organisation with a dedicated business model, a dedicated network and results that can attribute to further upscaling and replication. Naturally, in the first phases the activities will focus on establishing the Innovation Atelier and knowledge sharing to support the PED development. In later phases educational activities will become more prominent. For further detailed information on how establishing and developing the PED Innovation Ateliers, please go through *D.3.1. The PED Innovation Atelier organisation document* submitted in November 2022.

In order to be able to have a contributing role in upscaling and replication, the sustainability of the Innovation Atelier itself is an important issue. Therefore, the Innovation Atelier requires an organisation, management structure and sound business plan. Building up and establish a network with actors and stakeholders from the quadruple helix that embody and support the Innovation Atelier, is therefore a crucial task.

Example: Bilbao building a network for knowledge sharing

In the Atelier project Bilbao decided to build their Innovation Atelier on an existing broad network of experts, which includes a large network of stakeholders from outside the Atelier

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project. The knowledge exchange meetings directly influence projects outside the Atelier project, contributing to replication and upscaling of PEDs.

The existing network has been a great advantage for quickly developing upscaling and replication activities. The Bilbao Innovation Atelier emphasizes knowledge exchange in its activities. As such, many meetings and workshops have been organised to understand, among other things, how different cities are digitizing their assets and services, how electrification of heat demand could be supported in the PED and what experiences and best practices there are of public-private collaboration for energy efficiency funding. Relevant stakeholders from the quadruple helix are invited to each meeting. Reports on the meetings can be found here: ATELIER templates - openresearch.amsterdam

3.2.2. Mission and vision on replication and upscaling

Despite the fact that dissemination activities are often not developed until a later stage, the early stages of the Innovation Atelier are the starting point of contemplating the role of the Innovation Atelier in replication and upscaling. The upscaling and replication ambitions of the Innovation Atelier can be incorporated in the vision and mission of the local Innovation Atelier organisation. The vision and mission statement could, for example, include the ambition to share lessons learned with new PED developments or provide a blueprint of a PED to be used by other cities. Preferably, this role in replication and upscaling is acknowledged by local authorities.

In the Atelier project the local Innovation Ateliers of Amsterdam and Bilbao have included replication and upscaling ambitions in their missions.

Example- Amsterdam Innovation Atelier mission

Innovation Atelier Amsterdam (IAA) brings together and connects citizens, businesses and the local government to make the built environment energy positive.

This is done through a multi-disciplinary network of users, producers, governments and knowledge institutes, who jointly create, accelerate and implement innovative solutions.

The IAA is a catalyst that supports innovations and the implementation of innovations through an excellent network of local experts. The IAA is part of a larger EU-wide network which consists of leading knowledge institutes, government, business and energy communities. This network has developed a validated and integrated framework for developing and replicating positive energy districts in Europe, which can be adapted to the local context.
The IAA offers:

- Access to a pool of PED experts
- Adaptable framework for PED development
- Integrated funding strategies
- Knowledge on governance, development, design and community building
- Innovation Atelier meetings to connect, accelerate and realize PEDs

The Amsterdam mission emphasizes the importance of accelerating innovations, building an energy positive environment and network that is larger than the current selected PED area. The statement also refers to the lessons learned that will be shares by ‘developing an integrated adaptable framework for replicating PED’s in Europe’.

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Like Amsterdam, Bilbao also emphasises the importance of disseminating the lessons learned, sharing knowledge with other cities and being a place to share useful best practices for replication and upscaling PED solutions.

Including these ambitions in the vision and mission of the local Innovation Ateliers helps to formulate concrete activities/ actions that will contribute to the mission.

3.2.3. Activities

To support these ambitions on replication and upscaling, activities or services are developed by each of the local Innovation Ateliers. In Bilbao and Amsterdam, the Innovation Atelier initiates and participates in different upscaling and replication activities.

ATELIER recognize that activities can both support knowledge creation and knowledge sharing at the same time. Typically, knowledge sharing activities are organised by the emerging network, but they might soon result in knowledge sharing activities. The knowledge development meetings can for example have a ‘problem-solving’ focus and be dedicated to a specific challenge that arises during the implementation of innovation in the realization of the PEDs. These activities may be primarily focussed on the development of the current PED; activities to support innovations. However, these sessions are the starting point for the more knowledge sharing activities supporting upscaling and replication; the lessons learned from expert sessions are shared and provide valuable insights in how to replicate and upscale PED’s. (see Figure 20**¡Error! No se encuentra el origen de la referencia.**)

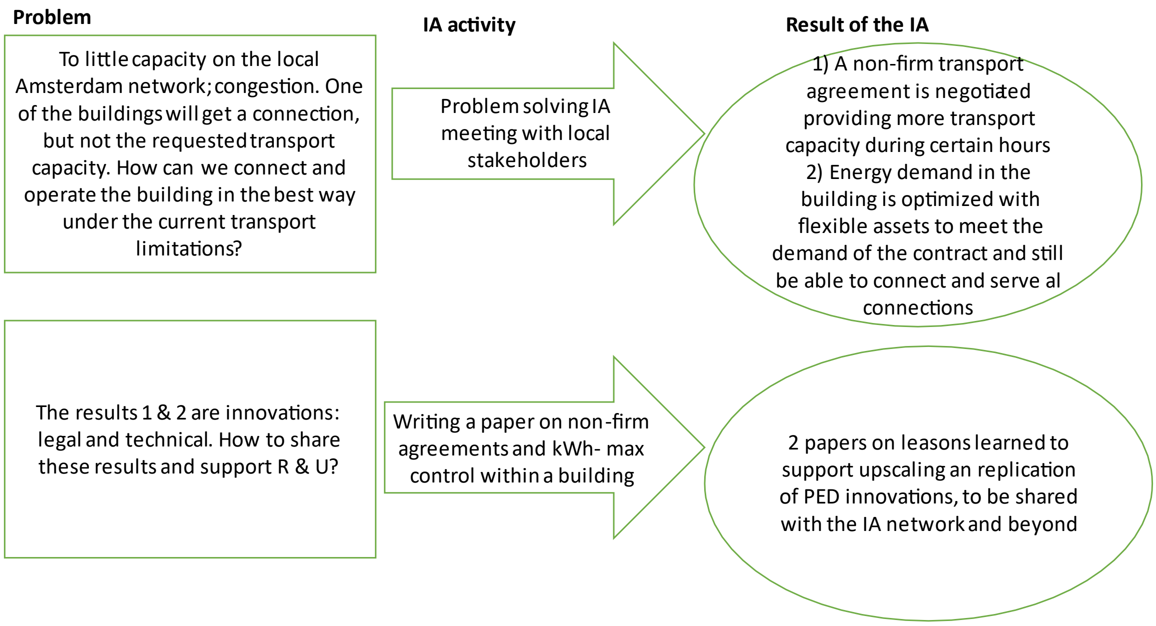

Figure 20. Example of how concrete problems can help formulated lessons

Image above shows an example of how concrete problems can help formulated lessons that can be shared and contribute to other PED developments.

Example: Sharing lessons learned

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In the ATELIER project the lighthouse cities Bilbao and Amsterdam have established Innovation Ateliers and organise workshops on different topics. From each of the sessions reports are made according to a standardized template. The reports are shared with the consortium partners and available here: ATELIER templates - openresearch.amsterdam

3.2.4. Innovation Tracks

Within the Innovation Ateliers the knowledge co-creation and knowledge sharing sessions are organised under four Innovation tracks;

1. *Integrated smart energy systems and electro-mobility*
2. *Governance, integrated planning and law*
3. *New financial instruments*
4. *Data, privacy and data platforms*

Each of the tracks delivers expertise and know-how on the specific knowledge domains to the network. The track-leaders of each track are responsible for organising (cross PED project, or cross city learning) meetings on these topics. The track leader is the linking pin in the expert network, that connects questions in the field with the right experts. Moreover, the track-leaders have an important role in the dissemination and visibility of knowledge developed in each track. The track leaders also play a role in enlarging the network with experts outside the project that strengthen the specific knowledge topics.

3.2.5. Setting up IA in FC

As part of the activities in the ATELIER project, each of the Fellow Cities (FC's) is establishing an Innovation Atelier in the local contact of their envisioned PED project-site. Lessons learned in both Lighthouse Cities (LC) are actively shared with the FC's in group- and one-on-one meetings. The FC's are working on establishing an Innovation Atelier organisation by setting up a supportive collaboration within their local innovation eco-system. The local network will also contribute to further elaboration and detailing of PED-plans and provide input on the Fellows' City Vision. The fellow cities will organise workshops to discuss, select and further improve their local smart urban solutions (as introduced in section 3). Expert meetings are organised with LC and FC under each of the Innovation Tracks to further intensify the exchange of knowledge and know-how.

How can the Innovation Ateliers methodology support the replication and upscaling?

The Innovation Atelier methodology can be used to support replication and upscaling. Cities' local Innovation Atelier organisation can embed the ambitions to foster further replication and upscaling within their vision and mission statement. The activities organised by the Innovation Atelier can fulfil the ambitions and are typically focussed on knowledge development and cross project / city knowledge sharing.

In the ATELIER project both Lighthouse cities Bilbao and Amsterdam use the Innovation Atelier actively as a methodology/ vehicle to support replication and upscaling at the city and regional level. The Fellow Cities also work on implementing an Innovation Atelier structure that will help them to fine-tune their PED ambitions, plans and solutions.

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For further detailed information on how establishing and developing the PED Innovation Ateliers, please go through *D.3.1. The PED Innovation Atelier organisation document* submitted in November 2020.

3.3. Citizen and stakeholder engagement strategy

The energy transition is a social phenomenon as much as it is a technical one. To date, the largest category of PEDs in the European Union is residential (39%) (Zhang 2021), and end-users are evidently impacted by changes in the energy system. Indeed, the energy transition implies a societal transition that changes the way we live, play, work, consume and move. ATELIER partners consider that the design and implementation of PEDs as part of the energy transition should be **participative and citizen-driven**. Based on the experience of the LCs in the context of WP7 and updated with recent findings, this section explains why and how to engage citizens in the PED replication process.

3.3.1. Engagement approach and the participation ladder

In ATELIER, citizen participation refers to the act of taking part in issues of public concern. It involves a wide range of different actors that shape the public sphere. Arnstein (1969) created a hierarchical ladder system of eight rungs to illustrate levels of citizen participation. The participation ladder displayed in **¡Error! No se encuentra el origen de la referencia.** Figure 21, which describes Arnstein's different levels of participation in policy making or a project and usually implies cooperation between a government and communities. The ladder bears resemblance with the levels of stakeholder engagement cited in the section above (Gerrits and Edelenbos 2004, op. cit.).

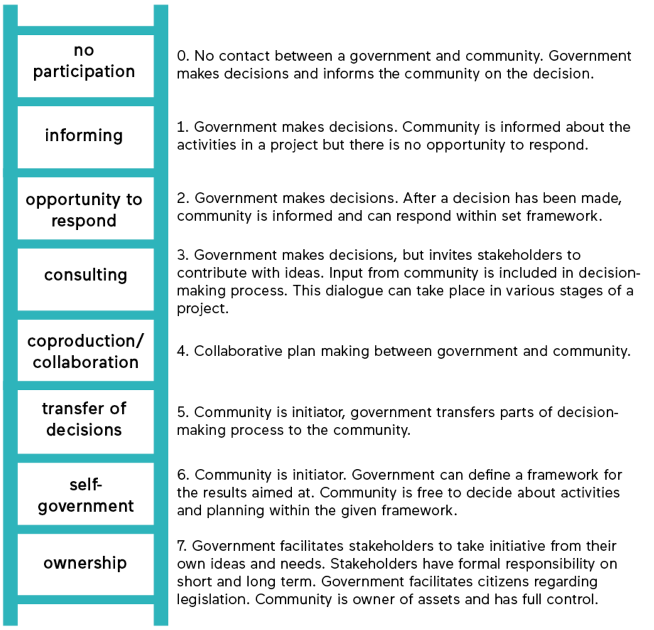

Figure 21. Participation ladder adapted from Arnstein's (1969) original

Participation does not always mean that a government is initiator and communities are participants. It can be the other way around and often both are happening at the same time. This is also true for the PEDs, where municipalities and developers take the lead in developing PED technologies, but citizen communities take their own initiatives or are represented in energy communities with pre-existing agendas.

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For different questions and phases during the design and development of PEDs, a government of communities can define what level of engagement is desirable. An **engagement strategy** will help in formulating the goals of citizen engagement, as engagement should support goals - in the overall project or even transcending the project. Citizen engagement is not an end in itself. In an engagement strategy a government or other type of organisation can define what level of citizen engagement is appropriate to support what goals and questions, and what type of activities follow from that. Consulting will not be a good option for questions when there is no room for adjustment. Ownership might be a good option when the goal is to develop a truly citizen-driven PED and foster support for complex transitions. All engagement levels imply different activities.

The terms participation and engagement are often used interchangeably, but difference may be found in where and how they are applied. While for the context of ATELIER the difference is too subtle to consider, the below paragraph will shed some light on where the different terms are usually to be found.

3.3.2. State of the art of the PED engagement process

The family of European PED projects confirms that citizen engagement is an important topic (Gollner et al 2020; Zhang 2021), however, engagement is not standardised, and projects tend to take their own approaches (Derkenbaeva 2022, Van Wees et al 2022, Fatima 2021). In literature, two areas of practice are relevant when considering citizen engagement in PEDs: (a) smart city initiatives and (b) spatial planning processes. In both areas, reviews are available. For example, Cortés-Cediel et al's (2019) review of 149 EU smart city initiatives concludes that a majority of projects "have aimed to achieve higher levels of participation (discussion and collaboration) than processes that just provide citizen information and petition functionalities". Also, initiatives tended to favour off-line and face-to-face methods over those relying on digital platforms.

Spatial planning (or its sibling term, urban area development) is a conventional field of work compared to smart city projects. In spatial planning, engagement is more often framed as 'participation' and has a longer history of practice, with more standardised and often mandatory practices. These forms of participation often resort to precisely the category that Cortés-Cediel (above) noted were less popular in smart city projects: informing and petitioning. Coincidently these are the lower rungs of the ladder that was introduced above. Also, according to Berčič (2015), the participation process in spatial planning lacks appropriate regulatory backing by the EU, and interpretations of what should be done and how vary widely. In a more recent study Nadin et al (2021) conclude that many EU governments have made significant progress in involving citizens in the spatial decision-making process – but not everywhere. In their words: *"One of the most consistent trends is increasing transparency and wider involvement of citizens in the planning process, although this engagement remains relatively weak in a sizeable proportion of countries, pointing to the need for further development of participatory planning practices."*

3.3.3. Citizen engagement to validate and enrich PED concepts

PED projects are generally highly aware of the need to balance technical and social innovation, and to properly involve and engage stakeholders and citizens (Baer et al 2021, Gollner et al 2020). Often, the implementation of zero- and positive energy districts is complex and site-specific. Implementing a PED is not about delivering 'off the shelf' technologies, but involves creating unique recipes out of technical, social, legal and economical solutions. PED designers

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and planners cannot know on beforehand what is the optimal solution. Consequently, the functions of citizen engagement are rich and many, and the approach (or approaches) chosen depend on the composition of civic stakeholders (residents and non-resident) and their respective information and engagement needs.

Often, implementing a PED will involve a combination of large scale and smaller scale interventions. The former often resemble the 'spatial planning' category and have smaller opportunity to adjust plans, while the latter resemble technology-driven 'smart city' interventions, interfacing more directly with the end-user and therefore requiring their direct involvement in the design process.

In both cases, the foremost function and objective of engagement is to ***validate* what planners have in mind, and *enrich* those choices where needed**. These enrichments vary in nature, from confirming the plans, to adjusting and complementing them:

(1) Confirmations of the plan – i.e. citizens indicate *in their words* that they value the ideas. These verbalisations of citizens' views can be used both in internal plans and in external (stakeholder) communication, such as social media posts or local communications.
(2) Adjustments to the original plan – e.g. citizens indicate that they need more direct control of their mobility options, or favour certain energy providers over others.
(3) Additions to the plan –i.e. aspects that were not in view before, such as the needs of elderly residents, or measures to align the foreseen plan with a local resident's initiative that has been activating people on energy saving for the past couple of years already. This ensures adoption and compatibility with the local context.

Stating that citizen engagement serves validation and enrichment purposes mainly, is not to say that engagement is merely 'nice-to-have'. By passing citizen's input means not only missing out on valuable insights, connections and opportunities, but might also result in failure of the project, or at least failure on some of its good intentions. For example, a Swiss PED study (Mihailova et al 2022) showed that residents' mobility preferences were key in determining PED support; the success depends on the responsiveness to the PED design to mobility preferences. Research into PED typologies also show how much they can differ in terms of business model and end-user value proposition, depending amongst others on who were able to shape the project early on (e.g. Derkenbaeva 2020)[18]. Generally, in the case of technical and social innovations that require direct action on the part of the end-user, more involved processes of co-design are recommended.

3.3.4. Guidelines on bootstrapping citizen and stakeholder engagement

Based on Bilbao and Amsterdam experience on city engagement in the context of WP7, the following steps are recommended to bootstrap public participation:

1. **Start lightly, then define goals and outcomes**

Approaches for citizen and stakeholder engagement, including co-creation and co-design, typically recommend an iterative approach: work in cycles, first starting with your own knowledge (e.g. setting goals, outcomes; performing a stakeholder mapping), and including stakeholders in successive cycles. Hence a first step is to make a longlist of potential goals and outcomes of citizen engagement: *why is it useful in our context, what do we want to get*

[18] Derkenbaeva E, Heinz H, Lopez Dallara ML, Mihailova D, Galanakis K, Stathopoulou E. Business models and consumers' value proposition for PEDs value generation by PEDs : best practices case study Book. Smart-BEEjS Project deliverable D6.2, 2020.

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out of it? Which strengths and weaknesses can we currently identify, would we start off an engagement process right now (SWOT analysis)?

Example:

In the ATELIER consortium, all cities need different engagement strategies to address the challenges in their PED development. Depending on the phase of development, different stakeholders are put at the centre of stakeholder mappings and engagement activities. Workshops where all ATELIER cities participate, contribute to formulating engagement strategies and activities.

One example is Budapest fellow city that plans on developing a PED area on an abandoned brownfield area in a central location of the city. In the initial phase of the project, a main stakeholder for the development team is another municipality department: the property management company. The development team needs a strategy for addressing the needs of the stakeholder which is both a sound story and business plan for developing the area in hand of the city itself instead of selling off the land. This requires a change of developing paradigm. One of the activities formulated is to delegate an employee of the property management company to the PED development team to explore the possibilities and work out various options and business models together.

2. Embed in decision process

Engagement of communities in urban development requires attention from people with a central role in the development process. As activities on various engagement levels need to be well timed with the decision-making process of PED development. Input from consultations or co-design does only work when the plans can still be adapted. Therefore, it is important to embed citizen engagement activities in a decision-making process and have a process designer and facilitator managing the links between engagement activities and project goals. The facilitator is in charge of organising the appropriate kind of facilitation for engagement in different stages of the development process, be it communication, organisation, financial support for community initiatives or facilitating with legal-planning means (Hettinga, 2018).

3. Storytelling: The importance of having a narrative

PED development processes are highly interdisciplinary processes. People from diverse professional and non-professional backgrounds are involved as developers or stakeholders. A shared narrative of what is being developed can be an effective means for good communication both among project partners and with stakeholders. The narrative should include a vision, which can be developed through a co-creative process. Preferably the narrative is drafted in easy-to-understand language and (an) image(s), to communicate with a broad public.

Example:

In the ATELIER project, the cities were challenged to shape stories of their PED developments by drawing the ‘where’, ‘for whom’, and their ‘main innovation’ in three simple sketches. By forcing participants to draw, we made sure that the cities could not fall back on their familiar language, but had to look at the story of the PED with a fresh pair of eyes.

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This way, all cities took a first step in crafting a simple story which could be communicated to a wide audience.

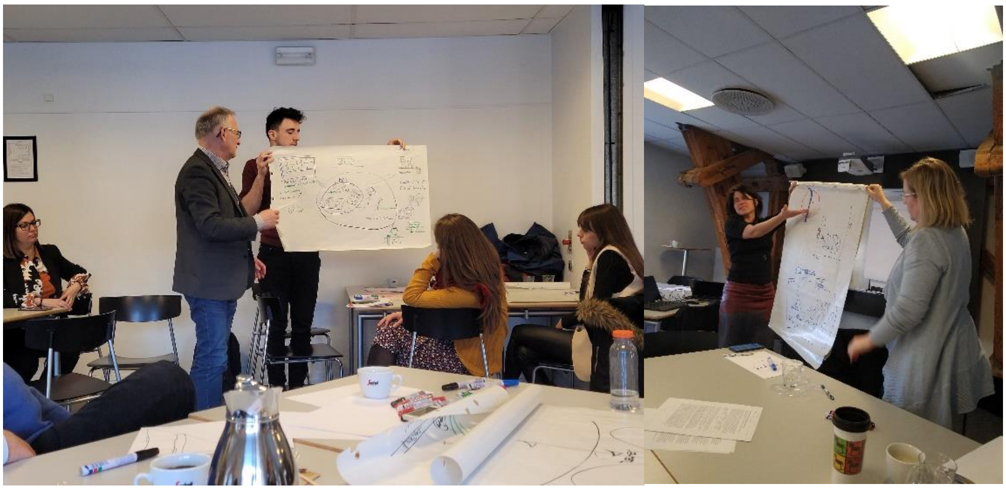

Figure 22. ATELIER fellows cities storytelling exercise

4. <u>Designing concrete engagement interventions</u>

The objectives and approach discussed above require translation into concrete *engagement interventions*. In the table below, different types of engagement interventions are described for different levels of engagement of the participation ladder. Besides, the phases in which this type of engagement activities along the PED replication strategy could be deployed, are identified.

Table 2. Engagement levels in ATELIER.

ENGAGEMENT LEVELS		Phases				
		I	II	III	IV	V
I	<u>Low-barrier engagement:</u> walk-in events for residents, neighbours, local entrepreneurs; or a street festival on the energy transition. These activities correlate with level 1 and 2 on the participation ladder, although we seek co-production by local stakeholders (level 4) to drive these events.	X	X	X		
II	<u>Participatory events and interventions:</u> those events that feature light forms of co-creation, such as community evenings, one-day competitions such as hackathons, singular Innovation Atelier events, and light-weight citizen science. Participation is more substantial than above, but probably lasts for one session only. These activities correlate with participation level 2 and 3 of the participation ladder.			X	X	
III	<u>Co-creation and co-design trajectories:</u> in-depth, longer duration participation where users are designers and many disciplines and stakeholder types are present or represented. These activities correlate with participation level 3 and 4 of the participation ladder.			X	X	X

5. <u>Documenting and formulating next steps</u>

In order to iteratively shape an engagement strategy and organise engagement activities, it is important to document well during engagement interventions and reflect on how the outcomes

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aligned with the goals. Reflect on the outcomes and go back to the project goals, then define what next steps are needed. Are the right people or groups involved? What type of input will benefit the project goals? What type of facilitation is needed to engage the right people or initiatives in this phase of the process? Adapt the process during the course of the PED development.

How can a Citizen engagement strategy support the replication and upscaling?

The function of citizen engagement in ATELIER replication and upscaling strategy is to ensure or obtain legitimacy for the intervention in varying contexts. Every potential PED area has different characteristics. A citizen engagement strategy, assessing what forms of engagement are appropriate for different issues and themes in the development process, can support a PED development process in which the solutions are tailored to the local situation. Both replication of PED solutions and scaling up innovations, benefit from the perspective of the residents, as they are a crucial actor and stakeholder in defining what innovations can feasibly be implemented and used in daily life.

The function of citizen engagement in ATELIER is mostly to obtain legitimacy and less to involve citizens in details. A co-design approach will give the residents the feeling of being heard, and the planners gain by the enriched sense of what they are planning.

For further detailed information on how mapping, engaging and empowering local citizens and other stakeholders, please go through *D.7.1. Local stakeholders engagement plans* submitted in June 2021.

3.4. Capacity building strategy

PEDs' main aim is to create liveable and innovative areas that facilitate the energy transition toward decarbonisation to meet the EU's climate, society, and economy targets. Such an ambitious objective requires a deep understanding of the cities' contextual conditions, policies, strategies, and solutions. Furthermore, it requires extensive knowledge, skills, and technologies (Krangsas et al., 2021)[19]. Complying with such ambitious requirements goes hand in hand with particular challenges. The fellow cities part of the Atelier project identified the following categories of challenges:

1. Governance: the need for new and innovative forms of collaborative governance, policy, regulations, and city administration.
2. Social: the need for the local community's support and engagement.
3. Market: the need for an effective market design, funding, and business model.
4. Technology: the need for balancing energy demand and supply systems.
5. Context: the need to consider regional and local differences.

These reoccurring challenges have been extensively discussed in the literature[20] and by other Smart Cities and Communities (SCC1) projects such as GrowSmarter, REMOURBAN, and

[19] Krangsås, S.G., Steemers, K., Konstantinou, T.,Soutullo, S.,Liu, M., Giancola, E., Prebreza, B., Ashrafian,T., Murauskaite, L., & Maas, N. Positive Energy Districts: Identifying Challenges and Interdependencies. Sustainability 2021, 13, 10551

[20] Good, N., Martinez Cesena, E.A., Mancarella, P.,Monti, A.,Pesch, D. & Ellis, K. (2017). Barriers, Challenges, and Recommendations Related to Development of Energy Positive Neighborhoods and Smart Energy Districts. In Energy Positive Neighborhoods and Smart Energy Districts; Elsevier: Amsterdam, The Netherlands, 2017; pp. 251–274.

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Triangulum[21]. They all revealed a common need for a "systematic understanding of the processes" and the key stakeholders' knowledge development.

The lack of knowledge by municipal staff in a PED project compromises one of the most commonly encountered barriers due to the novelty of PEDs. A continuous learning process to incorporate innovative technology into the government's everyday operations is required when local governments want to implement any innovative strategy supporting the long-term energy transition or any other transition paths. Besides considering the long-term vision, it is essential to consider the human resources needed for a PED project to evolve rapidly and firmly. Therefore, it is crucial to invest in the capacity-building of municipal staff and acquire suitable technology to address the competencies gaps.

Capacity building is a process or activity that improves the ability of a person or entity to "carry out stated objectives"[22]. In order to be effective, it should comply with several key characteristics. Capacity-building should be[23]:

- A continuous process of improvement.
- An internal process.
- A multidimensional process.

3.4.1. Methods for capacity building

ATELIER proposed the following methods as part of its capacity-building strategy and based on ATELIER's cities' knowledge needs:

1. Mapping: A survey should be carried out among the cities to identify competencies, evaluate them, and identify knowledge gaps.
2. Best practice project identification: Interviews with the cities are conducted to assess knowledge and needs and identify best practices for future knowledge exchange.
3. Development of training modules and assessments: The following activities were designed and carried out based on the cities' needs:
    a. Peer-to-peer sessions: The objective of the peer learning is sharing and exchanging knowledge among cities. Cities can share their best practices, lessons learnt, and recommendations in online sessions with their peers.
    b. Workshops and trainings: Participatory interactive workshops and trainings are held with the objective of knowledge development and activation, encouraging creative thinking and brainstorming, and team building. All the topics addressed during these sessions must be connected to relevant work packages.
    c. Demonstrations and visits: It is very beneficial that cities visit other cities to experience first-hand projects already finalised or work in progress. The main aim is for the hosting cities to showcase their successful PED elements. Moreover, they can share best practices and lessons learned. These visits can also be an excellent opportunity to receive tips and feedback from visiting cities and experts.
    d. Coaching program: This activity helps meet the cities' unique needs. Having coaches who are familiar with the cities' context due to their working

[21] Garcia-Fuentes, M.A., Enarsson. L., Fernandez, T., Granström, S., Gustaf, L., Cristina de Torre de, C., Stöffler, S., Simon Clement, S., Esben Pejstrup, E., & Rothballer, C. (2019). From dream to reality: sharing experiences from leading European Smart Cities.

[22] Goodman R.M., Speers M.A., McLeroy K., et al. (1998). Identifying and Defining the Dimensions of Community Capacity to Provide a Basis for Measurement. Health Education and Behavior. Vol. 25 (3): 258-278.

[23] Lusthaus, C., Anderson, G. & Murphy, E. (1995). Institutional Assessment: A framework for Strengthening Organizational Capacity for IDRC's Research Partners. International Development Research Center.

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experiences is an asset since cities are instructed and guided at a very personal level. Thus, this enables offering a more personalised and customised capacity-building program.

4. Staff Exchange: This activity's objective is to promote knowledge sharing and exchange, and expertise development. Participants gain new skills and perspectives. Furthermore, it is a motivation booster and expand the participants' network. This activity is a win-win for both the hosting city and the visiting city since all participants benefit from the exchange.

3.4.2. Guidelines to perform capacity building program in the different stages of the PED design process

Planning for replication is key. Each city project takes place within a specific territorial context. These contexts vary significantly from each other. Spatial, historical, social, political, and economic characteristics, are quite diverse between cities, neighbourhoods, and districts[24]. Therefore, it is essential to start thinking about the replication actions during the preparation plan. The complexity of the new context in terms of "geographical, legal, and organisational aspects" must be considered[25]. To achieve so, developing a capacity-building strategy by the stakeholders from Academia to support the replication activities along the different stages of the PED design process is a requirement. A sound capacity-building program designed to enhance PED knowledge and capabilities must be focused on three components: Energy systems, Regulations, and Business models.

Based on the ATELIER project's experience, the following recommendations are suggested when defining and implementing a capacity-building program:

1. Multidisciplinary approach: Stakeholders involved in the project's planning process must understand each context's uniqueness. They must become familiar with the geographical, legal, and organisational aspects. In order to do so, a multidisciplinary team is needed.
2. Municipal staff knowledge: It is critical to assess the knowledge and skills of the replicating team from the municipal staff. The following steps need to be taken to identify common competency gaps:
   a. Define competencies based on the best practice projects. Analysing the lessons learnt from other Lighthouse projects, the professional knowledge required for replicability and the skills and competencies required for success can be identified.
   b. Self-assessment questionnaire should be designed and distributed to the target groups to evaluate the competencies and the gaps. The objective is to identify the competence gaps among the target groups.
   c. Interviews should be conducted to verify the data gathered by the questionnaire, to dig in further into the target group's competencies and establish each municipality's level of knowledge. This serve as the starting point for the development of a learning program (training modules and assessments).
3. Development of the capacity building program. The competencies needs must be divided into different categories. The categories must be based on the research outcome to identify the competencies needs. Some potential categories could be

[24] Borsboom-van Beurden, J., Kallaos, J., Gindroz, S., Costa, S. & Riegler, J. (2019). Smart City Guidance Package. A Roadmap for Intergrated Planning and Implementation of Smart City Projects.
[25] Van Winden, W. et al (2016) Organising Smart City Projects – Lessons from Amsterdam.

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energy systems, innovation, stakeholder engagement, policies and regulations, and business models. Having the topics as core, the educational institution involved will develop different modules consisting of learning and training materials.

4. Implementation and continuous evaluation of the capacity-building program. It is vital to evaluate the program's impact continuously. This will be done by conducting satisfaction surveys among the cities and asking for feedback after every session held by the cities and experts involved. Whenever weak points or other gaps are identified, the team of experts led by the educational institution partner will work on improving them.

How can a Capacity building strategy support the replication and upscaling?

PEDs facilitate energy transition toward decarbonization. This process is ambitious and challenging and requires the municipality staff directly involved to have extensive knowledge and appropriate skills. Therefore, a solid capacity-building program is required to help the municipality staff acquire and develop the needed knowledge and skills.
For further detailed information on how developing and implementing a strong capacity building strategy, please go through *D.6.3. Report on the capacity building activities* submitted in October 2022.

3.5. Tool for PED technologies selection

Thanks to the collaboration environment stablished in the context of WP8, a technology selection assistance tool was developed gathering insights from MAKING-CITY and ATELIER projects to guide cities in the decision-making route for selecting different technical and non-technical solutions that could help cities to achieve the PED concept and therefore, be a step closer in the energy transition towards the desired city.

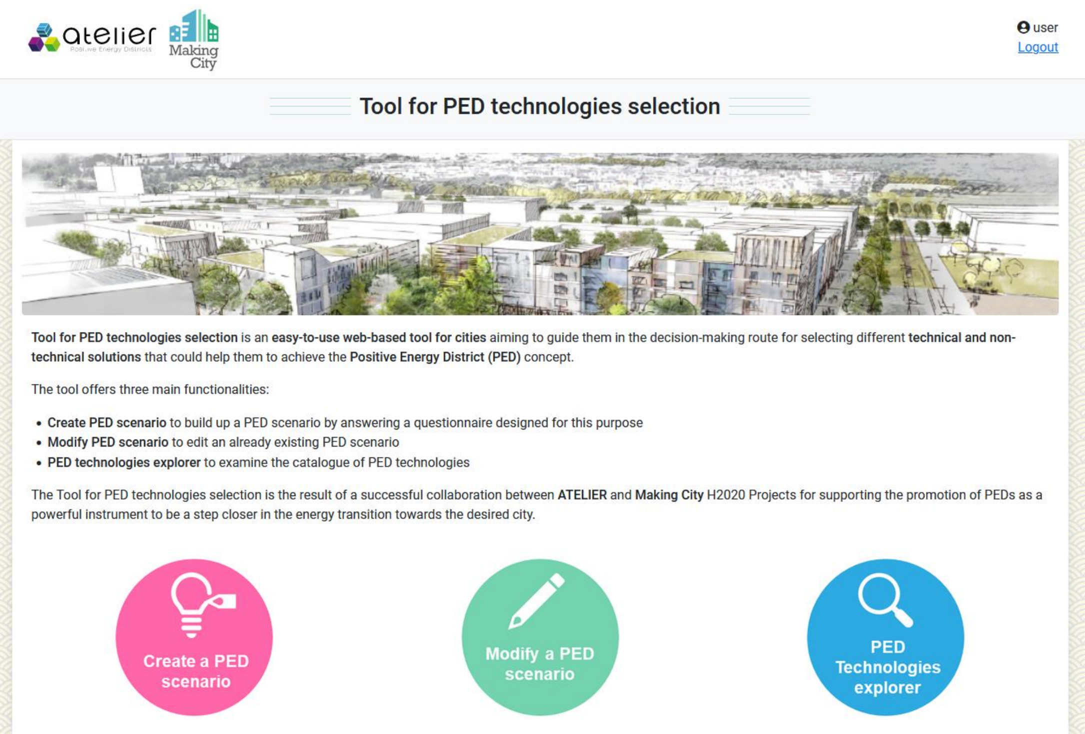

Figure 23. Tool interface

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It is an easy-to-use web-based tool for cities that offers three main functionalities:

1. Create PED scenario to build up a PED scenario by answering a questionnaire designed for this purpose
2. Modify PED scenario to edit an already existing PED scenario
3. PED technologies explorer to examine the catalogue of PED technologies. Nowadays only Making City technologies are included, but it is expected that in the near future ATELIER's ones (see section 3.7) will be also included.

The tool is based on a decision tree programmed, where different YES/NO questions are asked to the users and as a result, several technology packages (SPEC CARDs) are recommended. The questions are divided in eight blocks:

1. Ambition level (such as self-sufficient or climate neutral) and concept boundaries (geographical, functional and virtual)
2. Energy needs to be supply (i.e. heating, cooling, DHW and electricity needs)
3. Resources availability (such as solar potential, water surface nearby, etc.)
4. Urban macroform by means of characterizing the selected area between new development area or retrofitted
5. Type of buildings within your district in relation to their uses (residential, commercial…)
6. Energy infrastructures existing around the district
7. Energy services and management to be provided by the district
8. Social structure.

The answer to each question will add/discard some technologies, and the final combination of the technologies will result in a recommend technology package, such as this one:

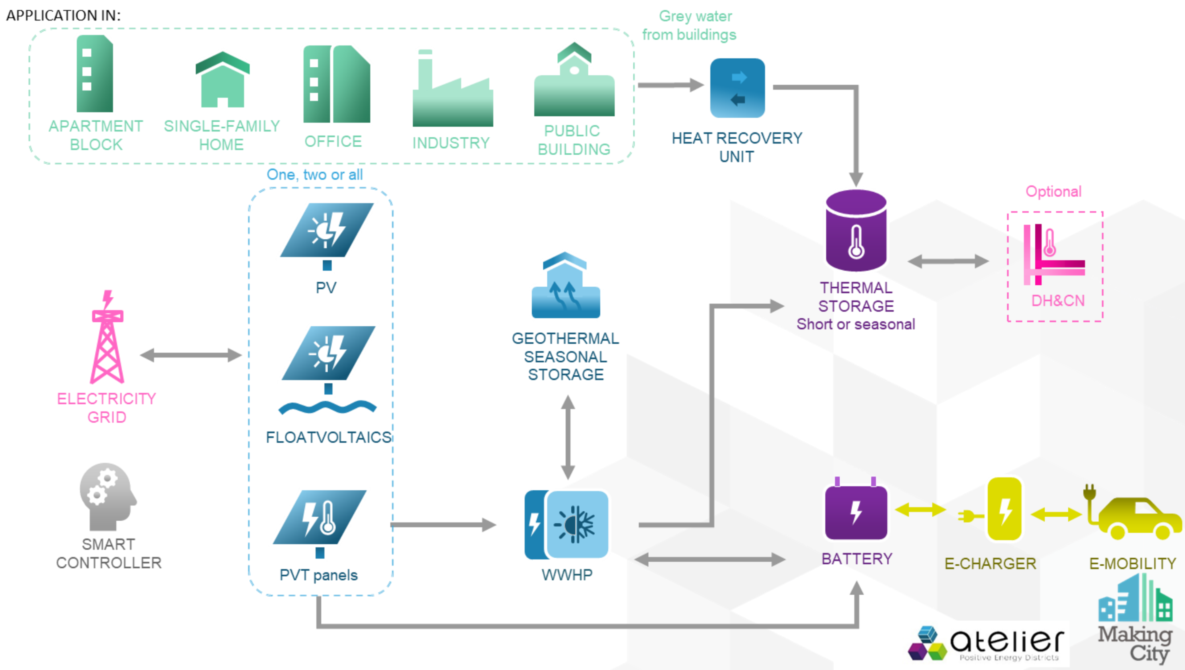

Figure 24. Technology package

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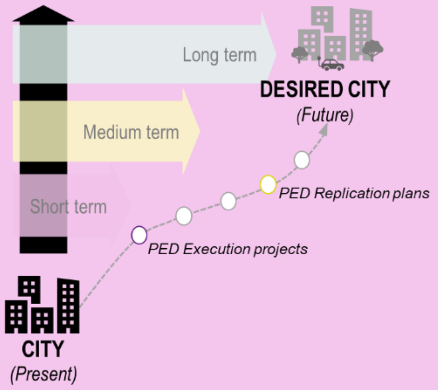
How can the Tool for technologies selection support the replication and upscaling?

This easy-to-use tool for technologies selection can strongly support the replication of PEDs by guiding city managers, as the main target users, when selecting smart urban solutions to achieve the PED concept desired while contributing to the city objectives.



Target users: City managers who want to implement PED concept.

Tool url: **https://tools.cartif.es/ped-tool/**

3.6. PED Calculation methodology

ATELIER will apply the PED calculation methodology (Gabaldón Moreno, Vélez, Alpagut, Hernández, & Sanz Montalvillo, 2021) from MAKING-CITY project (MAKING-CITY, 2018), which follows an 8-step methodology (see Figure 2), and is based on the approach of CEN/TR 15615 and ISO 52000 standards. As this calculation is meant for designing a district and evaluating its energy performance, the calculation direction is the opposite of the energy flow in the system (IEE-CENSE, 2010), starting from the energy needs until the primary energy assessment is performed.

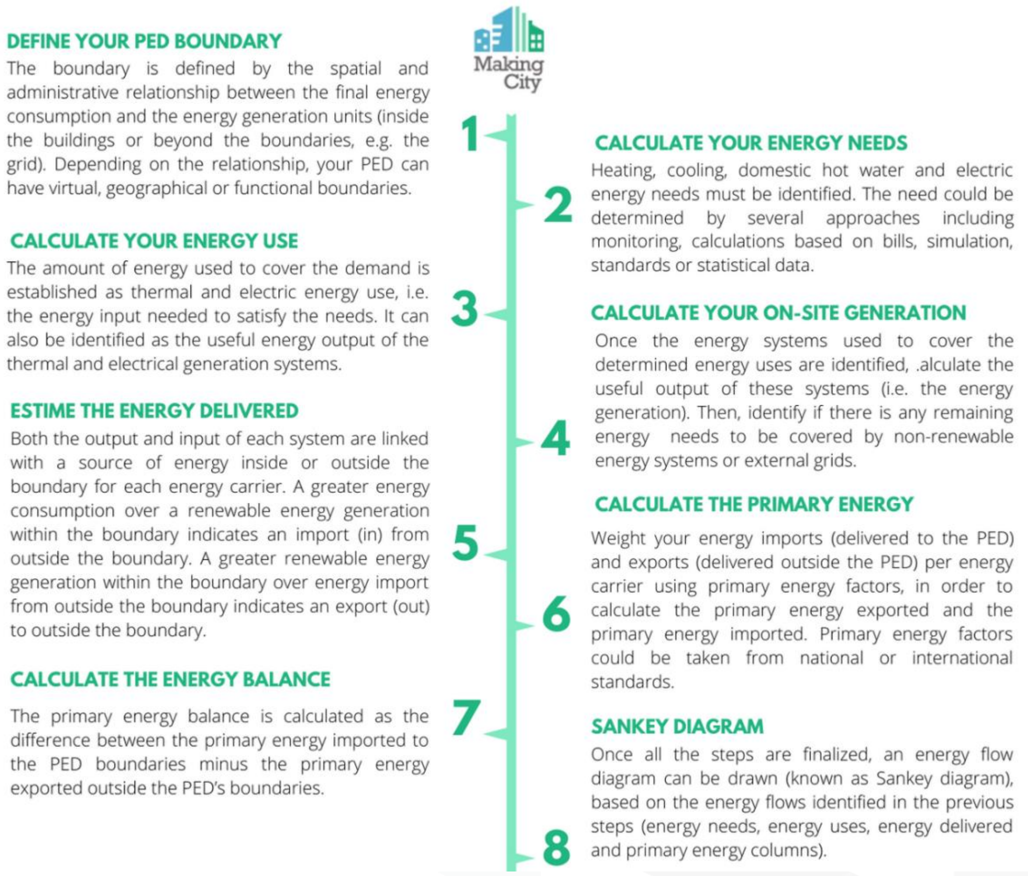


Figure 25. Steps of the calculation procedure

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(Gabaldón Moreno, Vélez, Alpagut, Hernández, & Sanz Montalvillo, 2021)

The first step consists of defining the boundaries of the district, which will allow to identify the loads to be considered and the amount of energy and resources that come from outside these boundaries. In ATELIER the boundaries are defined by geographical limits, i.e. delineating the area that is included for the calculation and its elements (e.g. residential, public, commercial and industrial buildings, infrastructures, etc.). Then, the energy needs of these elements its calculated, separating thermal and electric streams (as this two cannot be easily summed).

The second step is focused in the "Thermal energy needs" calculation, understood as the heat to be delivered or extracted to maintain an intended space or water (usually, domestic hot water) at a certain temperature, whereas "Electric energy needs" is the electric energy to cover the demand of lighting and ventilation (ISO, 2017). The energy needs are usually estimated using software tools, such as Energy+ (Jia & Srinivasan, 2020), CREST demand model (McKenna & Thomson, 2016) or DHWcalc (Jordan & Vajen, 2005).

Thirdly, the thermal and electric energy to satisfy these needs is calculated, which is known as "thermal and electric energy use". Sometimes both items are equal, especially if no energy is lost in the process. Thus, it depends on the energy efficiency of the emitter systems (e.g. fan coils, distribution systems, etc.). For example, if heat is produced in the basement of a tall building, and distributed to the different dwelling upwards, up to 15% of the energy can be lost when the pipes are installed at the façade. The energy nomenclature in the case of heat pumps is a bit trickier. Electricity-driven heat pumps have an electric energy use to provide heating or cooling to the rooms. In this case, the seasonal coefficient of performance (COP or EER) is used to transform one output (heating or cooling energy) into an input (electric need by the heat pump). Heat pumps then are considered as electric energy use to cover thermal energy needs.

To design a PED, the production coming from renewable energy sources (RES) should be prioritized to be able to achieve a positive energy balance. Thus, at the fourth step, the local RES production is calculated and maximized, covering as much as possible the energy uses with RES. Later, the remaining energy not covered by RES is supplied by non-renewable energy sources (e.g. natural gas-driven boilers) or by external grids (e.g. electricity or DHN), and, therefore, the final energy consumption (or energy delivered to the district- Step 5) coming from outside the boundaries is identified. As part of the sixth step, the energy delivered to the district (imported) and delivered outside the boundaries (exported) is transformed per each energy carrier into non-renewable primary energy using the non-renewable primary energy factors (PEF_{nren}):

- Primary Energy Imported (PEI):

$$\text{PEI} = \sum \text{Delivered energy per energy carrier} * \text{PEF}_{\text{nren}} \text{per energy carrier} \qquad \text{(eq. 1)}$$

It accounts for the energy supplied to the district that is produced outside the district limits.

- Primary Energy Exported (PEE):

$$\text{PEE} = \sum \text{Exported energy per energy carrier} * \text{PEF}_{\text{nren}} \text{per energy carrier} \qquad \text{(eq. 2)}$$

Finally, the balance is made (step 7, equation 3) and the associated Sankey diagram (step 8) is performed.

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$$PED\ Balance = PEI - PEE \qquad \text{(eq. 3)}$$

When designing a PED, it is recommended to go back and forth, in order to test different technology options until all the needs are covered and the positive energy balance is achieved.

3.7. Catalogue of smart urban solutions

Thanks to the collaboration established with MAKING-CITY project (GA 824418) as part of WP8 activities many results and further progress have been achieved such as the common Catalogue of smart urban solutions following the structure suggested by MAKING-CITY project in deliverable *D4.1 - Methodology and Guidelines for PED design,* submitted in November 2020.

Five key categories have been identified for the replication and upscaling of ATELIER PED concept for which ATELIER provides a catalogue of solutions (SPEC CARDs) aimed at packaging the smart technologies implemented in Bilbao and Amsterdam Lighthouse cities with their local ecosystem, impacts and co- benefits, business model and investment and societal aspects.

The different technologies implemented in ATELIER have been classified as follows:

- **Category 1 – Low Energy Demand**: technologies for reducing the energy demand, such as passive measures or buildings insulation. These technologies are the ones affecting land use planning, building envelope insulation and building materials.
- **Category 2 – Energy Management**: all interventions regarding monitoring, control, smart readiness, energy efficiency improvement or energy flexibility. The technologies included in this category are related to digitalization, provisioning of energy information, smart energy managers, or decentralised energy generation.
- **Category 3 – Integrated Infrastructures**: with solutions related to the integration of heat recovery systems, energy storage technologies, electromobility integration systems or district heating and cooling facilities.
- **Category 4 – Renewable energy systems and alternative urban energy sources**: solutions that allows energy supply from renewable sources, classified into three typologies, depending on whether the interventions are related to thermal energy use, electric use or combined heat and power.
- **Category 5 – Political, social and economic interventions**: all the non-technical solutions, such as financing instruments and business models, socially innovative solutions or interventions related to regulation and policies.

As shown in Table 3, these five categories are classified into four groups, depending on the field to which the interventions included in each category are related:

- **Demand side solutions:**
  - **Category 1**: Low energy demand
  - **Category 2**: Energy management
- **System integration solutions:**
  - **Category 3:** Integrated infrastructures
- **Supply side solutions:**
  - **Category 4:** Renewable energy systems and alternative urban energy sources
- **Non-technical solutions:**

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Category 5: Political, social and economical interventions.

Table 3. ATELIER solutions classification

DEMAND SIDE SOLUTIONS	Category 1: LOW ENERGY DEMAND	**1.1 - Land use planning**	1.1.1 - Sustainable mobility
			1.1.2- Bioclimatic strategies
		1.2 - Building envelope insulation	1.2.1 - Façade
			1.2.2 - Glazing
			1.2.3 - Solar blinds
			1.2.4 - Roofs: green, blue, white
		1.3 - Building materials	1.3.1 - Low embedded energy material
			1.3.2 - Recycled materials
	Category 2: ENERGY MANAGEMENT	**2.1 - Digitalization**	2.1.1 - Monitoring system
			2.1.2 - Smart lighting, power LED
		2.2 - Provisioning of energy information	2.2.1 - Smart interaction tools
		2.3 - Smart Home/Building/District energy managers	2.3.1 - Energy Management System
		2.4 - Decentralised energy generation	2.4.1 - Local Energy Market
SYSTEM INTEGRATION	Category 3: INTEGRATED INFRASTRUCTURES	**3.1 - Energy storage**	3.1.1 - Power storage (electrochemical storage)
			3.1.2 - Thermal storage
			3.1.3 - Gas storage (chemical storage)
		3.2 - District Heating & Cooling Facilities	3.2.1 - High temperature DH
			3.2.2 - Low temperature DH
		3.3 - Electromobility integration	3.3.1 - EV chargers
			3.3.2 - Electromobility hub
		3.4 - Heat pumps	3.4.1 - Air-air Heat pump
			3.4.2 - Air-water Heat pump
			3.4.3 - Water-water Heat pump
			3.4.4 - Hybrid heat pump
			3.4.5 - CO2 based heat pump
		3.5 - Heat recovery	3.5.1 - Mechanical ventilation with heat recovery

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			3.5.2 - Shower drain water heat recovery systems
SUPPLY SIDE SOLUTIONS	Category 4: RENEWABLE ENERGY SYSTEMS ALTERNATIVE URBAN ENERGY SOURCE	**4.1 - Thermal use**	4.1.1 - Solar thermal energy
			4.1.2 - Biomass
			4.1.3 - Biofuels
			4.1.4 - Biogas
			4.1.5 - Geothermal
			4.1.6 - Aerothermal & hydrothermal
			4.1.7 - Waste recovery
		4.2 - Electric use	4.2.1 - Solar PV
			4.2.2 - Solar Thermoelectric
			4.2.3 - Sea energy
			4.2.4 - Wind energy
			4.2.5 - Waste-to-energy
		4.3 - Combined heat & power	4.3.1 - Co-generation
			4.3.2 - Tri-generation
			4.3.3 - Poly-generation
NON-TECHNICAL SOLUTIONS	Category 5: POLITICAL, SOCIAL, ECONOMICAL INTERVENTIONS	**5.1 - Financing instruments & Business model**	5.1.1 - Energy communities
			5.1.2 - Energy Services Enterprise (ESE)
			5.1.3 - Innovative BM
			5.1.4 - Financial instruments
		5.2 - Social innovation	5.2.1 - Innovation Atelier
			5.2.2 - Citizen engagement strategies
		5.3 - Regulation & Policies	5.3.1 - Integrated Energy Planning
			5.3.2 - Energy Poverty Mitigation

Following this classification, the cities of Bilbao and Amsterdam have provided technical information for several solutions. In Table 4 it is shown which technologies are included in the ATELIER catalogue (gathered all together in Annex 2) at this stage, as well as the name of the solution package. COA –X and COB –X means that the solution is implemented in the City of Amsterdam or the City of Bilbao, respectively.

Note that many LC actions at this stage were still under re-definition so that they were not available to be included in the time this deliverable has been delivered.

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Table 4. Technologies included in the ATELIER catalogue of solutions

DEMAND SIDE SOLUTIONS	
Category 1: LOW ENERGY DEMAND	
1.2.1 - Façade	COA-S1.2.1-A Façade insulation
1.2.2 - Glazing	COA-S1.2.2-A Triple glazing
1.2.4 - Roofs: green, blue, white	COA-S1.2.4 Green roofs
1.3.1 - Low embedded energy material	COA-S1.3.1 Recycled/low embedded energy material
Category 2: ENERGY MANAGEMENT	
2.1.1 - Monitoring system	COB-S2.1.1-A Bilbao monitoring system
	COB-S2.1.1-B Bilbao Monitoring Platform
2.1.2 - Smart lighting, power LED	COA-S2.1.2 LED lighting
	COB-S2.1.2 Next generation city smart lighting system
2.3.1 - Energy Management System	COA-S2.3.1 Advanced EMS
	COB-S2.3.1-A Energy management system
	COB-S2.3.1-B Smart metering
SYSTEM INTEGRATION	
Category 3: INTEGRATED INFRASTRUCTURES	
3.1.1 - Power storage (electrochemical storage)	COA-S3.1.1 Li-ion electricity storage
3.1.2 - Thermal storage	COA-S3.1.2 Aquifer thermal energy storage
3.2.2 - Low temperature DH	COB-S3.2.2 District heating-geothermal ring
3.3.1 - EV chargers	COA-S3.3.1 EV chargers
3.3.2 - Electromobility hub	COA-S3.3.2 Electromobility hub
3.4.3 - Water-water Heat pump	COA-S3.4.3-A Republica Heat pumps
3.5.1 - Mechanical ventilation with heat recovery	COA-S3.5.1 Mechanical ventilation with heat recovery
3.5.2 - Shower drain water heat recovery systems	COA-S3.5.2 Shower drain water heat recovery systems
SUPPLY SIDE SOLUTIONS	
Category 4: RENEWABLE ENERGY SYSTEMS ALTERNATIVE URBAN ENERGY SOURCES	
4.2.1 - Solar PV	COA-S4.2.1-A Republica PV Panels
	COB-S4.2.1-A Bilbao Solar PV
NON-TECHNICAL SOLUTIONS	

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Category 5: POLITICAL, SOCIAL, ECONOMICAL INTERVENTIONS	
5.2.1 - Innovation Atelier	COB-S5.2.1 Innovation Atelier

For each one of these technologies, both Amsterdam and Bilbao have filled in the catalogue providing information regarding how the solution works, an analysis of the stakeholders involved, business model patterns, the identified barriers through a PESTEL analysis, possible adaptation needs for the replication and the expected impacts of the technology.

3.7.1. Cross cutting activity to detect potential barriers

During the last General Assembly organised in Matosinhos the 28-30th June 2022, a workshop was developed with a twofold objective: 1) establishing a dialogue among the Fellow Cities and the Lighthouse Cities' partners about the potential barriers for replicating the most relevant solutions of Amsterdam and Bilbao PED demonstration, 2) discussing the adaptation needs of the validated solutions.

The first part of session was leaded by the Lighthouse cities and the partners in charge of the solutions implementation, to exchange detailed information about the selected solutions. The concrete solutions that were presented are referenced in Table 5**¡Error! No se encuentra el origen de la referencia.**.

Table 5. ATELIER solutions presented in WP6 Workshop

Solution reference	Lighthouse City
COB-S2.3.1-A Energy management system	*City of Bilbao*
COA-S3.1.1 Li-ion electricity storage	*City of Amsterdam*
COB-S3.2.2 District heating-geothermal ring	*City of Bilbao*
COA-S3.3.2 Electromobility hub	*City of Amsterdam*
COA-S4.2.1-A Republica PV Panels	*City of Amsterdam*

These presentations were focused on technical aspects (using as basis the information collected in the ATELIER Catalogue of solutions) and, after such presentations, Fellow Cities were provided with five technical Cards with space to think about the adaptation needs to replicate the solution in their cities.

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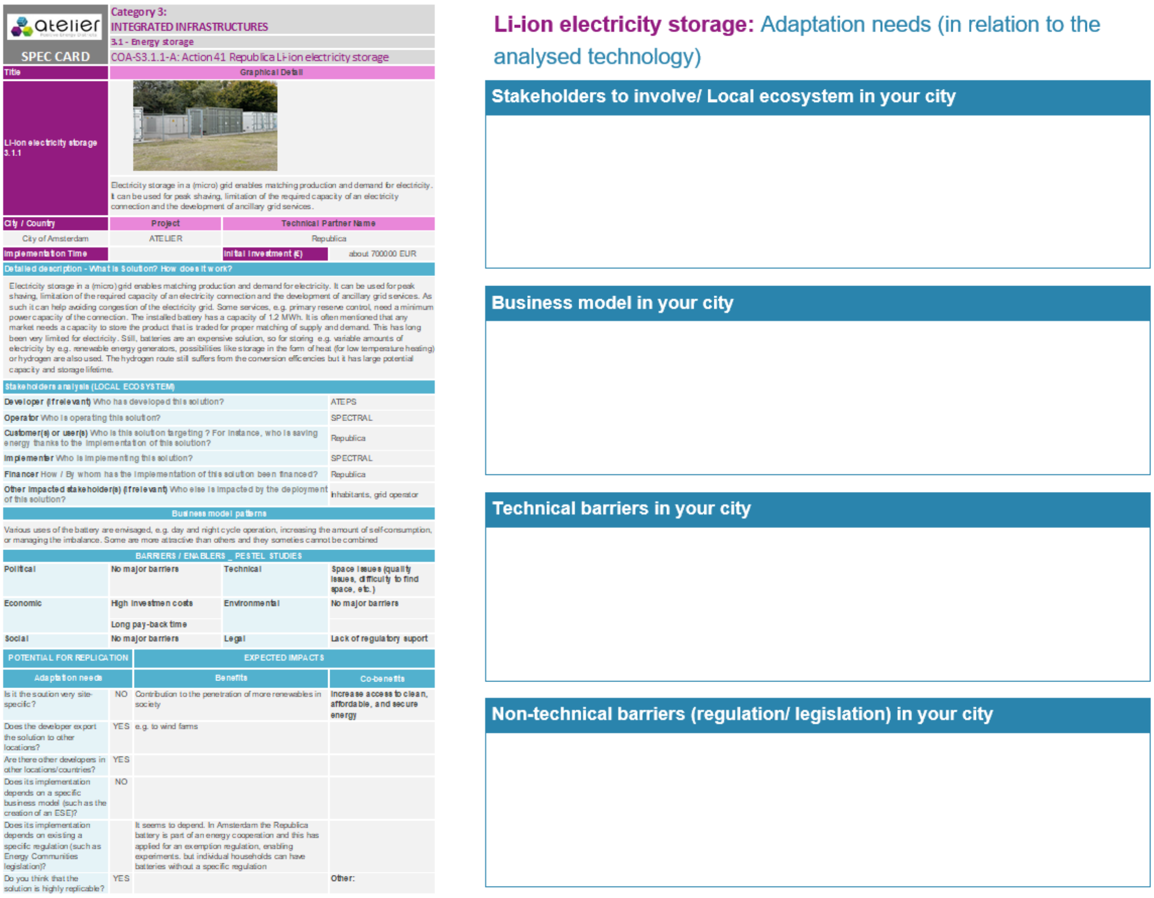

Figure 26. Technical cards provided in the Workshop

Fellow Cities discussed about how to adapt Lighthouse Cities' solutions to their own context and circumstances. Moreover, they identified several solutions that could be implemented in their PEDs and they were not considering so far. The debate generated during this workshop was also very fruitful since the technical partners joined the discussion groups and could clarify several technical aspects.

As result of the session, in the following section the adaptation needs identified and discussed for each solution presented by the fellow cities.

3.7.2. Adaptation needs identification

After the workshop in Matosinhos, Fellow Cities further discussed within their cities and stakeholders from their local ecosystem the adaptation needs of the solutions presented by the Lighthouse Cities that they consider interesting for their PEDs, and, as a result, they completed the technical cards they were provided with (see Annex 3 – Adaptation needs exercise).

Table 6. ATELIER Solutions analysed by each FC

Solution Analysed	Fellow City					
	BUD	COP	KRA	MAT	RIG	BRA
COA-S3.1.1 Li-ion electricity storage		X	X			X
COA-S3.3.2 Electromobility hub	X	X	X	X	X	X

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COA-S4.2.1-A Republica PV Panels	X	X		X	X	X
COB-S2.3.1-A Energy management system	X	X			X	
COB-S3.2.2 District heating-geothermal ring	X	X	X	X	X	

For each one of these solutions, the following four aspects have been analysed by the Fellow Cities:

- Stakeholders to involve/local ecosystem.
- Business models in Fellow Cities.
- Technical barriers in Fellow Cities.
- Non-technical barriers in Fellow Cities**.**

As a result, the adaptation needs and barriers identified by the FC are presented in Annex 3, and, for each technical solution, the most common adaptation needs are summarized from Table 7**¡Error! No se encuentra el origen de la referencia.** to Table 11.**¡Error! No se encuentra el origen de la referencia.**

Table 7. Adaptation needs for solution COA-S3.1.1

COA-S3.1.1 Li-ion electricity storage	
Stakeholders to involve / local ecosystem	- Building owners. - Energy communities. - Electricity supply companies. - Electricity network companies.
Business model in Fellow Cities	- Integrated in the building operation costs - Energy community - Third party proprietary business model
Technical barriers in Fellow Cities	- Space requirements. - Connection to the energy grid.
Non-technical barriers in Fellow Cities	- Lack of specific legislation - Fire safety regulations - High costs

Table 8. Adaptation needs for solution COA-S3.3.2

COA-S3.3.2 Electromobility hub	
Stakeholders to involve / local ecosystem	- National/Regional energy agencies. - E-mobility services providers. - Municipalities. - Electricity supply companies. - Transport operators.
Business model in Fellow Cities	- Sharing as a service. - Energy community. - HUB by itself and afterwards gains profits. - Private companies operating the service.
Technical barriers in Fellow Cities	- Difficulty to find a suitable location for the charging points. - Lack of power connection capacity. - Long distance to potential connection points.
Non-technical barriers in Fellow Cities	- Legal obstacles on public space usage. - Fire safety regulations. - Historical character of the city.

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	- Risk of vandalism. - Cost of the service. - Possible need for amendments in municipal regulations. - Lack of harmonised norms and standards.

Table 9. Adaptation needs for COA-S4.2.1-A

COA-S4.2.1-A Republica PV Panels	
Stakeholders to involve / local ecosystem	- National/Regional energy agencies. - Building owners. - Municipalities. - Electricity supply companies. - Building users.
Business model in Fellow Cities	- User owned business model (or prosumers). - Integrated in the building operation costs. - Third party proprietary business model. - Energy community. - Crowdfunding.
Technical barriers in Fellow Cities	- Space requirements. - Connection to the energy grid.
Non-technical barriers in Fellow Cities	- Its application may not be allowed in specific buildings (e.g. historically significant buildings). - Lack of awareness within the municipal administration, developers and future investors. - Fire safety regulation. - Lack of legal development.

Table 10. Adaptation needs for COB-S2.3.1-A Energy Management System

COB-S2.3.1 Energy management system	
Stakeholders to involve / local ecosystem	- National/Regional energy agencies. - Municipalities. - Electricity supply companies. - Building owners. - Building operators. - Energy communities. - Energy consumers.
Business model in Fellow Cities	- Integrated in the building operator costs. - Third party proprietary business model. - No business models identified.
Technical barriers in Fellow Cities	- Technical compatibility of equipment. - Slow data exchange process. - Variation of data granularity from building to building. - Limited availability, quality and use of output data for decision-making process and further monitoring.
Non-technical barriers in Fellow Cities	- Lack of supportive policies. - Permission for data access is needed. - Lack of awareness among all parties if IT and IA solutions.

Table 11. Adaptation needs for COB-S3.2.2

COB-S3.2.2 District heating-geothermal ring

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Stakeholders to involve / local ecosystem	- National/Regional energy agencies. - Municipalities. - District heating companies. - Building owners. - Energy communities.
Business model in Fellow Cities	- Integrated in the existing district heating/cooling business models. - Third party proprietary business model. - Energy communities.
Technical barriers in Fellow Cities	- Lack of geothermal energy potential. - Large infrastructure. - Lack of space for water wells. - Lack of experience with district heating/cooling networks.
Non-technical barriers in Fellow Cities	- High investment costs. - Lack of specific regulation. - End user engagement. - No specific loans available. - Need of environmental impact assessments.

4. Guidelines for a PED Upscaling and replication strategy definition

In this section we will introduce a set of guidelines and steps to support cities in the replication of PED concept.

The replication strategy is at the heart of WP6 activities aiming at helping cities get smarter and faster when exploring opportunities to achieve their long-term goals in their urban districts. This report is a handbook for municipalities and their stakeholders on how to replicate PED concept, in identifying areas or districts with high potential to set up PED replication plans in line with the City Vision's goals.

The strategy is targeted at implementing solutions from the Lighthouse cities in other districts, either in the Lighthouse cities and Fellow cities, or in the metropolitan regions around the ATELIER cities or in any other city outside ATELIER cities' context.

As the JRC states "When upscaling from a building to a district scale, one must not simply replicate the requirements from small to big scale, as the requirements for a cluster of buildings will differ. The challenge is which requirements should stay, which can be modified, which need to be added and which are part of another regime (e.g. indoor environment requirements, which are part of building codes.)". The design of PEDs and its replication should consider the residents' needs, the goal to match demand and production as well as achieve an over-production of RES and looking to the district as a holistic urban system.

Therefore, ATELIER PED Replication and Upscaling strategy is focused on district energy retrofitting, covering a quantitative energy model approach where the current energy demand and production (supply), including energy sources and smart grid solutions, are analysed. It also includes qualitative methods for investigating non-technological barriers and possibilities as well as review of possible business models for ensuring the PED concept accomplishment.

Thus, the ATELIER PED Replication strategy is defined with the following steps:

- Phase 0: Understanding the city
- Phase I: Creation of your Stakeholder group
- Phase II: City diagnosis at DISTRICT level
- Phase III: Definition of the alternatives to study
- Phase IV: Selection of the intervention scenarios
- Phase V: Replication strategies
- Phase VI: Execution Project and commissioning
- Phase VII: Monitoring and impact assessment

The next diagram represents the phases of ATELIER PED Replication and Upscaling strategy in chronological order, including keys and relevant aspects. Furthermore, as a transversal activity, capacity building and stakeholder dialogue is maintained along the phases, to ensure it correct implementation.

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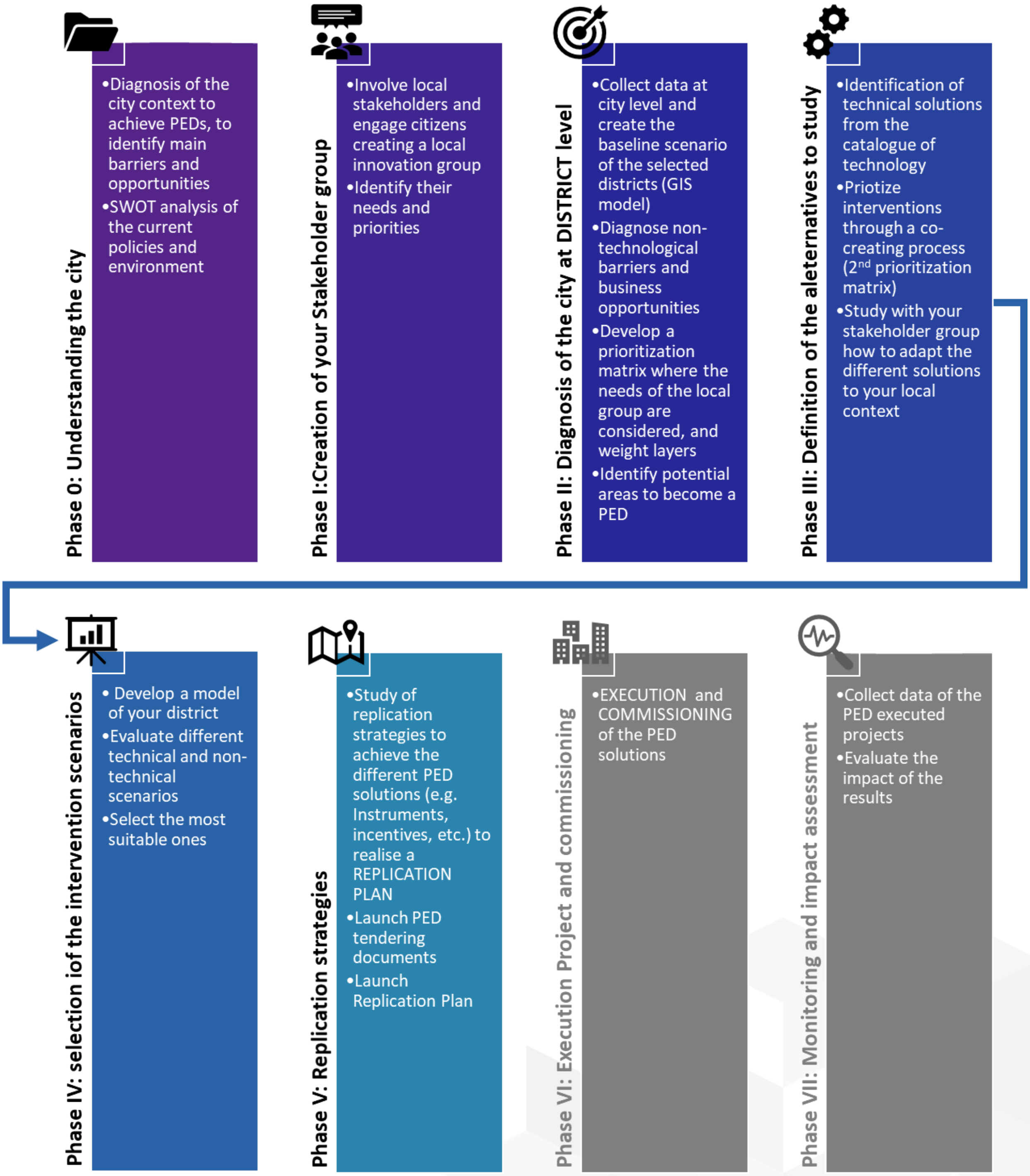

Figure 27. Phases of the Upscaling and Replication strategy (Phase 0 to Phase V).

Note that phases VI and VII are in grey colour as they will not be implemented in ATELIER project

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4.1. Phase 0: Understanding the city context

4.1.1. Objectives

PEDs are one, but powerful solution, of the wide range of actions available that a city could apply to achieve their long-term climate and energy goals. So that, it is highly important to start understanding the specific urban contexts before integrating them into city strategies.

The main objective of this phase is to support cities in mapping their current state (*Where do we come from? And, where are we?*), and identifying the challenges related to the replication of the ATELIER PED concept.

This analysis, combined with the definition of the long-term city vision 2050 (*Where do we want to go?*) will allow the identification of the transition pathway and the definition of the general objectives that will guide this energy transition.

City's background and information is gathered in order to get to know the context through the analysis of the cities' priorities and expectations, as well as the local innovation ecosystem.

4.1.2. Guidelines to understand the city context

There are two possible starting phases when implementing the guidelines for PED replication. In the first case, the case that cities do not have a Long-term City Vision ready or any similar Strategic Energy Planning, then they should start performing a pre-diagnosis of the city and to make a global approach to define the city characteristics and find out the problems and challenges that will aid to define objectives later on; in summary the necessities of the city. But in the case of cities that have set their long-term City Vision 2050 roadmap can start in Phase I.

Management

The role of the municipality with a transformative and locomotive power, is the centre of the "Replication Strategy Design" from strategy development to design, implementation, evaluation and optimisation of implemented projects with access to all the previous strategic plans, and data to be collected of the city.

ATELIER proposes a **Governance model** (see section **¡Error! No se encuentra el origen de la referencia.**) based on the creation of **Smart City Planning Groups (SCPG)** consisting of policy makers, representatives of the main municipal departments and key local stakeholders aiming to orchestrate the planning dynamics ensuring an integrated approach.

Assessment of existing city plans

The analysis of existing city plans performed is a very good first step before the development of any city strategy to obtain relevant information on the context of the cities and answer the question: *Where do we come from?*

ATELIER considers/introduces a two-step process for the analysis of plans. First, an identification of city, regional and national plans, as well as other relevant documents have been made as a first approach to the documents of the city; through a quick analysis that includes the following aspects (see Table 12) to be gathered from existing city documents:

Table 12. Information extracted from the References identification

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Information to be extracted from the references identification		
IDENTIFICATION	Title of the document	In original language and in English (translation)
BASIC INFORMATION	Type of document	If the document is: Plan/ Project/ Article/ Law/ Book/ Guideline/ Roadmap
	City and Country	The corresponding ATELIER city and is country
	Language	The language in which the document is and its availability in English language (Yes/ Only executive summary/ No)
	Scope	If the document is set at national, regional, local (city) level or other
	Citizen engagement strategies	If the document includes strategies to engage citizens or if citizens have been involved during its development
IMPORTANT DATES	Year of adoption	The year in which the document has been adopted after been approved
	Last year of the implementation period and Expiring date	The year for which the implementation is planned to end, and the year in which the document finishes
	Revision year	The year in which is scheduled to be revised or the time frequency in which will be reviewed
VISION	Vision years	If the plan or document sets a vision to 2020/ 2030/ 2050 or other year
SECTORS INVOLVED	Main sector	Main sector that the document addresses
	Other sectors	Other sectors included in the document: Energy/ Mobility/ Urban transition/ ICT/ others
	It includes quantified actions contributing to energy transition?	Yes/ No
OBJECTIVES AND TARGETS	If the document includes targets related to the following topics:	Emissions reduction, Promotion of RES, Energy efficiency, Reduction of energy poverty, Air quality, Other
	Quantified targets	If the document includes quantification for any of the targets included
STRATEGIES	Adaptation or Mitigation strategies	If the document includes strategies for adaptation or mitigation to climate change effects
OTHER INFORMATION	Link	The link to the document (to the English language version when available)
	Comments	Other relevant or interesting information to be taken into account

Second, from the documents identified, the most relevant and interesting ones were selected to be further analysed within a template that collects deeply information, which automatically filled sections from previous information gathered for the identification, and additional fields included for a more thorough analysis (see Table 13. Information gathered for the in-depth analysis of selected plans).

The template and the whole analysis of the plans by each city are included in D2.1 (Annex 2), while a shorter and focused analysis of the current relevant plans for each city is included in D2.1 (sections of each city, from 5 to 12). This shorter analysis includes the **scope** (national,

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regional or local: city level), the name of the plan, the **timeline** (year of adoption and year towards the targets are set), **targets** (highlighting the main targets, adding quantification when there is).

Table 13. Information gathered for the in-depth analysis of selected plans

Information gathered for the in-depth analysis of selected plans		
IDENTIFICATION	City and Country	*From first identification template*
	Title of the document	*From first identification template*
BASIC INFORMATION	Brief description of the Plan	Brief description of the main purpose of the Plan
	Type of document	*From first identification template*
	Language	*From first identification template*
	Stakeholders involved	Key stakeholders involved in the development of the Plan: public/private; municipal (cross-departmental), local, regional…
	Scope	*From first identification template*
	Citizen engagement strategies	Explanation/ brief description of the strategies for citizen engagement if the plan does include them
	Relevance for the ATELIER 2050 City Vision	Description of the way in what it is relevant (interesting, useful, providing relevant information or figures) for the implementation of the ATELIER 2050 City Vision
IMPORTANT DATES	Implementation period (beginning and ending)	*From first identification template*
	Expiring date	*From first identification template*
	Revision year	*From first identification template*
	Vision years	*From first identification template*
SECTORS INVOLVED	Main sector considered	*From first identification template*
	Other sectors	*From first identification template*
STRATEGIES	Strategies included	*From first identification template*
OBJECTIVES AND TARGETS	**Main target of the Plan**	Highlight of the main target that the Plan addresses
	Total targets included	The number of the total targets considered in the Plan
	Total expected energy savings	Value and units of the expected energy savings to be achieved
	Total expected emissions reduction	Value and units of the expected emissions reduction to be achieved
	Dates	Of reference year and target year for the target
	Target #1	Name/Title of the goal or main purpose (brief)
	Highlighted actions	Brief description of the main actions related to the goal regarding energy transition (best practices)
	Actuation areas	Actuation areas of the city in which the actions are going to be carried out (if there)
	Related to	Select: Emissions reduction / Promotion of RES / Energy Efficiency / Reduction of energy poverty / Air quality / Other (specify)
	Quantification	Name of the quantified target, value and units

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	Implementation status	Select: Finalised / On-going / Just getting started / Cancelled due to lack of budget / Cancelled due to technical issues / Other (specify)
	Financial scheme	Brief description of the financial scheme
	Target #2	*… (same information for all the relevant targets, i.e. those related to energy transition)*
ACTIONS	Actions Planned	Total number of actions and number of quantitative actions
	Title of the action/ main purpose (#1)	
	Related target	From previous targets' list
	Implementation period	Beginning and ending year
	Current status	Select: Finalised / In progress / Promising results / Being redefines / Cancelled due to lack of budget / Cancelled due to technical issues / Other (specify)
	Expected energy savings	Value and units
	Title of the action/ main purpose (#2)	*… (same information for all the relevant actions)*
ADDITIONAL INFORMATION	Figure/ Table	Brief explanation of the interest of including the figure or table and copy/paste it

Analysis of the Local Innovation Ecosystem

The shift towards sustainable development requires the enhancement of innovation as well as facing the still common lack of cooperation among different actors, and between science and business. Efforts should be made on overcoming obstacles with respect to administrative procedures, limited skills in managing joint public-private cooperation and smart urban solutions.

The innovation systems' model development has evolved from clusters, through networks, triple- and quadruple-helix model to finally reach the innovation ecosystem, as it can been seen in Figure 28.

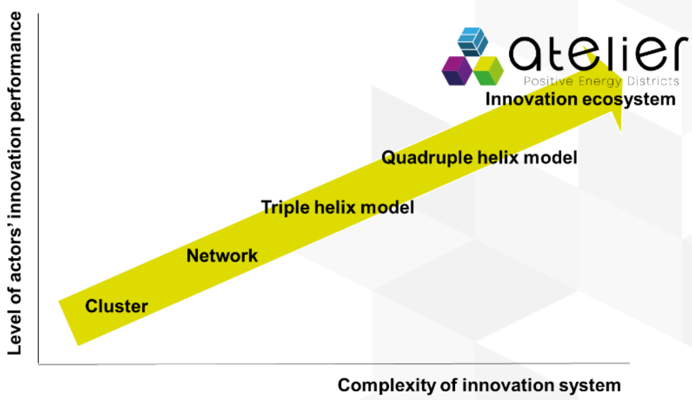

Figure 28. Innovation system's model's development

ATELIER proposed to apply **a Quadruple Helix innovation Model** bringing together four major groups of actors: University, industry, government and society. The cooperation among

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them will be necessary during the PED concept replication process in order to integrate the city context knowledge and the integrated vision needed.

For the analysis of the current local innovation structure, the Ecosystem Pie Model (EPM) tool[26]can be used as a useful tool for understanding the city current innovation structure. The Ecosystem Pie Model is based on three main elements, as it can be seen in Figure 29.

The first one, located in the centre of the model represents the Ecosystem Value Proposition (EVP). The second section is devoted to the User segments, which define the target market for the value created in the ecosystem. They are divided into several parts by radial lines. The third section represents Actors of the innovation ecosystem.

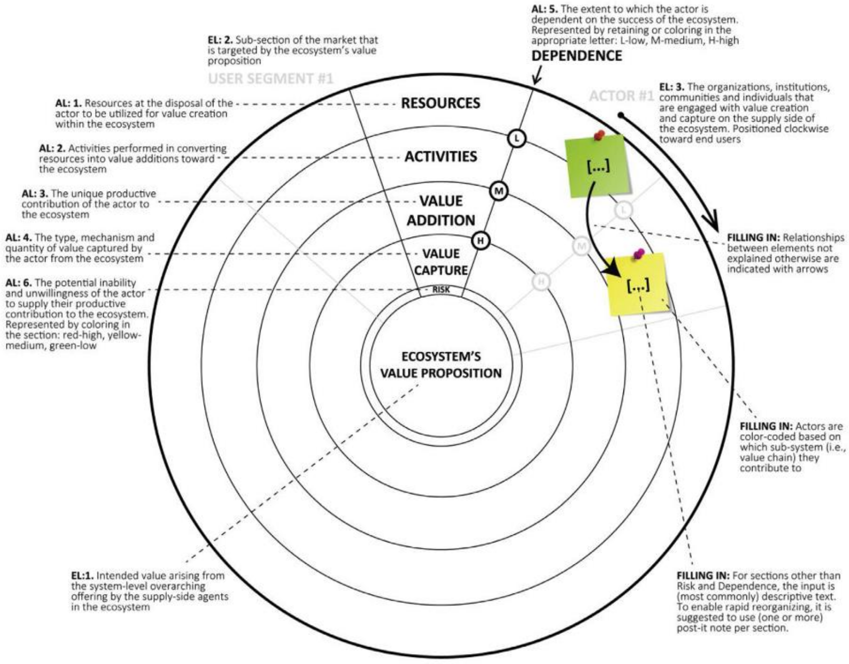

Figure 29. The Ecosystem Pie Model tool[27]

Each of the user segment is analysed based on five factors and later the dependence is determined. These factors are:

- Resources, the actor can use to create the value in the ecosystem.
- Activities, intended as the individual contributions of the actor to the ecosystem.
- Value addition, the result of activities that the actor brings to the ecosystem which is based on the user's competitive advantage.
- Value capture, represents the value created by the ecosystem that is captured by a particular actor.

26 Talmar, M.; Walrave, B.; Podoynitsyna, K.S.; Holmström, J.; Romme, A.G.L. Mapping, analyzing and designing innovation ecosystems: The ecosystem pie model. Long Range Plann. 2018, 101850.
27 Talmar, M.; Walrave, B.; Podoynitsyna, K.S.; Holmström, J.; Romme, A.G.L. How to Map, Analyse and Design Innovation Ecosystems Using the Ecosystem Pie Model. 2020.

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Example: Bilbao's innovation ecosystem model

Bilbao innovation ecosystem model was built upon an existing Cluster (The Basque Energy Cluster), which integrates the main companies and stakeholders from the energy value chains operating in the Basque Country. The cluster partners produce similar goods and services under the same market area, in this case the Energy sector. Cooperation among companies and research institutions (e.g. Tecnalia and Deusto) was established to achieve the common goal defined in the PED area of Zorrotzaurre paving the foundation of the innovation structure (Networks).
The Triple Helix Model (understood as described as a university-industry-government relations model) was achieved naturally with the involvement of Bilbao's municipality and the Basque Energy Agency (EVE), as key actors in the city transformation.

The efficacy of the triple Helix Model has been doubted over last years since the interconnection among the society, research institutions, governments and companies should be strong, continuous and dynamic in order to ensure the expected targets achievement. Therefore, Bilbao's innovation ecosystem model aims at engaging citizens so as to meet their expectations (Quadruple Helix model).

Bilbao's innovation ecosystem model is still in the way of achieving the highest level of innovation performance since the Citizens engagement is a quite challenge task.

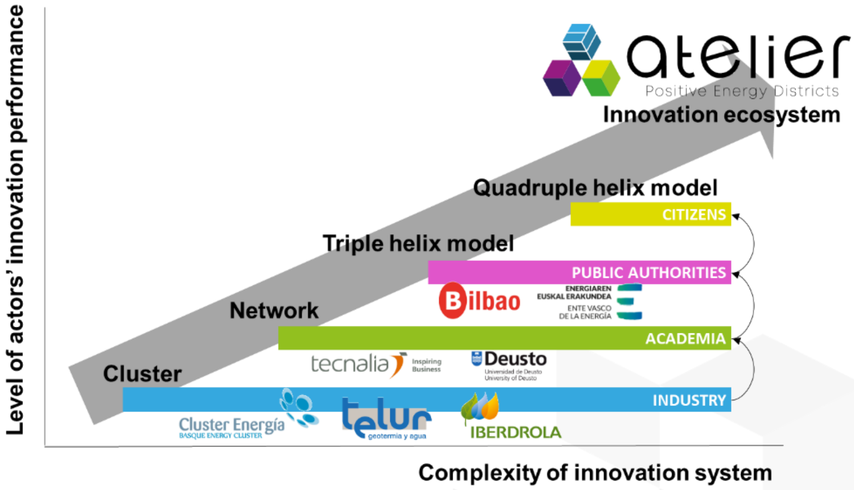

Figure 30. Bilbao's Innovation system's model's development

City diagnosis for replication -SWOT analysis

In this step, a diagnose analysis is performed to evaluate the replication potential of ATELIER PED concept by identifying different aspects that will allow or hinder a high potential of replication.

SWOT analysis of the environment can help to identify the weaknesses and strengths of the city context to achieve a specific objective (e.g. PED concept replication) whereas opportunities and threats identify the externalities that can obstruct it or enable it[28]. Since, as already mentioned, a PED is characterised by mixed-used buildings with low demand and

[28] Humphrey, A. (2005). SWOT Analysis for Management Consulting. SRI Alumni Newsletter

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energy efficiency measures, a positive energy balance, renewable energy production, and liveable and affordable districts, several questions have been produced related to each characteristic, for orient the search and analysis of the city context to achieve PEDs. Once these answers are obtained, the city can assess if it is a strength, a weakness, an opportunity or a threat for achieving and implemented PEDs in their cities. Table 14 shows the template proposed for the complete diagnosis performed for each city, in which it is related each mentioned characteristic of a PED with different aspects to be analysed and considered in the cities.

Table 14. PED SWOT analysis

CHARACTERISTICS OF THE PED	WHAT TO LOOK FOR
Positive Energy Balance	Regulation on energy certificates (transposition of the EPBD)
	Electricity regulation (*Is it possible to export energy? At what price?*)
	Electricity regulation (*Is it possible the peer-to-peer exchange?*)
	Electricity regulation (*Does it need too much paperwork to create an energy community?)*
	Gas regulation (*Is it possible to export H_2?*)
	District Heating regulation (*Is it necessary to connect? Is it possible to be a prosumer?*)
Renewable Energy Production	Electricity regulation (*Is there any limit on the capacity to be installed?*)
	Is there any legal burden on the installation of some specific energy technology?
	Does the city have experience in similar projects (nZEBs, Low DHN, VPP, living labs, etc.)?
Efficient buildings / Building stock demand	Existing building stock status
	Regulation on energy certificates (EPBD)/ nZEBs
	Social housing requirements (also related with affordable)
	Funds to energy saving renovations
Affordability	People density
	Gross Domestic Product (GDP)
	Cost of Energy (GRID + DHN, gas, etc.)
Liveability	Green areas available (*Is there any regulation on minimum areas, or something?*)
	Holistic approach (*Does the city build in a holistic way, mixed-used districts?*)
	Public transport and sustainable mobility status
	Average time that people spent to get to work
	Number of supermarkets per km^2
	Unemployment rate
PED implementation	National plans
	Local plans

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	SEAP/SECAPs
	Incentives to district projects
Context	Experiences
	Mobility
	Other

After this analysis, by combining the external environment's opportunities and threats with the city strengths and weaknesses, different strategies can be identified for the future replication of PEDs[29]. This is known as SWOT analysis. The idea is that these analyses are performed by the city itself, organising a workshop involving different actors.

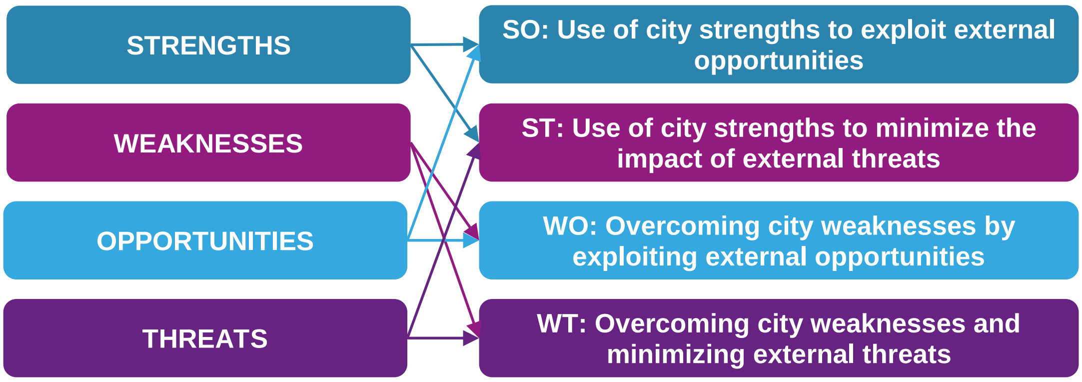

Figure 31. SWOT Analysis

Source: https://www.business-to-you.com/swot-analysis/

The aim is to give preliminary ideas for the Replication plans, and how the strategies can be further developed to become actions. The SWOT analysis in *Phase 0*, will help at the *Phase III: Identification of interventions* as the chosen technologies and measures in the city might differ depending on their context.

So, all previous gathered information of each Fellow city on the different PED characteristics was organised by CARTIF in a SWOT table (see Table 15) to see the information as a whole at a glance and in a more structured way.

Table 15. SWOT template for the analyses results

	HELPFUL	HARMFUL
INTERNAL FACTORS (City context)	STRENGHTS	WEAKNESSES
EXTERNAL FACTORS (National, EU level)	OPPORTUNITIES	THREATS

Strategic city objectives to be addressed

Whether or not the city has a defined long-term City Vision 2050, this step is focused in setting the priorities to highlight which strategic city objectives will be tackled by replicating ATELIER PED concept. This takes its reference not only from the SWOT analysis results, but from the local innovation ecosystem participation.

[29] Weihrich, H. (1982). The TOWS Matrix: A Tool for Situational Analysis.

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The strategic city objectives, that aims to guide the city energy transformation, can cover various dimensions of the city. However, due to the scope of ATELIER project the attention is paid to those objectives that are focused on **building a sustainable future of cities by PEDs implementation**.

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Main potential impacts to achieve by PED implementation, are:

Table 16. Main potential impacts to achieve by PED implementation, related with the SDGs and the strategic city objectives

Main potential impacts		SDG related		Strategic city objective
Reduce energy bills	Ending energy poverty with action on climate change through targets on increasing renewable and efficient energy use.	*Target 7.1 Universal access to affordable, reliable and modern energy services*		• Affordable energy
Increase the Renewable Energy Ratio (RER) factor	The current reliance on fossil fuels is unsustainable and harmful to the planet, which is why we have to change the way we produce energy.	*Target 7.2 Increase the share of renewable energy in the global energy mix*		• Clean energies • Clean transport • Face climate change • Electrifying H&C
Improve energy efficient buildings	Current building stock in cities is inefficient, and increases the total energy consumption, which is why improve its energy efficiency is key.	*Target 7.3 Double the improvement in energy efficiency*		• Efficient buildings • Efficient lighting
Improve air quality	People living in cities suffer from exposure to poor air quality and impacts on short and long-term human health continues to be a major concern.	*Target 3.9 Reduce the deaths and illnesses from air, water and soil pollution* *Target 11.6 Reduce the environmental impact of cities*		• Face air pollution • Liveable city
Affordable energy & housing	Provide equal opportunities to citizens and fight (energy) poverty is a top priority of societies (social justice), ensure affordable access to energy and housing for citizens is key.	*Target 7.1 Universal access to affordable, reliable and modern energy services* *Target 11.1 Universal access to adequate, safe and affordable housing*		• Affordable houses • Affordable energy • Circular economy
Liveable cities	Achieve a "liveable" city is key to ensure citizens' wellbeing. It is related with several city aspects: resilient and sustainable infrastructures, transport, housing and urbanization, access to green public spaces, climate resilience, protect biodiversity.	*Target 9.1 Sustainable and resilient infrastructure* *Target 9.2 Sustainable industrialization* *Target 11.3 Inclusive and sustainable urbanization capacity* *Target 11.7 Access to green and public spaces* *Target 13.1 Resilience to climate-related hazards* *Target 15.1 Ensure conservation, restoration and sustainable use of ecosystems*		• Liveable city • Clean transport • Nearly zero waste • Efficient lighting • Face climate change
Achieve zero energy imports	Related to climate neutrality/self-sufficiency, no energy imports should be ensured.	*Target 7.2 Increase the share of renewable energy in the global energy mix* *Target 7.3 Double the improvement in energy efficiency* *Target 8.4 Improve global resource efficiency in consumption and production*		• Self-sufficient city • No fossil fuel dependent
Achieve a positive energy balance	Related to climate neutrality/self-sufficiency, a positive energy balance helps to produce the energy that cannot in other areas.			• Self-sufficient city • No fossil fuel dependent • Electrifying H&C

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4.2. Phase I: Creation of your stakeholder group

4.2.1. Objectives

The objective of this phase is to create a stable and self-sustaining working group of local stakeholders (i.e. Innovation Ateliers) involving the local innovation ecosystem in tailoring and supporting the implementation of the smart urban solutions while removing legal, financial or social barriers.

As it can be seen in section **¡Error! No se encuentra el origen de la referencia.**, ATELIER project proposes a novelty innovation model to manage stakeholders' knowledge production, establishing a new way of collaboration and organisation in the PED sites.

4.2.2. Guidelines

The PED solution Booklet from SCIS, states that "The success of implementing PEDs will not only depend on the availability of technical solutions but also on social, political and business commitment". Thus, all stakeholders need to be involved in the decisions from the beginning, as well as to ensure citizens are engaged. In fact, citizens may play the biggest role in PEDs as can become active prosumers (i.e. aware consumers that also produced energy and participate in the market). In this way ATELIER proposes a Citizen engagement strategy to ensure that the replication and upscaling strategy in participative and citizen-driven while proposing measures/actions to improve their environmental and energy awareness and co-creating methods that can help them to feel included, understand and part of the PED development process (Ahlers, et al., 2020).

Stakeholder analysis/mapping

To identify the relevant stakeholders, a stakeholder analysis/mapping can be performed. In this stakeholder analysis one should make a list of all people and organizations, who can influence (positive as well as negative) the PED Demonstrator. They should be those:

- whose interest are affected by the actions to be taken;
- whose activities affect the actions to be taken;
- whose have information, resources and the necessary expertise;
- and whose participation is needed for successful implementation

After identifying the most important actors, the interests and goals/ objectives of the stakeholders should be identified and mapped, for example through interviews. The following questions can contribute to gaining a complete overview of the stakeholder field and respective interests:

- *What will the stakeholders contribute to the PED demo?*
- *What kind of knowledge do the stakeholders possess?*
- *What are the relevant interests and goals of the stakeholders?*
- *How do the stakeholders interpret the vision, mission and goals of the PED Innovation Atelier?*
- *How well informed are the stakeholders about the vision, mission and goals?*
- *What are the (possible) motives for these stakeholders to participate, or not to participate?*

Stakeholders can have different views and perspectives. Gaining insight in the actual perspectives of agents is necessary to understand the actions and position of different

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stakeholders in the course of the project. In a process of interaction, people with different perspectives can bring different point of view to the table to enrich ideas. Therefore, it should be ensured that the different perspectives are present and considered in the process (Slob, 2010)

GrowSmarter project (GA no 646456) identified key stakeholders that facilitate the cities replication planning process, as shown in Table 17.

Table 17. Stakeholders' aims identification

Group	Stakeholder	Key to
ACADEMIA	Universities and research	Create knowledge to enable innovative solutions in the city/PEDs and provide the necessary framework for it.
PUBLIC AUTHORITIES	Urban Planning and Housing department	Identify and integrate smart solutions development opportunities in on-going and future city developments.
	Environment and Climate Change departments	Align local plans, policies and regulations with the strategies of the replication plan and implement environmental restrictions for projects and measures.
	Transport and Mobility departments Local public and private transport operators Local traffic police Local start-ups Car manufacturers	Design and implement transport and mobility sustainable solutions measures in the city/PEDs
	Information and Communication Technology (ICT) departments:	Identify synergies and define joint strategies for the digital transformation processes and (future) public services.
	International Relations departments	Engage and manage EU funds and projects that can provide synergies between projects for further collaboration and potential financing alternatives.
	National/Regional energy agencies and authorities	Be aware of the plans on the city and align their regional/national plans/strategies with to ensure local ones
INDUSTRY	Energy utilities Network operators Urban infrastructure operators ICT companies City services operators (such as waste management)	Design and implement sustainable solutions measures in the city/PEDs
SOCIETY	Citizens Housing associations Cooperatives	Be heard and engaged, if the measures shall be (socially) accepted and properly used to work effectively. Cooperatives might enhance and help to achieve this aim, as transparent and democratic actor.

Stakeholder involvement

Stakeholder management alongside an (open) innovation model perspective is crucial.

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Stakeholders involvement is key in bringing relevant knowledge and resources to the Innovation Ateliers. Well-designed collaborative knowledge production processes help to generate meaningful results for the involved policy makers, scientists and stakeholders by joint production of documents, models, fact finding etc. People who can combine different fields of knowledge and can attach to different communities play an important role in the processes that guide the activities (Slob, 2010). Stakeholder knowledge can be distinguished in procedural knowledge (knowledge about which laws and regulations are applicable, the procedural stages of these laws or regulations and the timing of them); scientific knowledge (the formal knowledge, most of the time encoded in reports or models, which can be used to understand problems and find solutions) and local knowledge (tacit knowledge of the people living in the area that resembles specific knowledge about certain aspects of the environment) (Slob, 2017).

How to involve stakeholders

The success of implementing PEDs and replicate the ATELIER PED Concept will mainly depend on the early involvement of stakeholders. Of course, the context will guide you on the different availability of the technical solutions, but to ensure that these are applied, **the social, political and business environment needs to be assessed** and involved.

Before you involve stakeholders, it is recommended to define **which role you want to give them,** for example: do you want them to have a permanent role - become a member of the PED Innovation Atelier, invite them as an expert, or do you just want to inform them? The kinds of involvement activities will depend on the type and target of activity envisaged and, on the stakeholders, disciplines and sectors implicated over the decision-making process:

- Co-design activities (e.g. workshops, focus groups or other means to develop agendas, roadmaps and policies) often including deep discussion on the implications, the ethics, the benefits and the challenges related to R&I courses of action or technology development.
- Co-creation activities (involving citizens and/or end-users directly in the development of new knowledge or innovation, for instance through citizen science and user-led innovation).
- Co-assessment activities such as assisting in the monitoring, evaluation and feedback to governance of a project, projects, policies or programmes on an iterative or even continual basis.

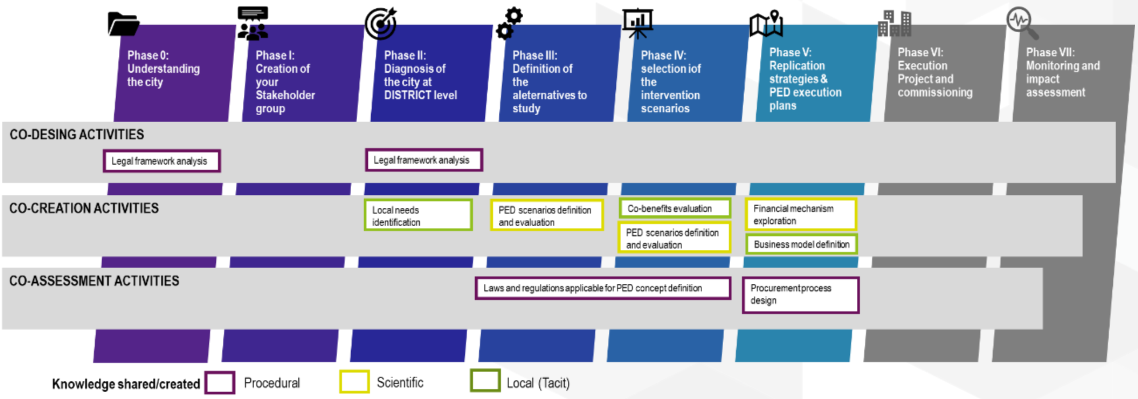

Figure 32. Tentative stakeholders involvement activities over the decision-making process

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A well-designed stakeholder involvement process is open and transparent. It should be facilitated by professionals who are used to design and facilitate these processes, and should be divided into logical steps (for the stakeholders) and contain stakeholder meetings. This process design should be communicated and presented to the stakeholders in the beginning of the process. To create transparency and fairness, the process requires "rules of the game". These rules of the game contain rules for entering and leaving the process, how decisions are made, how information is brought into the process etc. These rules should be discussed with and should be approved by the involved stakeholders.

Example: Co-creation workshops

Different methods, tools and forms of participation can be suitable and effective. Table 18 shows different cases where co-creation[30] workshops were applied:

Table 18. Examples of co-creation workshops applied in different EU contexts[31]

Project name/City name	Description	Source
Barrio la pinada	Participatory design through workshops focused in 4 main areas: energy, circular economy, community development and urban design. People participate raising their opinions and questions. Furthermore, every month different events are organized to engage people and taught them about sustainable practices	https://www.barriolapinada.es/taller-cocreacion-con-los-vecinos/
Oficina de l'Energia	A common space in the city of Valencia to give workshops and information to empower citizens in the energy transition	http://canviclimatic.org/es/oficina-de-l-energia/que-es-la-oficina/
Ukraine	e-procurerent system "ProZorro" is an open platform (open-source) developed by a group of stakeholders (civil society, government and the private sector) that contains all public purchasing data for monitoring all government tenders and procurement data, and provide feedback	https://www.opengovpartnership.org/wp-content/uploads/2019/06/OGP-Participation-Co-Creation-Toolkit.pdf
Armenia	When developing Armenia's third Action Plan, several events were held to engage CSOs, experts, citizens, and government agencies via an online tool, such as „civicomment", „Discuto" or google docs.	

4.3. Phase II: City diagnosis at district level

4.3.1. Objectives

The objective of this phase is to perform an analysis and diagnosis of the whole city to identify potential areas or districts in which focus the replication or upscaling strategy to become a PED. The methodology suggested at this stage is based on multicriteria assessment techniques applied to territorial analyses by geographical information systems (GIS).

[30] Methods to involve users in the development of goods and services and the creation of value (Prahalad & Ramaswamy 2004; Voorberg et al. 2014).

[31] *Co-creation in Urban Governance: From Inclusion to Innovation*. Available from: https://www.researchgate.net/publication/323612706_Co-creation_in_Urban_Governance_From_Inclusion_to_Innovation [accessed Oct 22 2020].

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The final objective is to build and obtain an index (composite indicator) which represents the potential for implementing the PED concept and technical solutions.

4.3.2. Guidelines to perform the city diagnosis at district level

To go from city level to district one, a territorial analysis based on exploiting GIS data is proposed to identify which PED areas are more suitable to deploy PEDs. For this purpose, an evaluation framework has been defined and explained in the following section.

Table 8 relates characteristics of the PED with potential impacts and GIS data needed to evaluate that these characteristics might be met. With data and weighting each layer, it might be possible to detect the areas.

Evaluation framework for territorial analysis

The basis for the evaluation process is the calculation of key performance indicators (spatial explicit) to measure the desired PED impacts (Measurable objective). These georeferenced indicators will be normalized, weighted and aggregated to calculate a global index named as “PED potential index”.

The general scheme for the evaluation of the potential of a district to become a PED, is to build some indexes as the calculation and aggregation of indicators. These indicators are grouped according to “core categories”, each one to fit under one of the defined measurable objectives that must be evaluated (see figure below).

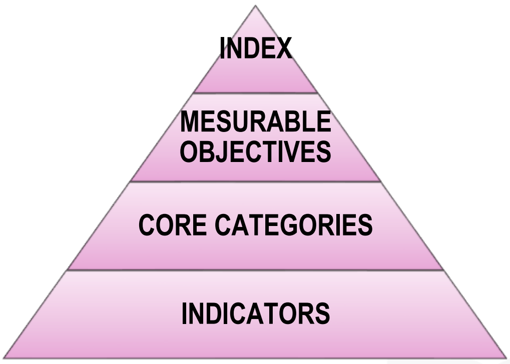

Figure 33. General Scheme for the Evaluation Framework

Following this scheme, the design of an index has the main objective of developing a single metric to measure the accomplishment of a specific purpose, a model for effective communication.

Measurable objectives are related to the main purpose of the index but are focused on more specific objectives that can be more easily evaluated. Usually, they are associated with global aspects or issues that can aggregate some core categories used for making an adequate organization of the indicators, which are the key variables, measured from real or calculated data. Indicators are used to assess a specific characteristic and they are helpful to diagnose problems and discover patterns.

Figure 34 shows measurable objectives and core categories and its relationships with indicators for the PED potential Index at district Level.

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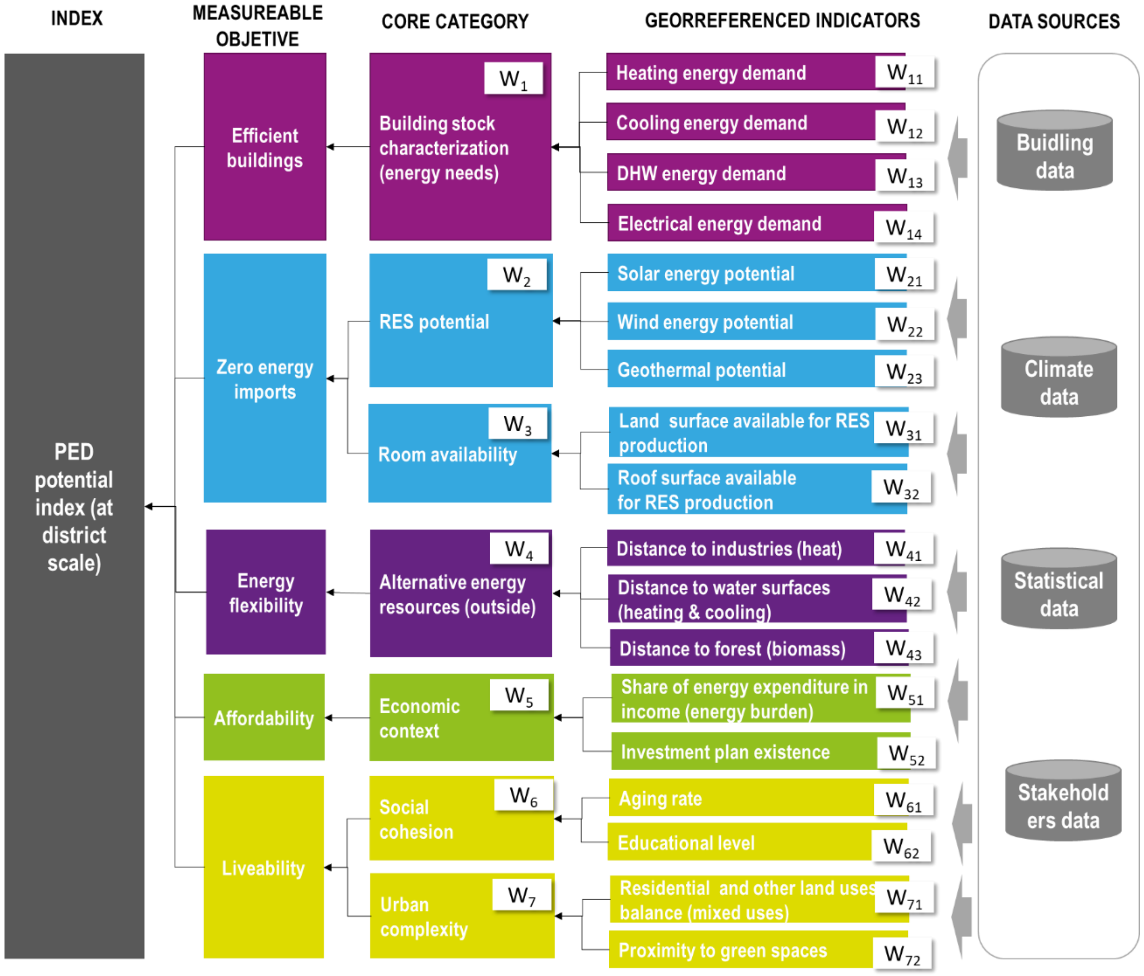

Figure 34. General scheme to calculate PED potential index

GLOBAL INDEX AT DISTRICT LEVEL:

The main objective or key purpose for proposed index is the definition of a single and normalised methodology to measure the potential of a district (city area) on the path to become a PED, making easier the selection/prioritization of candidate areas and assisting city managers. These objectives are explained below:

- Set a reference methodology for benchmarking and comparison candidate city districts/areas
- Normalise results to make them comparable.
- Translate complex information in a more comprehensive way.
- Provide tools to help city managers in the decision-making process.

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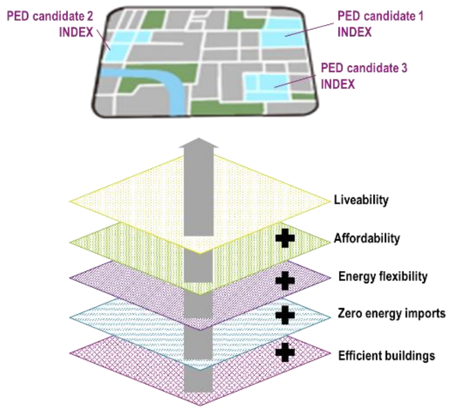

Figure 35. Global index at district level

MEASURABLE OBJECTIVES and CORE CATEGORIES:

Once defined global purpose for the index, the next level in the Evaluation Framework are the measurable objectives. Without forgetting the overall goal, measurable objectives are focused on specific issues of the district that contribute to desired PED impacts.

- ***EFFICIENT BUILDINGS***

One of the most important components of a PED is Energy Efficiency in buildings, which can be improved by using passive measures (e.g. improving the thermal insulation, shadings devices etc.) or active measures (e.g. low heating system temperatures, warm-water and ventilation systems, etc.) so as to reduce either the energy demand or energy consumption of the building in their different energy uses (i.e. Thermal (heating, cooling and DHW generation) or electrical uses)

This measurable objective aims to characterize the efficiency of the city building stock considering different sectors (residential, industrial, public, commercial, etc.) preferably and EPB ISO52000 loads. Therefore, the core category for this measurable objective will be the "Building stock characterization"

ATELIER is using Enerkad® tool developed by TECNALIA to perform the Building stock Characterization of ATELIER cities as part of the City Vision development (WP2). It bases its calculations on the heating degree hour method taking into account different characteristics of each building, like the building use and the construction year, which will define other parameters used in the calculations through inference rules.

Departing from the basic information and potentially other locally measured data, statistics or simulations of the building stock, the energy needs for heating, cooling, DHW, lighting and appliances are obtained. If the information related to the building energy systems is provided, the energy consumption for the different final uses, the emissions and the primary energy demand and therefore, the non-renewable and total primary energy balances will also be calculated.

- ***ZERO ENERGY IMPORTS***

Energy systems for PEDs will require a higher share of renewable energy sources (RES) for heat, cooling and electricity, compared to current situation. This is achieved by: 1) integration of renewable energy sources into buildings and their immediate surroundings, such as PV roofs, and 2) adding stand-alone RES production facilities to the PED, such as PV-plants.

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This measurable objective aims to evaluate the potential renewable energy production, so as to be able to identify areas that have big RES potential and, therefore, need less changes to become a PED. Additionally, the available room, either in the building roofs of in the district will be quantified to prioritize those areas with higher RES potential but also with higher available room for RES installations.

ATELIER will use specific algorithms developed by CARTIF to carry out the RES potential evaluation in ATELIER cities.

- ***ENERGY FLEXIBILITY***

Energy flexibility in PEDs is pursued to provide cost-effective solutions across all time scales, meeting the peak and peak net loads, and avoiding loss of load. Besides, energy flexibility in PEDs can greatly contribute to balance the energy systems of the city or even the region, following a multi-scale approach aligned with the city/region strategies objectives of becoming self-sufficient or energy independent.

So that, it will be valuable the distance to existing alternative energy sources, such as Industries to heat waste recovery, Water surfaces to be utilized as heat source for heating / cooling purposes, or Forests (green areas) to be utilized as energy generation areas by biomass (forest waste).

- ***AFFORDABILITY***

A household's energy burden provides an indication of energy affordability. It is well-known that energy efficiency measures and renewable energy sources can make energy access more affordable by reducing the energy burden (the percentage of household income spent on energy bills[32]) on households and businesses.

Factors that may increase energy burdens include the physical condition of a home (i.e. building stock energy needs), a household's ability to invest in energy-efficient upgrades (i.e. level of incomes), and the availability of energy efficiency programs and incentives (i.e. existence of investments plans).

- ***LIVEABILITY***

Urban liveability is the ability of urban spaces to fulfil the expectations of its inhabitants for wellbeing and quality of life. Spatial planning practises provide the regulatory framework for spatial development aspects both functional (urban function) and morphological (urban form) aspects affecting the urban liveability of a city.

This relevant and desired concept is the result of the interaction among the physical parts of the different systems that are composing the city (e.g. buildings, infrastructures, public spaces, etc.). ATELIER will focus on evaluating the social cohesion and urban complexity of the city as one of the main aspects that affect the interaction among city systems, both physical and socio-economics ones.

Social cohesion in an urban context refers to the degree of coexistence between groups of people with different cultures, ages, incomes and professions. ATELIER will seek for areas with higher levels of social cohesion, since it is acknowledged that it will lead the collaboration

[32] Researchers define households with a 6% energy burden or higher to experience a high burden.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 864374.

for mutual benefits and contribute to the acceptance on innovate urban solutions needed for PED implementation [33].

Urban complexity attends to the urban organization (spatial planning), to the degree of mix of uses and functions implanted in a determined area. Urban complexity is the reflection of the interactions established in the city between organized entities, also called legal entities: economic activities, associations, facilities and institutions. ATELIER will seek for areas with higher levels of complexity (mixed uses).

INDICATORS:

In accordance with the general scheme explained in Figure 34, the foundation for the holistic assessment in city districts of the potential to become a PED are the indicators.

Consequently, indicators are the lowest level variables of the evaluation framework linked with particular characteristics of city areas or districts. As it is said, indicators are valuable to establish a diagnosis of starting points, to benchmark and assist on the decision-making process.

In the following table are listed the indicators for index calculation and district level, grouped by measurable objective. If it is possible due to the existence of sufficient data, all of them will be calculated for the entire city but at the district level annually.

Table 19. List of indicators for the different categories

EFFICIENT BUILDINGS
Building stock characterization (energy needs)
• Heating energy demand [kWh/m^{2}year] • Cooling energy demand [kWh/m^{2}year] • DHW energy demand [kWh/m^{2}year] • Electrical energy demand (lighting, appliances, etc.) [kWh/m^{2}year]
ZERO ENERGY IMPORTS
RES potential
• Solar energy potential [MWh/year] • Wind energy potential [MWh/year] • Geothermal energy potential [MWh/year]
Room availability
• Land surface available for RES production [m^2] • Roof surface available for RES production [m^2]
ENERGY FLEXIBILITY
Alternative energy resources (outside)
• Distance to industries [Km] • Distance to water surfaces [Km] • Distance to forest [Km]
AFFORDABILITY
Economic context
• Share of energy expenditure in income [%] • Investment plan existing [Yes/No]
LIVEABILITY

[33] Luisa Lode, M., Coosemans, T., Ramirez Camargo, L. Is social cohesion decisive for energy cooperatives existence? A quantitative analysis, Environmental Innovation and Societal Transitions Volume 43, 2022, Pages 173-199, ISSN 2210-4224,. (https://doi.org/10.1016/j.eist.2022.04.002).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 864374.

Social cohesion
• Aging rate [%] • Educational level [%]
Urban complexity
• Residential and other land uses balance [%] • Proximity to green spaces [Km]

Methodology for building the PED potential Index at district level

The main steps of the development of the methodology are the following:

1. Data Collection and Analysis.
2. Calculation and Normalisation of Indicators.
3. Weighting and Aggregation to calculate Index.
4. Uncertainly and Sensitivity Analysis.

These different aspects of the methodology are described in more details below. As it is shown in the next figure, the application of this methodology is a learning process based on data availability and in the hypotheses carried out with respect to normalization, weighting and aggregation processes. Uncertainly and sensitivity analysis stage is the most important step to examine the suitability of evaluation methodology, from the selection of indicators to aggregation techniques.

1. DATA COLLECTION AND ANALYSIS

Georeferenced data used for calculating indicators are one of the most critical issues to obtain a reliable index. The impact of data consistency and validity on the obtained results is a key point to be considered in the methodology for constructing indexes. At the same time, lack of information can also limit the potential for developed indexes, providing a distorted vision of the assessed goals.

In the case of ATELIER project, most of the information is compiled from different official sources as municipalities of global databases.

In conclusion of this first stage of data collection, it is important to get a deep knowledge of data quality, its sources and its constraints in order to build a robust index. All these considerations must be taken into account in the remaining steps of the methodology.

2. CALCULATION AND NORMALISATION OF INDICATORS

Once the process of data collection and analysis is finished, indicators are calculated using available data, according to their definition. Depending on the objective to be achieved, these calculated values can be considered as definitive or they should be normalised.

There are many different methods for normalisation described in the bibliography: ranking, standardisation, distance to a reference, categorical scales, indicators above or below the mean, percentage of differences, etc., but the selected method should be relevant for the issue of interest in each case, taking into account the theoretical framework and the data available.

In the next stages of the ATELIER project, when available data are analysed the most appropriate method will be chosen:

3. WEIGHTING AND AGGREGATION TO CALCULATE INDEX

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The last step in the process of construction of composite indexes is the aggregation stage, assigning different weights to every normalized indicator for each dimension

Within each core category, particular weights are given to indicators included in that category which are aggregated, resulting a partial index for every category. The same process is carried out for each measurable objective obtaining intermediate indexes for every measurable objective as well, by aggregating indexes for categories included in each objective. Finally, these intermediate indexes for each measurable objective are again weighted and aggregated to obtain the final global index.

There are several different techniques to accomplish weighting process, some of them based on statistical methods, others that place a stronger emphasis on expert judgment, and others intermediate techniques between both positions that consider participatory approaches. ATELIER will follow the later, and the weighing process suggested will be based on participatory processes with the local stakeholders group (Innovation Ateliers) created.

Depending on selected weighting technique, an aggregation method can be applicable. There are mainly two types of aggregation methods: linear and geometric. The linear aggregation method (i.e. weighted sum) is usually applied when all indicators share the same measurement unit; tends to compensate low and high values. Geometric aggregation is a better option to avoid excessive compensation.

4. UNCERTAINLY AND SENSITIVITY ANALYSIS

The last stage of the methodology for building the index to assess the potential of a city area or district to become a PED is the uncertainty and sensitivity analysis.

The confidence in the defined evaluation framework and in the composed indexes has to be assessed according to uncertainties associated with the process of building indexes and assumptions made. Furthermore, sensitivity analysis is needed to examine the impact of changes on inputs or different hypothesis in the value of calculated indexes. Both analyses are useful to build a robustness index, considering the process of constructing the indexes as an iterative process in order to obtain the best approach to their main goals.

Sensitivity analysis is thus a significant process to fit the methodology in order to assure that the impact of the project and the proposed urban regeneration model is displayed in some way in the calculated indexes.

In principle, uncertainties associated with the evaluation methodology that must be assessed in this stage are the following:

- Indicators selected.
- Data used and chosen scheme for imputation of missing data.
- Categories for grouping indicators.
- Normalisation scheme.
- Weighting and aggregation techniques.

Considering these issues, a specific "*what-if*" type of analysis will be carried out to determine the sensitivity of global indexes to changes in each of these aspects. An index will be sensitive to a parameter if small changes in that parameter results in a large change in the index.

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As general criteria, a statistical method based on modifies uncertainty sources randomly and individually to analyse the impact of those changes. A more detailed description of the specific technique chosen will be given in next deliverables scheduled in the WP6 of the project.

Selection of a suitable are to become a PED

As a result of Phase II, an aggregated index is obtained for each city district, supporting and easing the city managers decision making when identifying and prioritizing city areas to become a PED. A rank will be provided to the city managers to validate and take a final decision on which district focus the replication strategy according with the results obtained.

4.4. Phase III: Definition of the alternatives to study

4.4.1. Objectives

The objective of this phase is to define the alternatives to study at district level. For that purpose, the local innovation ecosystem has been created in phase I. With the stakeholder group a selection of possible combination of technologies (scenarios) in each area can be done considering co-benefits to be obtained (e.g. improve air quality, reduce energy bills, etc.) as well as possible local providers in the city (that could lead to less transport emissions and underpin socio-economic co-benefits).

The final objective will be to have a list of combination of technical solutions that will be assessed in Phase IV.

4.4.2. Guidelines

Baseline scenario

In order to give a specific answer to the question *Where are we?* And to ease the comparison with the alterative scenarios in the next phase, it is required to build a baseline scenario of the selected district. This base case situation is the aggregation of the main information that describes the current performance of the area before the implementation of any measure or strategy. It is important to highlight that those aspects to be improved by the proposed scenarios should be defined also in this baseline scenario.

ATELIER will follow the 8-steps-methodology for PED calculation explained in section **¡Error! No se encuentra el origen de la referencia.** for calculating the different scenarios to be evaluated as well as the baseline scenario at this stage.

Figure 36. 8-steps methodology for baseline calculation

In a first step, the boundaries will be defined, generally geographical boundaries will be selected for the baseline scenario.

Bioclimatic analysis. Bioclimatic Chart

Bioclimatic design is used to define potential building design strategies that utilize natural energy resources and minimize conventional energy use. So that, the objective of this step is to analyse the specific climate characteristics of the selected area using bioclimatic charts (e.g.

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Olgyay and Givoni Bioclimatic charts) as the pre-design stage in the selection of passive measures in the district selected.

Passive measures are key to reduce the energy needs of a district or building as well as contribute to a better quality of life in the district thanks to a deeper knowledge of the urban climate.

The Givoni bioclimatic chart allows determining the bioclimatic strategy to be adopted based on the hygrothermal conditions of a building at a certain time of the year. Therefore, it promotes comfortable buildings that reduce energy use through appropriate building design strategies.

The diagram shows 12 different zones associated with their respective bioclimatic techniques that allow reaching the comfort zone (zone 1).

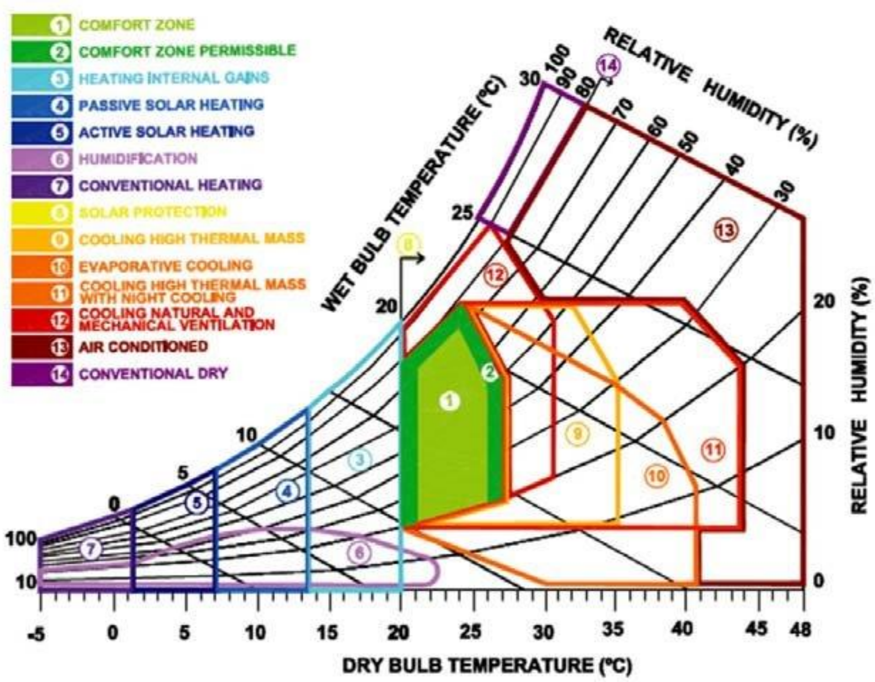

Figure 37. Givoni bioclimatic chart (Givoni 1992)

To use the chart, hourly weather data of the specific district location is superimposed onto the chart to calculate the number of hours that fall into each design strategy, and find the appropriate design strategies for that location.

Nowadays, there are a huge number of tools and software available for assisting architects in the early phase of a passive energy design.

Identification of technical and non-technical solutions

When designing and planning a particular concept in your city or district, the synergies between all the sectors (cross-sectoral approach) and stakeholders (cross-actor approach) must be identified. As it has been seen in Figure 6, PED consist of 4 main elements, but there might be more if a community perspective (with citizens involved in the process) is included. In fact, in ATELIER we proposed to have the following elements:

- Energy efficiency: in buildings and system, to avoid waste of energy, and maximize infrastructure performance

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- Renewable energy technologies: to produce as much as possible from green energies and reduce the associated impacts of implementing a solution
- Energy flexibility: as enabler of efficient and optimal energy management that can help to reduce peak loads, waste and energy bills, as well as to help the outside grids when needed
- Green and smart mobility: which can include e-mobility (electric vehicles, fuel cell vehicles), charging stations, hydrogen refuelling stations, as well as public transportation and pedestrian movement
- Citizen and community engagement: to ensure the value of the PED is sustained in a long-term and characteristic such as “high living standard”, “affordable”, “inclusive” etc. are achieved, the concept of community and involvement of citizen must be enhanced.

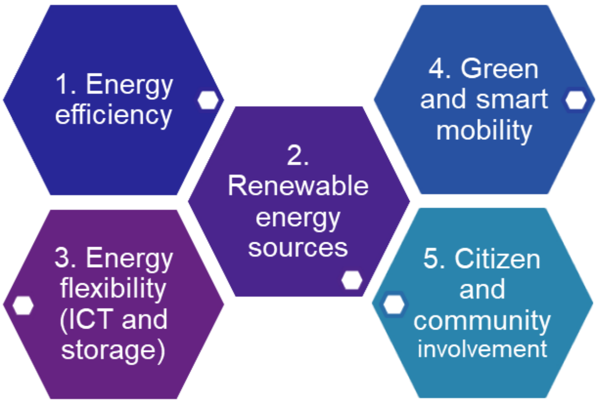

Figure 38. Components of PED and energy communities

Own elaboration, based on: **(Ahlers, et al., 2020)** *and* **(Moroni, Antoniucci, & Bisello, 2019)**

To identify the alternatives in each element, co-creation workshops, guidelines and assessment studies such as the PESTLE analysis, can be used. Thus, the 3 pillars of this phase are:

1. Apply co-creation methods in the open innovation ecosystem to ensure that all needs of stakeholders and citizens are considered, and a communal spirit and cohesiveness is implemented.
2. Guide cities on the existing technical and non-technical solutions
3. Identify the barriers and enablers of the solutions in the specific context (the chosen district)

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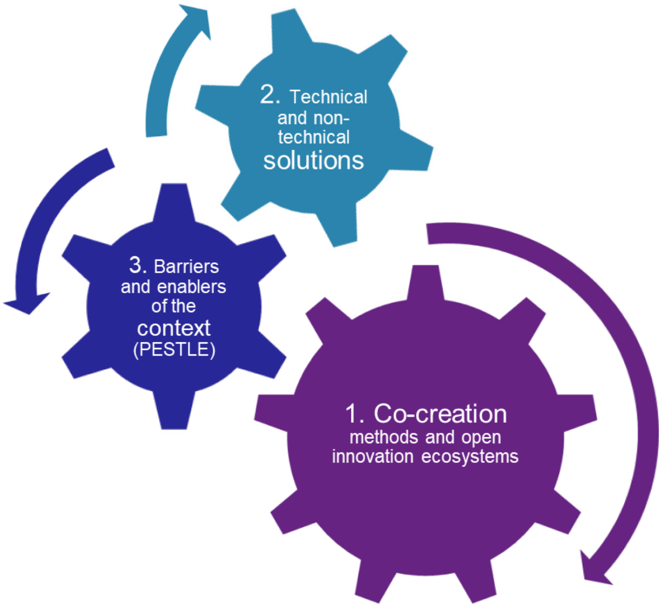

Figure 39. Pillars for phase III

Considering the barriers and enablers, and RES identified in phase 0, cities will be able to use ATELIER Catalogue of smart urban solutions (see Annex 2 - Catalogue of solutions for replication) and the Tool for PED technologies selection[34] to select and check different energy solutions combinations (called scenarios) to guarantee their objectives (e.g. achieve self-sufficiency).

The tool can be used in a co-creation workshop, in which the answers to the tool are given and result is assessed, identifying: links between the desired technologies, stakeholders available in the district, and resources; and/or possible Business models alternatives that are feasible for each technology/stakeholder. The aim is to agree in different alternatives for each selected area.

Table 20. Possible co-design process

	Steps
1	*Gather relevant information from phase 0 to be able to answer questions depending on the area or at city level*
2	*Organise an event for your stakeholder group (e.g. a roundtable). Prefilled the tool with different options and print the answers to vote and discuss them together. Other alternative can be to use the tool in real time*
3	*During the event you should guide the conversation/discussion around the following topics:* - *How does the resulting technologies affect each stakeholder? (financially, legally, economically- is it a competitor or not, etc.)* - *Are the resulting technologies attractive for the stakeholders? Who can take responsibility of some of them? Who can finance them?* - *Try to draw co-benefits together (see* Table 21. Co-benefits to be identified *)* - *How the business model can be drafted to benefit most parties? (e.g. ESCO can invest and ensure a certain amount of savings are achieved and build the business model around it; the citizens pay less compare to the previous*

[34] https://tools.cartif.es/ped-tool/

	- *Identify what each partner can offer and what can be offered in exchange by the municipality (tax reductions, adaptation of some local ordinance, specific funds etc.)* - *Identify potential gaps and future capacity building needs* - *Etc.*
4	*Wrap up the main conclusions and try to fill the table of scenarios to study*

The following co-benefits can be assessed together:

Table 21. Co-benefits to be identified

Climate resilience (CR)	Contribute to climate adaptation
	Contribute to climate mitigation
Local economy, entrepreneurship and innovation (LEI)	Local economy enhancement
	Financial savings for citizens
	Increase employment rate and jobs
	Decrease future maintenance costs
Social inclusion and education	Social cohesion (gender, minority groups)
	Enhance citizen participation, connectivity and community
	Improve access to information, Social capacity building
	Raise awareness/ behavioural change
Health and well-being	Improve air quality
	Reduce noise pollution
	Reduce hot stops/ urban islands in the city
	Enhance attractiveness of the city
	Promote healthier and more attractive lifestyles
Biodiversity	Reduce ecological footprint
	Greater biodiversity
Resource management and efficiency *(circular economy)*	Waste efficiency
	Water efficiency
	Food efficiency
	Sustainable land use

The scenarios to study can be filled out in a table selecting 3 to 6 technical solutions per scenario, and defining up to 3 scenarios in total (you can select later on, depending on the area, the scenarios to study). Also, if there are different stakeholders in each area, different workshops can be performed at local level.

Table 22. Co-benefits to be identified

	Scenario 1						Scenario 2	Scenario 3
Co-benefits identified per technology(T)	T1	T2	T3	T4	T5	..	…	…

Table 23. Examples of scenarios to discuss with stakeholders depending on technology

Technology	*Stakeholders(Phase I)*	*Business model alternatives*

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District heating network with Waste heat integration with heat pumps	District heating operator and Waste heat provider (e.g. supermarket)	Prosumer contract between district heating operator and waste heat provider (e.g. provide heat at supply temperature in determined hours and pay according to quality and kWh provided).
Ancillary services to grid (e.g. 1MW demand response)	Company X or energy community inside the PED with 1MW of flexible load Grid operator	Demand response contract between PED and Grid operator. PED is reimbursed when 1MW can be shifted (per time, or even for just the grid having the opportunity to shift it). Penalties can be performed if PED does not commit to switch off/on when grid needs it.

A political, economic, social, technical, environmental, legal, spatial (PESTLE) study of the **Technical solutions** in each district, to identify specific barriers and enablers of the solutions could be also performed.

Other co-creation workshops can be performed such as:

- *Conference around the topic (like CityXchange)*
- *Climathon in Valencia*
- *Webinar, like Gzira*
- *Virtual Reality workshops*
- *Organise a GamePED (from MAKING-CITY project[35])*

Example: Review of technical and non-technical solutions already implemented in PEDs

As +CityXchange project (GA No. 824260) D4.3 states, "Solutions are measures that a city implements to achieve a certain objective. The roll-out of E-buses for example could be a solution to decrease carbon emissions".
Currently, 21 district PED cases have been analysed from Europe, and the results are shown in Figure 40. It can be observed that the most common technology is solar (which includes PV, PVT, thermal solar panels, etc.) which is applied in all cases. District heating networks (DHN) are the next solutions applied, followed by geothermal technologies and heat pumps (57%). Bioenergy (which includes biomass from forest waste, biogas, solid urban revalorisation, etc.) is only applied in 1 out of 3 projects, whereas wind is only applied in one project. Furthermore, 30% of the cities decided also to recover part of the waste heat from some facilities (e.g. data centers).

[35] *MAKING-CITY project https://makingcity.eu/wp-content/uploads/2021/12/MakingCity_D4_1_Methodology_and_Guidelines_for_PED_design_final.pdf*

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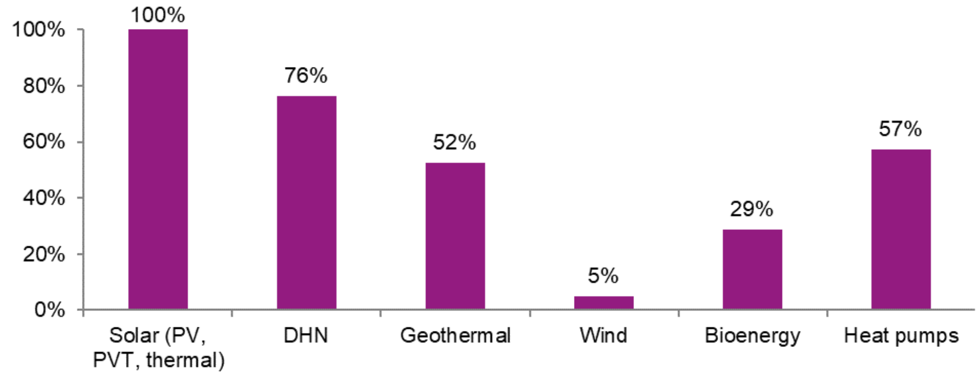

Figure 40. Technologies applied in PEDs

As non-technical solutions or instruments (i.e. enabler interventions that help you to implement the technical solutions or that allows you to enhance a specific co-benefit), energy communities are the most widely used social innovation solution that is being applied now in PEDs, for example in Schoonship (Amsterdam, the Netherlands).

In Mobility also soft-mobility actions such as "a low emission zone" in the PED or ban car entrance, can be performed. In Switzerland, there is restriction for every inhabitant not to consume more than 2000W per capita in the specific area of Hunziker. In Freiburg (Germany), the district of Vauban created a green corridor along the district with tram, and in principle there was areas for parking cars, but due to citizens willing the area also became a green area. Multipurpose buildings can be also to gather educational activities, energy generation or recreational activities, like Copenhill (Copenague, Denmark). Also, waste-to-energy solutions such as community composting can be performed, like in Nitra (Slovaquia).

4.5. Phase IV: Prioritization and selection of the intervention SCENARIO

4.5.1. Objectives

During Phase IV, the alternative scenarios (combining technical and non-technical urban solutions) at district level are evaluated according to the objectives and the city/district analysis. The most suitable scenario considering cost-effectiveness and other impacts (environmental performance, economic and social aspects) is selected to be part of the replication strategy and PED execution plan.

4.5.2. Guidelines

For an optimal design is critical to determine the costs and impacts of implementing a concept or a group of solutions. Models can be used to study and assess several intervention scenarios or alternatives. In this section how to make a PED detailed design is explained and later this process can be scale up to each of the areas identified in phase II, studying in each area the alternatives identified in phase III.

Scenario assessment

Areas have been ranked in phase II. Thus, the Innovation Atelier group can preselect one of the areas to make a PED detailed design study. Once the area is selected, and the scenarios to study have been predefined, the solutions can be assessed. Thus, a techno-economic study for assessing the different scenarios and find the optimal design can be performed for each

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alternative scenario in the selected areas. Investment costs, operating costs, technical (operating regime, efficiencies, etc.), pollutants saved, etc. can be estimated thanks to an energy system model.

Next figure shows the main steps for the selection and prioritization of scenario phase.

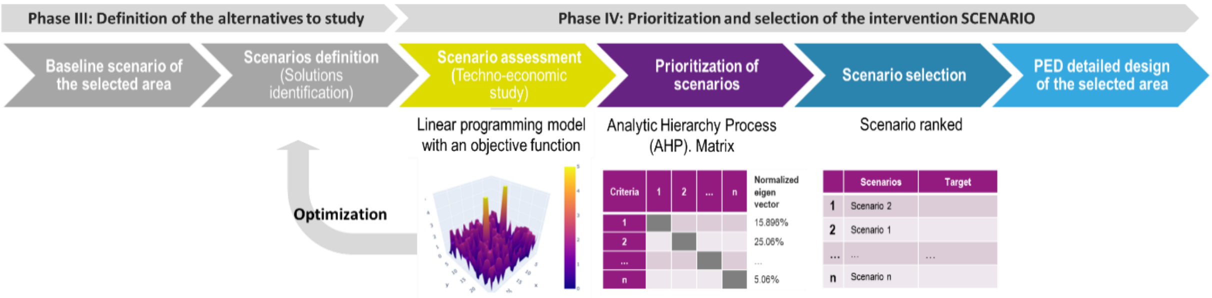

Figure 41. Steps to be followed at Phase IV

The first step focuses on the **Scenario assessment**. Here, the results of the different scenarios configuration in the Phase III are evaluated using a linear programming model with an objective function (cost minimization for each hour), sizing the optimal solution (capacities to install of each technology). The results are post-processed to assess the following indicators defined in the following table:

Table 24. Key Performance Indicators (KPI) as desired impacts, and related formula

Impacts desired[36] (Criteria)	KPI calculation
Increase RER (Renewable Energy Ratio) factor	$RER = \frac{PE_{ren}}{PE_{total}}$
Improve air quality	Net PM reduction: $PM\ PED = DE_{bs,c} \cdot PM_c - DE_{PED,c} \cdot PM_{PED,c}$ Net GHG reduction: $GHG\ PED = DE_{bs,c} \cdot GHG_c - DE_{PED,c} \cdot GHG_{PED,c}$
Reduce bills	$Costs\ Saved = \sum OPEX_{bs} - \sum OPEX_{PED}$ Ratio between energy cost and income per household
Achieve zero energy imports	Primary energy within the boundary $Fossil\ fuel\ dependency$ $EP_{nren,imp} \rightarrow 0$ Hours with storage
Achieve a Positive Energy Balance	Net PED balance: $BALANCE\ PED_{nren} = PE_{nren,imp} - PE_{nren,exp}$ Hours with surplus
Efficient buildings / Building stock demand	$Efficiency = \frac{\sum Energy\ needs}{PE_{total}}$ Self-consumption ratio
Affordability	$CAPEX = \sum I_i$ Investment-to-income ratio = CAPEX / income per capita Payback period
Liveability	Comfort achieved Co-benefits of health and well-being achieved Co-benefits of social inclusion and education achieved

[36] Bs: indicates baseline, c: carrier, ren:renewable, total: renewable+non-renewable, nren: non-renewable, imp: imports, exp:exports. PE= Primary energy, DE= deliver energy

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Prioritization of scenarios

The second step is focused on the **Prioritization of scenarios,** once the potential scenarios have been evaluated in detail. For this purpose, ATELIER project recommends applying an Analytic Hierarchy Process (AHP) to combine the output of the models used for the analysis of scenarios and the opinion of the local stakeholders involved in the decision-making group.

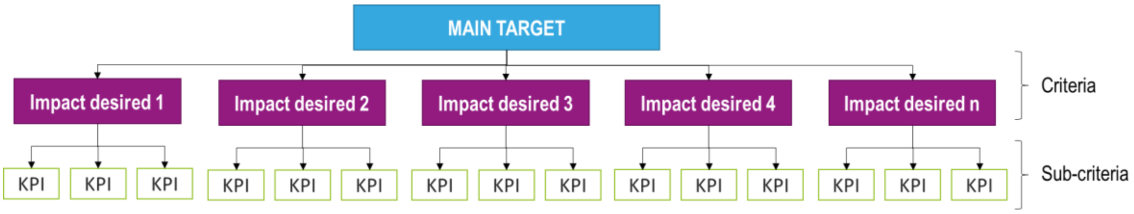

Figure 42. Hierarchical problem structuring (example)

Each scenario will have the same target. However, the implementation of each scenario will have a different effect in each of the PED impacts desired, so that it is recommended that each of the desired impacts will be weighted by performing a pairwise comparison for the criteria defined. Here the relative importance of each criteria respect to the other ones is pairwise evaluated.

The gathering of the relative importance of the criteria between each other need to be done collecting the opinion of the main stakeholders involved as part of the Innovation Atelier. As result of this participatory process, a normalised matrix and the priority vector (eigenvector or relative vector) for each of the criteria are obtained.

Scenario selection

The third step will be the **Scenario selection**, multiplying the prioritization vector of the scenario by the prioritization vector of the criteria, the final weighted result is obtained for each scenario. The result is a number for each scenario and therefore, the scenarios can be compared directly. The scenario with the highest result is in principle the one that should be prioritized according to the relevance that all the stakeholders have provided to each criterion evaluated.

Once that the entire process has been completed there is a possibility (if the result obtained from the prioritization process are conflictive for any reason), to repeat, review or modify the weighting process of the criteria. This could be done with the same group or including a new group of stakeholders from the local innovation ecosystem (Innovation Atelier) and following the same process.

The scenario selected, that contains different measures, and the different analysis and decision-making process made in previous phases will be gathered in the Replication strategy synthesis document in the following Phase V.

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Replication & Upscaling of the PED concept to the whole city (or EU)

The above-mentioned process (Figure 43) can be applied in each of the areas identified in Phase II, studying in each area the alternatives identified in Phase III.

So that, the Replication strategy will be formed by as many replication plans as PED detail designs are included for the selected areas.

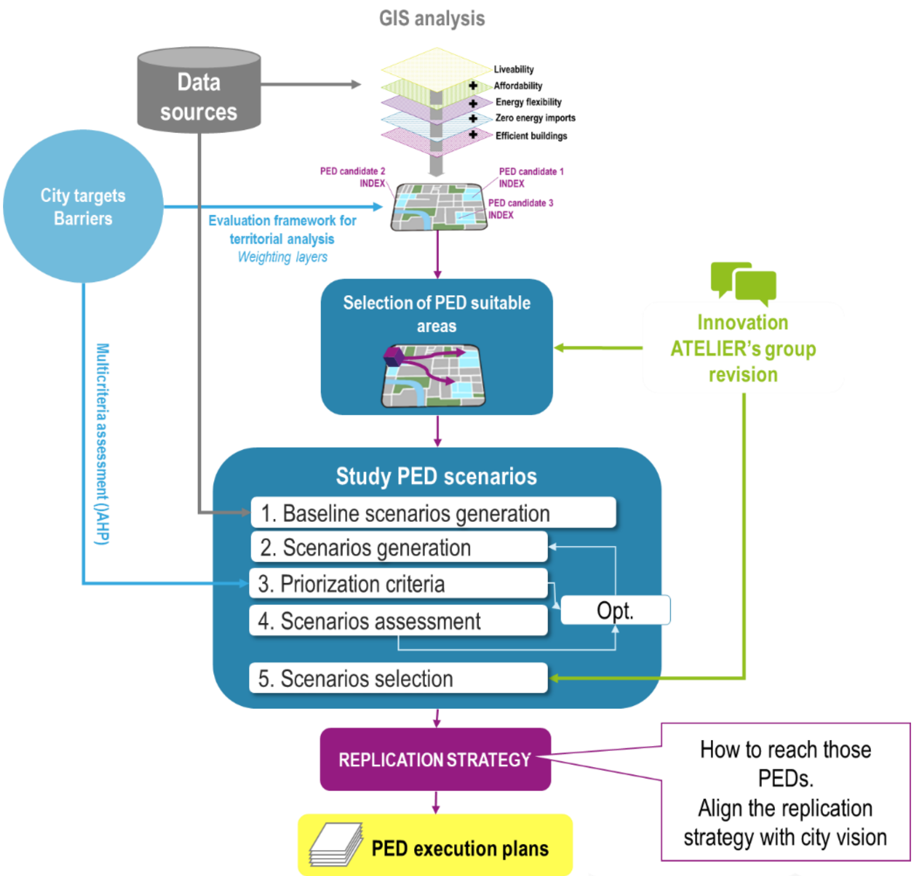

Figure 43. Overall approach for identifying areas, prioritizing solutions, find strategies to ensure the plan will succeed, and incorporate the ideas in a replication plan.

4.6. Phase V: REPLICATION Strategies & PED execution plan

4.6.1. Objectives

During this phase, the final definition of the PED Replication Strategy as a synthesis document based on the previous phases is delivered. The PED solutions included in the strategies should be further detailed so as to be able to initiate a public procurement for their execution or implementation. Recommendations to select the suitable procurement method is included in 'Method of Procurement (MOP)' subsection.

Suitable financial mechanisms will be identified at this stage to obtain the necessary funds to ensure the replication strategy implementation. Furthermore, their integration within the City Vision of the city will be pursued.

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4.6.2. Guidelines

Business model and financial mechanisms definition

The definition of the business model for PED replication is a complex task due to the different aspects that should be taken into account simultaneously; the high number of stakeholders involved that can play different roles; as well as the technical considerations or boundaries definition. In addition, the long-term character affected by the uncertainty of the energy process and risk exposure, and the high investment required for this scale of actions are relevant.

When tackling the definition of the business model for PED replication, three ways/steps can be followed:

1. **Identification of the stakeholders to be involved as part of the Business Model:** Some of the potential stakeholders that could take part in the PED implementation are (among others): Energy service companies, Energy supply companies, Construction companies, Architectural firms, Energy consulting, Engineering firm, Energy management companies, Private/public financial entities, the Municipality and the end users (building owners and tenants).
2. **Identification of the service offered or demanded by the stakeholders:** Some of the potential services that could be offered/demanded are (among others): housing rent, construction management, energy management, design of energy retrofitting solutions, financial services, energy supply, coordination and licensing, etc.
3. **Identification of recipient of the service offered** (to whom is offered the service)

Once all of the stakeholders that are required and the services offered or demanded for PED implementation have been identified, it is suggested to collect all this relevant information to the well-known Business Model Canvas proposed in 2005 by Alexander Osterwalder [37].

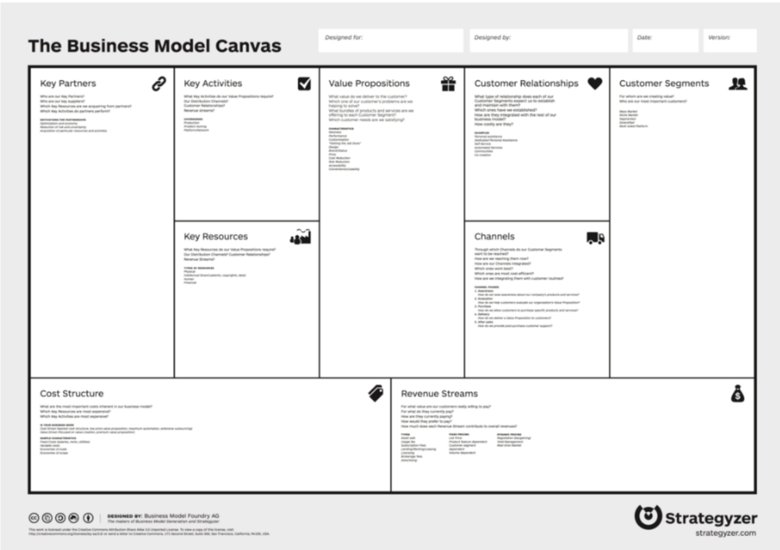

Figure 44. Business model canvas

[37] Osterwalder, Alexander; Pigneur, Yves; Clark, Tim (2010). Business Model Generation: A Handbook For Visionaries, Game Changers, and Challengers. Strategyzer series. Hoboken, NJ: John Wiley & Sons. ISBN 9780470876411. OCLC 648031756.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 864374.

In order to define each service, several key aspects should be analysed: i) Description of the service, *who could offer that service? Who could demand that service?* and ii) Identification of financing opportunities, *which ways of financing are possible to develop this service?*

Financing PED replication requires innovative financial schemes and new business models. So that the objective of this step will be to explore the main innovative financial schemes and business model, and discuss among the members of the local innovation ecosystem the feasibility of implementing them. Therefore, a key role will be played at this stage the Innovation Ateliers, since the perfect environment to engage the local innovation ecosystem and support the city managers on this relevant task, investigating and discussing the feasibility of already implemented financing schemes at European level.

To attract the necessary capital for investments, smart urban solutions have to be found to:

- Reduce the real and perceived risks of investment;
- Develop project aggregation mechanisms to create bankable and sizeable investments with reduced transaction costs;
- Develop off balance sheet investment systems with private mechanisms (development of special purpose vehicles and PPPs).

Supportive economic instruments and the application of proper business models with tailor made financial mechanisms, is a possibility to facilitate more smart urban solutions investments. Therefore, the business model definition for the PED execution will also provide an assessment of which business models and financing schemes can facilitate this type of investment in order to provide better solutions for access to capital for investments.

In this scenario the EU, governments and public financial institutions have the capacity to develop the necessary tools to promote innovation and the deployment of novel solutions. As reference, some of the main existing EU and not necessarily connected to the EU funding possibilities in the energy sector (European Commission, 2022) are presented in Table 25 and Table 26.

Table 25. EU instruments to finance the PED implementation

EU instruments to finance the PED implementation
Cohesion Fund
The EU's Cohesion Fund[38] aims to reduce economic and social disparity between EU countries and promote sustainable development. The fund supports energy-related projects that benefit the environment for example by reducing greenhouse gas emissions, increasing the use of renewable energy or improving energy efficiency. Part of the Cohesion Fund is used to implement the energy union strategy with the help of the Energy and Managing Authorities Network[39] (EMA).
Connecting Europe Facility
The Connecting Europe Facility[40] (CEF) is the EU's funding instrument for boosting energy, transport, and digital infrastructure. In 2018, the CEF was renewed for 2021-2027 with a budget of €42.3 billion to support investments in EU infrastructure networks for energy (€8.7 billion), transport (€30.6 billion) and digital (€3 billion). This represents a 47% increase compared to 2014-2020, see "EU Budget for the future" CEF factsheet[41] for further information.
European Investment Bank and the European Fund for Strategic Investments:
The European Investment Bank (EIB) helps finance energy projects by providing companies with loans and other financial instruments. The EIB, together with the European Commission, launched

[38] https://ec.europa.eu/regional_policy/en/2021_2027/
[39] https://energy.ec.europa.eu/topics/funding-and-financing/eu-funding-possibilities-energy-sector/energy-and-managing-authorities-network-meetings_en
[40] https://ec.europa.eu/info/funding-tenders/find-funding/eu-funding-programmes/connecting-europe-facility_en
[41] https://energy.ec.europa.eu/system/files/2018-06/cef_factsheet_0.pdf

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the European Investment Advisory Hub[42] as part of the Investment Plan for Europe. The hub acts as a single access point that provides advice and expertise on administration and project development across the EU. The European Fund for Strategic Investments[43] (EFSI) is a joint initiative between the EIB Group (the EIB and the European Investment Fund) and the Commission. It aims to mobilise private investment in projects which are strategically important for the EU, including the areas of energy efficiency, renewable energy, power grids and interconnectors – all essential to speed up the decarbonisation of the EU economy.
European Regional Development Fund
The European Regional Development Fund (ERDF) aims to strengthen economic, social and territorial cohesion in the European Union by correcting imbalances between its regions. In 2021-2027 it will enable investments in a smarter, greener, more connected and more social Europe that is closer to its citizens. The ERDF finances programmes[44] in shared responsibility between the European Commission and national and regional authorities in Member States.
Horizon Europe programme
Around €5.8 billion will be invested in energy research and innovation projects in the EU's Horizon Europe programme 2021-2022 . These projects aim at the creation and improvement of clean energy technologies, such as smart energy networks, tidal power and energy storage.
InvestEU
The InvestEU Programme[45] supports sustainable investment, innovation and job creation in Europe. It will bring together, under one roof, the European Fund for Strategic Investments and 13 other EU financial instruments and aims to trigger more than €372 billion in additional investment over the period 2021-2027.
Just Transition Mechanism
The Just Transition Mechanism is a financial tool that provide tailored support to the most vulnerable and coal-intensive regions in the transition to a greener economy. Over the period 2021-2027, it will mobilise at least €150 billion of investments to alleviate the socio-economic impact. The mechanism consists of three pillars: I) A Just Transition Fund[46] of €40 billion to primarily provide grants; II) A dedicated scheme under InvestEU to crowd in private investments; III) A public sector loan facility with the EIB Group to mobilise additional investments and leverage public financing.
LIFE programme: Clean Energy Transition
The new sub-programme of the LIFE Programme is dedicated to clean energy transition[47]. It aims to offer support to deliver on sustainable energy-related polices that contribute to reach the European Green Deal objectives. With a budget close to € 1 billion for the period 2021-2027, the sub-programme aims to facilitate the transition towards an energy efficient, renewable energy based and resilient economy by funding coordination and support actions across Europe.
Modernisation fund
This fund will contribute to the investment needs of the 10 lower-income EU countries: Bulgaria, Croatia, Czechia, Estonia, Hungary, Latvia, Lithuania, Poland, Romania and Slovakia. It supports investments in generation and use of energy from renewable energy sources, energy efficiency, energy storage, modernisation of energy networks and the just transition in carbon-dependent regions. The total revenues of the fund may amount to some €14 billion in 2021-30, depending on the carbon price. The European Investment Bank (EIB) auctions the EU allowances of the Modernisation Fund[48], assesses investments proposed by the beneficiary EU countries, manages revenues and transfers resources.
Recovery and Resilience Facility
The Recovery and Resilience Facility49 (RRF) is the key instrument at the heart of NextGenerationEU, the EU's plan for emerging stronger from the COVID-19 pandemic. It is structured around 6 pillars:

[42] https://advisory.eib.org/index
[43] https://www.eib.org/en/products/mandates-partnerships/efsi/index.htm
[44] https://ec.europa.eu/regional_policy/en/atlas/programmes/
[45] https://investeu.europa.eu/index_en
[46] https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal/finance-and-green-deal/just-transition-mechanism/just-transition-funding-sources_en
[47] https://cinea.ec.europa.eu/programmes/life/clean-energy-transition_en
[48] https://climate.ec.europa.eu/eu-action/funding-climate-action/modernisation-fund_en
[49] https://ec.europa.eu/info/business-economy-euro/recovery-coronavirus/recovery-and-resilience-facility_en

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green transition; digital transformation; economic cohesion, productivity and competitiveness; social and territorial cohesion; health, economic, social and institutional resilience; policies for the next generation. The RRF will help the EU achieve its target of climate neutrality by 2050.
The Innovation Fund
The Innovation Fund[50], which is the successor of the NER 300 programme[51], is one of the largest funding programmes in the world that is dedicated to the demonstration of innovative low-carbon technologies. The fund focuses on technologies and big flagship projects that can bring significant emissions reductions, including innovative low-carbon technologies and processes in energy-intensive industries, carbon capture and utilisation, carbon capture and storage, renewable energy generation and energy storage.
European Energy Programme for Recovery
Launched in 2009 in order to support key investments in the context of the economic crisis and in order to promote energy transition, the €3.98 billion European Energy Programme for Recovery (EEPR) finance aimed to fund 44 gas and electricity infrastructure projects, 9 offshore wind projects and 6 carbon capture and storage projects. The Commission continues to monitor closely the on-going remaining projects. Lessons learned from EEPR were used in the preparation and the implementation of the projects of common interest (PCI).

Table 26. Other potential financing schemes and instruments

Financing schemes and instruments
Bonds and Large Loans
• **Green bonds** finance environmental or climate projects investing in renewable energy, energy efficiency, pollution prevention and control, biodiversity, clean transportation, sustainable water management, climate change adaptation, eco-efficient products, production technologies and processes. • **Sustainability bonds** finance a combination of green and social projects (certain green projects with social co-benefits or certain social projects having environmental co-benefits). • **Sustainability-linked bonds**. The financial or structural characteristics (the coupon rate) can fluctuate depending on the achievement of predefined sustainability targets by the issuer. • **Green loans** finance exclusively green projects addressing key areas of environmental concern, such as climate change, natural resources depletion, loss of biodiversity, and air, water and soil pollution. • **Sustainability-linked loans**. Instrument paid by the borrower, where the interest rate is dynamic and linked to some selected sustainability performance indicators, such as carbon emissions or an ESG target. • **Social bonds** finance social projects, including projects aiming at creating food security and sustainable food systems, at sustaining vulnerable groups in the aftermath of a natural disaster, or at alleviating unemployment stemming from a socio-economic crisis.
Asset Backed Security (ABS)
ABS is an investment security collateralized by a pool of assets, (loans, leases, credit card debt, royalties, or receivables). It is like an MBS mortgage-backed security, except that the underlying securities are not mortgage-based. For investors, ABSs can be an alternative to corporate debt. ABS is financing schemes, issued against securitization operations, like the normal bonds. The procedure for creating an ABS - securitization - is the act by which a company separates a series of receivables from its balance sheet, "packages" them appropriately and sells them on the market, together with the cash flows they generate, through the SPV with the aim of generating liquidity.
Energy Performance Contract (EPC)
EPC is a form of 'creative financing' for capital improvement which allows funding energy upgrades from cost reductions. Under an EPC arrangement an external organization (ESCO) implements a project to deliver energy efficiency, or a renewable energy project, and uses the stream of income from the cost savings, or the renewable energy produced, to repay the costs of the project, including the costs of the investment. Essentially the ESCO will not receive its payment unless the project delivers energy savings as expected.
Revolving Fund

[50] https://climate.ec.europa.eu/eu-action/funding-climate-action/innovation-fund_en
[51] https://climate.ec.europa.eu/eu-action/funding-climate-action/ner-300-programme_en

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It is an investment scheme able to leverage an amount of money to trigger additional investments. For example: a city has 10 million but it needs 180 million to follow-up investments. According to market, the 10 million fund should be matched with at least 170 million € of equity at market conditions (the typical ratio equity/loan is 20/80). This means that the financial leverage should be activated, by increasing the costs of the equity repayment and it frustrates the non-cyclical nature of the investments. Settling a dedicated Revolving Fund scheme, by funding interventions in equity and shifting to a mix of equity grants and loans. The added value of the scheme will allow the revolving equity to be repaid sooner and activate the loop of the iterative process. A city, or its Special Purpose Vehicle, will establish several cut off dates, the pre-amortizing period, the size of the loan maximum eligible per each project and the bindings for the repayment (in which percentage, in which annual rate and in how many years). This will bring the 10 million fund to be committed several times for several projects and will work as a leverage. How much the 10 million could achieve is a matter of selling the above listed operational variables. The scheme incorporates and fine-tunes some features of what is currently in use by: • EIB – the structure of the intermediated loans for SMEs and mid-caps • CINEA – the mechanism related to the CEF Transport blending and reflow – 20% funding gap rule for works implementation • Some crowdlending platforms – the principles of convertible loans. Thanks to the Revolving scheme, the equity obtained by a city will be the first to be repaid according to the Economic and Financial Plan. It will be establishing a pre-amortizing period, giving the investment project a liquidity buffer, waiting for the development of the revenue stream and the cash in-flow. It will be possible to establish the first tranches of the return from debt through the discounting of future revenues. The investment project can also be securitized and the assets part will become the junior part.
The equity Crowdfund
Over the past years, and especially during the pandemic period, the public sector finance has been stressed without possibility to Fund and Finance any “low income or long-term returns project”. The equity crowdfunding has the potential to offer a new model of finance via an investment-based business model that generates social, environmental and economic returns. On November 2020, The EC issued the new Regulation on European Crowdfunding Service Providers (ECSP) for business, creating uniform rules across the EU for the provision of investment-based and lending-based crowdfunding services related to business financing. It is addressed to the growing market of Investment Crowded platforms with an EU passport based and it allows them to offer their services across the EU with a single authorisation. If we look at the positive energy districts, those based on crowdfunding schemes shows several features: citizens invest in their own social dimensioned district, even with a focus on renewable energy sources and low pollutant activities; new financially viable business cases generating green local jobs; new use of abandoned and brown field public and private spaces. A benchmark on crowdfunding instruments reveals that the equity crowdfunding would be a new tool of civic engagement with local residents and service users. The average size of several crowdfunding campaign (the possible cap that a PED could profile for district demonstration) is around 350k € for each district. The commitment is generally from the Institutional public investors/authorities for the 45% and to the private investors for the 55% equally split between Institutional Private Investors and small-retail-crowded investors.

Investment attraction

Last but not least, it would be also relevant to explore **ways of investment attraction** (i.e. incentives or policies instruments), aiming at support the business model implementation and complement the already identified technical solutions included as part of the PED scenario selected:

Policy instruments range from “doing nothing”, to providing information for the public, to guiding people’s choices first through behavioural interventions and then financial incentives, up to the

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highest levels of intervention which restrict and eliminate personal choices[52]. Following on from this, ATELIER will consider two main types of policy instruments: 1) hard policy instruments as those that restrict choice through laws, regulations and mandates and can alter financial incentives through levies, taxes and subsidies; 2) soft policies instruments, which include 'moral suasion' and educational campaigns, such as 'fact-based' health warnings, which focus on providing information to alter behaviours.

Table 27. Potential investment attraction measures (Policy instruments)

Policy instrument type	
Hard policy instruments	Laws
	Regulations and mandates
	Levies, taxes (e.g. carbon taxes) and subsides
	Market-based
Soft policy instruments	Education campaigns
	Nudge
	Eco-labelling
	Pollutant release and transfer registers
	Biodiversity registers
	Awareness raising (including award schemes)
	Information dissemination

Method of Procurement (MOP)

The procurement process is defined as "the process of finding, agreeing terms and acquiring goods services or works from an external source, often via a tendering or competitive bidding process studying financial trends to ensure that company money is being spent wisely". Usually in public procurement it is mandatory to include a tender/bidding process and therefore, to select a Method of Procurement (MOP). In the literature there are 6 main MOP[53]:

1. <u>Open Tendering:</u> Open tendering is shorthand for competitive bidding. It allows companies to bid on goods in an open competition or open solicitation manner.
2. <u>Restricted Tendering:</u> Unlike open tendering, restricted tendering only places a limit on the amount of request for tenders that can be sent by a supplier or service provider. Because of this selective process, restricted tendering is also sometimes referred to as selective tendering.
3. <u>Request for Proposals (RFP):</u> Similarly, in the procurement world, a RFP is a method used when suppliers or service providers are proposing their good or service to a procurement team for review.
4. <u>Two Stage Tendering:</u> There are two procedures that are used under the two-stage tendering method.
    a. The first procedure is very similar to the RFP method as discussed above. The procurement team receives a proposal with two envelopes – one with the proposal itself and one with the associated financial information. The difference is the bidder is required to submit a technical proposal that highlights their solutions to fulfilling the requirements as specified by the municipal procuring department. This proposal is scored according to the relevance of the solution to the needs of the procurer. The highest scored proposal is invited for further discussion in an attempt

[52] Banerjee, S., Savani, M. and Shreedhar, G. (2021) 'Public support for 'soft' versus 'hard' public policies: Review of the evidence'. Journal of Behavioral Public Administration. pp. 1 – 37. ISSN: 2576-6465.
[53] https://blog.udemy.com/procurement-methods/

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to reach an agreement. After the final agreement for the technical proposal is reached, the bidder is invited to submit their financial proposal and then further discussions ensue to negotiate a contract.

b. The second procedure is much like the above, however, instead of the bidder submitting a fully completed technical proposal, a partial proposal is submitted. The methodology and technical specifications will be included but not to the fullest extent. This allows room for even more customization and discussion. Once the highest qualified bidder is selected, they will be invited to submit a thorough technical proposal along with a financial proposal. The technical proposal will be evaluated and only then will the financial proposal be opened. The combined score of both the technical proposal and the financial proposal are the grounds on which a bidder is contracted.

5. Request for Quotations: This procurement method is used for small-valued goods or services. There is no formal proposal drafted from either party in this method. Essentially, the procurement entity selects a minimum of three suppliers or service providers that they wish to get quotes from. A comparison of quotes is analysed and the best selection determined by requirement compliance is chosen.
6. Single-Source: Single source procurement is a non-competitive method that should only be used under specific circumstances. Single source procurement occurs when the procuring entity intends to acquire goods or services from a sole provider. This method should undergo a strict approval process from management before being used.

In the end, the type of procurement method chosen will be highly relative to the conditions of the public procurement effort and the type of good or service being acquired. All procurement methods follow tight legal frameworks to ensure all standards are being met and quality in the selection process exists.

The Municipality, as the PED promoter, should publish the tender document according to the selected Method of Procurement. It is interesting to include public participation techniques at this point to add legitimacy for the tender.

Independently of the MOP selected the following principles will be pursued[54]:

- Transparency: Information on the public procurement process must be made available to all public procurement stakeholders: contractors, suppliers, service providers, and the public at large, unless there are valid and legal reasons for keeping certain information confidential.
- Integrity: by means of: i) *Integrity of the Public Procurement Process:* essentially reliability. Bidders, and all other stakeholders, must be able to rely on any information disseminated by the procuring entity, formally or informally; and ii) *Integrity of Public Procurement Practitioners*: Practitioners working within procuring entities, and other government officials involved in the public procurement process, must display personal and professional integrity.
- Economy: Public procurement should manage public funds with care and due diligence so that prices paid for goods, services and works are acceptable and represent good value for the public funds expended on them.
- Openness: Public procurement requirements should be open to all qualified organizations and individuals.
- Fairness: fairness as treating all bidders equally.

[54] Jorge A. Lynch T. Public Procurement: Principles, Categories and Methods. 2013.

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- Competition: Public procurement requirements should be widely disseminated to increase the chances of a good market response, leading to the award of competitively-priced contracts. The use of non-competitive procurement methods, although justified under certain conditions, should be kept to a minimum.
- Accountability: Accountability in public procurement means that anyone involved in the procurement process is responsible for their actions and decisions with respect to the public procurement process.

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5. Conclusions

The concept of this document has emerged from the need of cities to obtain a comprehensive methodology that is able to guide them towards delivering replication and upscaling strategies in their urban environment.

The methodology presented in this document embraces, on the one hand a set of guidelines for PED replication, by means of a step-by-step methodology to help cities on the road to replicate PEDs as key solutions towards climate neutrality. On the other, it proposes enablers that have key roles in bridging over the gap among the different steps to be accomplished. Such enablers include empowerment of political actors through innovative governance models definition, technical players from the local innovation ecosystem and citizens participation, as well as the way to overcome management barriers through a capacity building strategy deployment.

However, the methods, tools and models provided within this deliverable are still to be tested within the next Tasks 6.4 and 6.5 of the project, in order for the (potentially refined) methodology to stand the test of reality in the long run. The usability and appropriateness of the methodology will be tested by ATELIER follower cities in the following months.

Further conclusions are to be based on the experiences gained/gathered during the testing phase with the fellows cities when their replication and upscaling strategies becomes possible to report on the real applicability of the methodology for different cities in Europe.

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Annex 1 - Self-evaluation tool (*.xlsm)

"Positive Energy Districts (PED) are energy efficient districts that have net zero carbon dioxide (CO2) emissions and work towards an annual local surplus production of renewable energy (RES)." SETPlan

Self-evaluate your district, by clicking which elements are considered in the Energy Balance, indicators used, PED limits and Objectives within your definition

Elements considered in the Energy Balance

Buildings (residential)

Heating ☐ | Cooling ☐ | DHW ☐ | Lighting ☐ | Appliances ☐ | Ventilation ☐ | Humidification ☐ | car charging (at the buildings) ☐ | Other: Specify

Public buildings, private enterprises & Industry

Heating ☐ | Cooling ☐ | DHW ☐ | Lighting ☐ | Appliances ☐ | Ventilation ☐ | Humidification ☐ | car charging point (at the buildings) ☐ | Processes & others ☐ | Other: Specify

Public services and infrastructures

Lighting ☐ | Water ☐ | Food ☐ | Wastewater ☐ | Waste ☐ | Other: Specify

Mobility

Private ☐ | Public ☐ | Cars passing through ☐ | Refueling visitors ☐ | Other: Specify

Zero or Positive Energy Balance is achieved in terms of:

Total or Non-renewable Primary Energy or not achieved

Other indicators calculated:

Net CO_2 equivalent emissions ☐

Other: Specify

PED limits (Select one: geographic or virtual or functional, and, additionally: if green-certificates are considered)

Geographic ☐ | Virtual ☐ | Functional ☐ | Green-certificates in public build. ☐ | Green-certificates in private buildings ☐

Objective of the PED

100% Self-Sufficient ☐ | Positive ☐ | Circular-economy ☐

TYPE OF PED= [rule-based equation to get different type of PEDs depending on the clicked boxes]

Definition of the different type of PEDs

PED-dynamic	Positive energy district that dynamically exchanges energy flows with the grids (surpluses and shortages). Limits are geographical or functional. Calculation is made in total or non-RES terms
PED-virtual	Positive energy district that dynamically exchanges energy flows with the grids (surpluses and shortages). Limits are virtual. Calculation is made in total or non-RES terms
PED-autonomous	Positive energy district with no imports from the hinterland, which even helps to balance the wider grid outside. Limits are geographical or functional. Calculation is made in total or non-RES terms
Pre-PED	Zero energy balance(in terms of total or non-RES primary energy),or positive but with an energy difference acquired on the market by importing certified green energy to private buildings (realizing a zero carbon district)
circular-Pre-PED	A district with efficient solutions and taken into account a circular economy perspective, but its energy balance is not positive
No-PED	A district that is not positive neither self-sufficient and it does not consider a circular economy perspective.

Reference: based on JPI Urban Europe and EERA discussions

Excel prepared by : Andrea Gabaldón (CARTIF), Patxi Hernández (TECNALIA)

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Annex 2 - Catalogue of solutions for replication

Category 1: LOW ENERGY DEMAND	
1.2.1 - Façade	COA-S1.2.1-A Façade insulation
1.2.2 - Glazing	COA-S1.2.2-A Triple glazing
1.2.4 - Roofs: green, blue, white	COA-S1.2.4 Green roofs
1.3.1 - Low embedded energy material	COA-S1.3.1 Recycled/low embedded energy material
Category 2: ENERGY MANAGEMENT	
2.1.1 - Monitoring system	COB-S2.1.1-A Bilbao monitoring system
	COB-S2.1.1-B Bilbao monitoring platform
2.1.2 - Smart lighting, power LED	COA-S2.1.2 LED lighting
	COB-S2.1.2 Next generation city smart lighting system
2.3.1 - Energy Management System	COA-S2.3.1 Advanced EMS
	COB-S2.3.1-A Energy management system
	COB-S2.3.1-B Smart Metering
Category 3: INTEGRATED INFRASTRUCTURES	
3.1.1 - Power storage (electrochemical storage)	COA-S3.1.1 Li-ion electricity storage
3.1.2 - Thermal storage	COA-S3.1.2 Aquifer thermal energy storage
3.2.2 - Low temperature DHN	COB-S3.2.2 District heating-geothermal ring
3.3.1 - EV chargers	COA-S3.3.1 EV chargers
3.3.2 - Electromobility hub	COA-S3.3.2 Electromobility hub
3.4.3 - Water-water Heat pump	COA-S3.4.3-A Republica Heat pumps
	COB-S3.4.3 Water-water Heat pumps
3.5.1 - Mechanical ventilation with heat recovery	COA-S3.5.1 Mechanical ventilation with heat recovery
3.5.2 - Shower drain water heat recovery systems	COA-S3.5.2 Shower drain water heat recovery systems
Category 4: RENEWABLE ENERGY SYSTEMS ALTERNATIVE URBAN ENERGY SOURCES	
4.2.1 - Solar PV	COA-S4.2.1-A Republica PV Panels
	COB-S4.2.1-A Bilbao Solar PV
Category 5: POLITICAL, SOCIAL, ECONOMICAL INTERVENTIONS	
5.2.1 - Innovation Atelier	COB-S5.2.1 Innovation Atelier

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SPEC CARD	Category 1: LOW ENERGY DEMAND 1.2 - Building envelope insulation 1.2.1. - Façade	
Title	**Graphical Detail**	
COA-S1.2.1-A Façade Insulation		
City / Country	**Project**	**Technical Partner Name**
City of Amsterdam	ATELIER	Republica, Poppies
Implementation Time	< 6 months	**Initial Investment (€)**

Detailed description - What is Solution? How does it work?

The buildings of the Republica and Poppies group receive an insulation package to make the buildings very low energy buildings. Actual values depend on the location in the building and have values over Rc=5 m2K/W

Stakeholders analysis (LOCAL ECOSYSTEM)

Developer (if relevant) Who has developed this solution?	Republica/Poppies
Operator Who is operating this solution?	no operation needed
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	building users
Implementer Who is implementing this solution?	Republica/Poppies
Financer How / By whom has the implementation of this solution been financed?	Republica/Poppies
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	--

Business model patterns

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BARRIERS / ENABLERS _ PESTEL STUDIES			
Political	No major barriers	**Technical**	No major barriers
Economic	No major barriers	**Environmental**	No major barriers
Social	No major barriers	**Legal**	No major barriers
POTENTIAL FOR REPLICATION		**EXPECTED IMPACTS**	
Adaptation needs		**Benefits**	**Co-benefits**
Is it the solution very site-specific?	NO	Contributes to the energy performance of buildings by minimizing heat losses	Reduce GHG emissions
Does the developer export the solution to other locations?	YES		Reduce energy needs
Are there other developers in other locations/countries?	YES		Financial savings for citizens
Does its implementation depend on a specific business model (such as the creation of an ESE)?	NO		
Does its implementation depend on existing specific regulation (such as Energy Communities legislation)?	NO		
Do you think that the solution is highly replicable?	YES		**Other:**
Relevant Publications / Presentations / Services / Products to this Solution			
Reference applications of this Solution			

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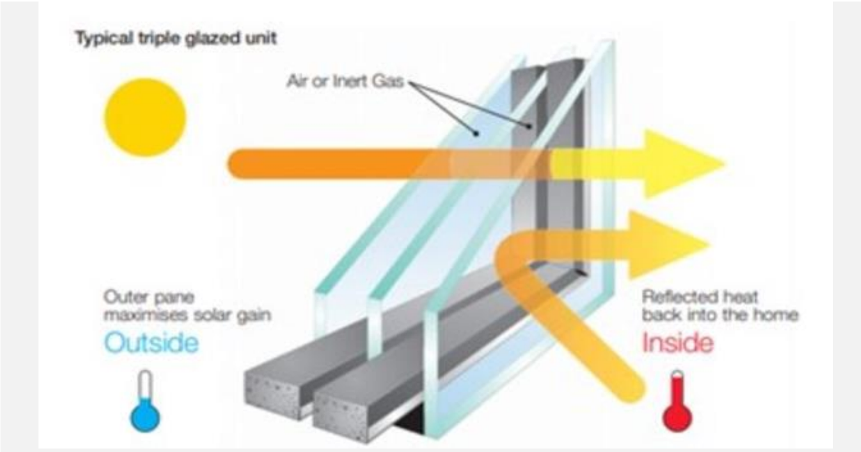
SPEC CARD	Category 1: LOW ENERGY DEMAND 1.2 - Building envelope insulation 1.2.2 Glazing	
Title	**Graphical Detail**	
COA-S1.2.2-A Triple Gazing		
City / Country	**Project**	**Technical Partner Name**
City of Amsterdam	ATELIER	Republica
Implementation Time	< 6 months	**Initial Investment (€)**

Detailed description - What is Solution? How does it work?

The residential and the commercial buildings of the Republica group receive triple glazing in well insulated window frames to make the buildings very low energy buildings. The heat transmission coefficient of the window plus frames is Uwindow = 1.0 W/ m2K. It maximises solar gain and minimises heat loss by coatings that reflect the heat in the house back inside.

Stakeholders analysis (LOCAL ECOSYSTEM)

Developer (if relevant) Who has developed this solution?	Republica
Operator Who is operating this solution?	Republica
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	Users of the buildings
Implementer Who is implementing this solution?	Vink Bouw
Financer How / By whom has the implementation of this solution been financed?	Republica
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	

Business model patterns

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 864374.

BARRIERS / ENABLERS _ PESTEL STUDIES			
Political	No major barriers	**Technical**	No major barriers
Economic	No major barriers	**Environmental**	No major barriers
Social	No major barriers	**Legal**	No major barriers
POTENTIAL FOR REPLICATION		**EXPECTED IMPACTS**	
Adaptation needs		**Benefits**	**Co-benefits**
Is it the solution very site-specific?	NO		Reduce GHG emissions
Does the developer export the solution to other locations?	YES		Reduce energy needs
Are there other developers in other locations/countries?	YES		Financial savings for citizens
Does its implementation depend on a specific business model (such as the creation of an ESE)?	NO		Reduce noise issues
Does its implementation depend on existing specific regulation (such as Energy Communities legislation)?	NO		
Do you think that the solution is highly replicable?	YES		**Other:**
Relevant Publications / Presentations / Services / Products to this Solution			
https://www.homebuilding.co.uk/advice/triple-glazed-windows-do-they-make-sense			
Reference applications of this Solution			

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 864374.

SPEC CARD	Category 1: LOW ENERGY DEMAND		
	1.2 - Building envelope insulation		
	1.2.4 - Roofs: green, blue, white		
Title	**Graphical Detail**		
COA-S1.2.4 - Green Roofs			
City / Country	**Project**	**Technical Partner Name**	
City of Amsterdam	ATELIER		
Implementation Time	6-12 months	**Initial Investment (€)**	

Detailed description - What is Solution? How does it work?
Both Republica and Poppies will be equipped with green roofs. Urban water management is supported by green roofs on the buildings. The evaporation of water keeps the roofs cool, which reduces cooling load in the summer and the performance of the PV panels improves. Additionally, it regulates water discharge to the sewer system, avoiding overloads during heavy showers. The roofs will be covered with vegetation below the PV panels.

Stakeholders analysis (LOCAL ECOSYSTEM)	
Developer (if relevant) Who has developed this solution?	Republica, Edwin Oostmeijer
Operator Who is operating this solution?	Republica, Edwin Oostmeijer
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	Users of the building
Implementer Who is implementing this solution?	Vink Bouw, Edwin Oostmeijer
Financer How / By whom has the implementation of this solution been financed?	Republica, Edwin Oostmeijer

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Other impacted stakeholder(s) (if relevant) **Who else is impacted by the deployment of this solution?**			Neighbourhood inhabitants
Business model patterns			
BARRIERS / ENABLERS _ PESTEL STUDIES			
Political	No major barriers	**Technical**	No major barriers
Economic	High investment costs	**Environmental**	No major barriers
Social	No major barriers	**Legal**	No major barriers
POTENTIAL FOR REPLICATION		**EXPECTED IMPACTS**	
Adaptation needs		**Benefits**	**Co-benefits**
Is it the solution very site-specific?	NO	Reduction of water load on sewer system	Enhance stability of the urban infrastructure
Does the developer export the solution to other locations?	YES	Cooler roof in summer	Increase employment rate and Jobs
Are there other developers in other locations/countries?	YES	Higher PV yield because of reduced roof temperature	Better water management
Does its implementation depend on a specific business model (such as the creation of an ESE)?	NO		Improve air quality
Does its implementation depend on existing specific regulation (such as Energy Communities legislation)?	NO		
Do you think that the solution is highly replicable?	YES		**Other:**
Relevant Publications / Presentations / Services / Products to this Solution			
https://resilio.amsterdam/en/our-climate-is-changing-smart-blue-green-resilio-roofs-are-a-solution/			
https://livingroofs.org/green-roofs-solar-power/			
Reference applications of this Solution			
https://www.solarsedum.nl/projecten			

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 864374.

SPEC CARD	**Category 1: LOW ENERGY DEMAND**		
	1.3 - Building materials		
	1.3.1 - Low embedded energy materiales		
Title	**Graphical Detail**		
COA-S1.3.1-A Recycled/low embedded energy materials			
City / Country	**Project**	**Technical Partner Name**	
City of Amsterdam	ATELIER	Republica, Poppies	
Implementation Time		**Initial Investment (€)**	

Detailed description - What is Solution? How does it work?

At least one façade of each building of the Republic commercial and residential buildings group will be constructed from recycled/low embedded energy material. For modern buildings, embedded energy as well as the energy needed for construction and demolition are a significant fraction of the "life cycle energy use" of building and therefore it is gaining more and more attention.
The Poppies buildings will make ample use of recycled/low embedded energy material. It was part of the tender specifications for this building. For modern buildings, embedded energy as well as the energy needed for construction and demolition are a significant fraction of the "life cycle energy use" of building and therefore it is gaining more and more attention.

Stakeholders analysis (LOCAL ECOSYSTEM)

Developer (if relevant) Who has developed this solution?	Republica, Edwin Oostmeier
Operator Who is operating this solution?	Republica, Edwin Oostmeier
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	Building users
Implementer Who is implementing this solution?	Republica, Edwin Oostmeier

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Financer How / By whom has the implementation of this solution been financed?			Republica, Edwin Oostmeier
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?			Building users
Business model patterns			
Requirement of the buildings (regulation). Cost will be reflected in sales/rental price			
BARRIERS / ENABLERS _ PESTEL STUDIES			
Political	No major barriers	**Technical**	Need of adapting solutions to different client/user needs or to different situations
Economic	No major barriers	**Environmental**	Low environmental impact
Social	No major barriers	**Legal**	No major barriers
POTENTIAL FOR REPLICATION		**EXPECTED IMPACTS**	
Adaptation needs		**Benefits**	**Co-benefits**
Is it the solution very site-specific?	NO	Reduction of construction waste	Promote the materials cycle
Does the developer export the solution to other locations?	YES	Low embedded energy	Reduce GHG emissions
Are there other developers in other locations/countries?	YES	In piloting phase, material cost can be higher than for traditional material, availability needs to be ensured well in advance.	Better waste management
Does its implementation depend on a specific business model (such as the creation of an ESE)?	NO		
Does its implementation depend on existing specific regulation (such as Energy Communities legislation)?	NO	no, but one has to take into account fire regulations.	
Do you think that the solution is highly replicable?	YES		**Other:**
Relevant Publications / Presentations / Services / Products to this Solution			
Reference applications of this Solution			

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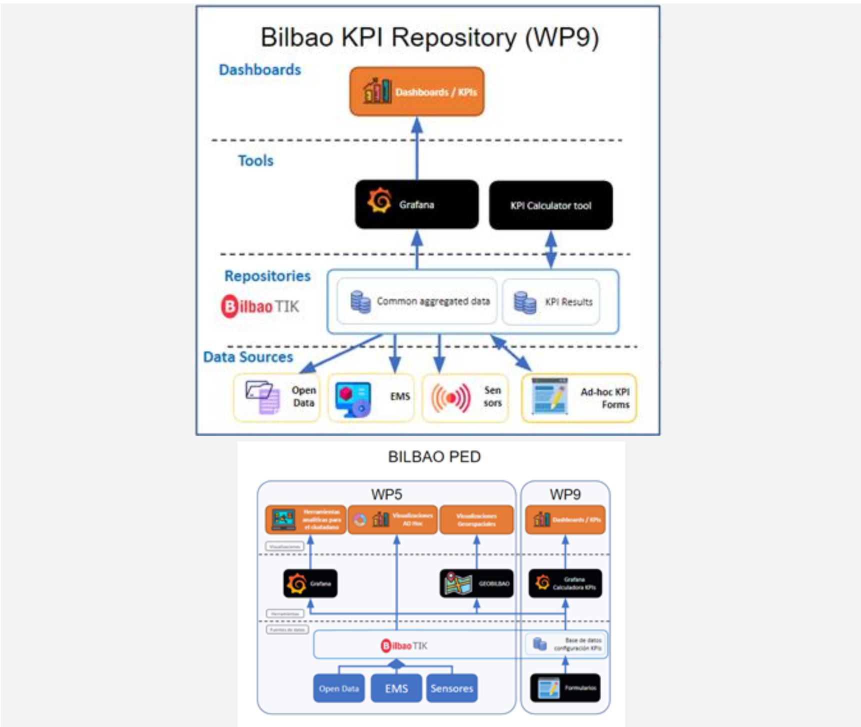
SPEC CARD	Category 2: ENERGY MANAGEMENT & ENERGY EFICIENCY 2.1 - Digitalization 2.1.1 - Monitoring system		
Title	**Graphical Detail**		
COB-S2.1.1-A Bilbao Monitoring System			
City / Country	**Project**	**Technical Partner Name**	
City of Bilbao	ATELIER	University of Deusto (UDEUSTO)	
Implementation Time	1-3 years	**Initial Investment (€)**	

Detailed description - What is Solution? How does it work?

This solution is meant to be a central hub where all measures are collected and organised to be further studied through the calculation of the KPIs of the COB. This solution will have a rate of gathering data in some cases by the means of sensors and in other cases is a person who will upload the data (it is defined in terms of the KPI type)

Stakeholders analysis (LOCAL ECOSYSTEM)

Developer (if relevant) Who has developed this solution?	UDEUSTO
Operator Who is operating this solution?	Bilbao TIK
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	Residents of the PED

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Implementer **Who is implementing this solution?**			City Council of Bilbao
Financer **How / By whom has the implementation of this solution been financed?**			European Comission
Other impacted stakeholder(s) (if relevant) **Who else is impacted by the deployment of this solution?**			Citizens, TELUR, IBERDROLA, City of Council of Bilbao, TECNALIA
Business model patterns			
BARRIERS / ENABLERS _ PESTEL STUDIES			
Political	Lack of central planning	**Technical**	No major barriers
	Lack of coordination between teams in charge of the implementation		
Economic	Lack of business models	**Environmental**	No major barriers
Social	Lack of citizen/consumer awareness	**Legal**	Limited by data privacy and security concerns
POTENTIAL FOR REPLICATION		**EXPECTED IMPACTS**	
Adaptation needs		**Benefits**	**Co-benefits**
Is it the solution very site-specific?	YES	Increase energy awareness	Enhance citizen participation, connectivity and community
Does the developer export the solution to other locations?	YES	Increase the performance of the Energy Management System	Improve access to information
Are there other developers in other locations/countries?	NO		Provide users with energy management capabilities
Does its implementation depend on a specific business model (such as the creation of an ESE)?	NO		Allow to know energy consumption patterns
Does its implementation depend on existing specific regulation (such as Energy Communities legislation)?	NO		
Do you think that the solution is highly replicable?	YES		**Other:**
Relevant Publications / Presentations / Services / Products to this Solution			

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Urban district modelling simulation-based analysis: under which scenarios can we achieve a Positive Energy District? (DOI: 10.1109/SSD52085.2021.9429457)	
La oportunidad de crear proyectos de ciudades inteligentes a escala municipal. Implementando un distrito de energía positiva en Zorrozaurre * (https://www.euskadi.eus/web01-a2reveko/es/k86aEkonomiazWar/ekonomiaz/abrirArticulo?idpubl=96&registro=13)	
Reference applications of this Solution	

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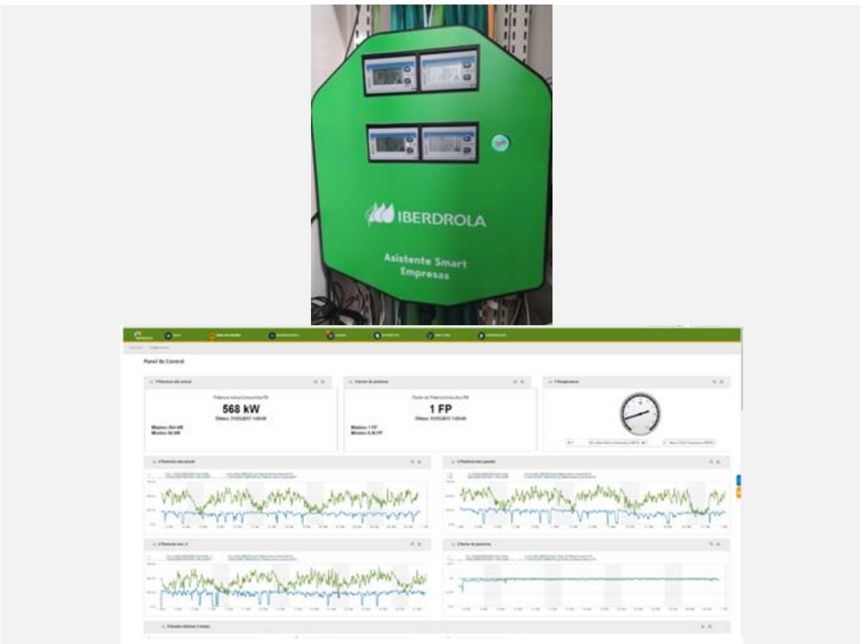
SPEC CARD	Category 2: ENERGY MANAGEMENT & ENERGY EFICIENCY	
	2.1 - Digitalization	
	2.1.1 - Monitoring system	
Title	**Graphical Detail**	
COB-S2.1.1-B Bilbao Monitoring Platform		
City / Country	**Project**	**Technical Partner Name**
City of Bilbao	ATELIER	IBERDROLA CLIENTES
Implementation Time		**Initial Investment (€)**

Detailed description - What is Solution? How does it work?

Iberdrola offers its customers solutions for knowing, addressing and reducing its climate impact. One of these solutions is our “Smart Assistant” family of products and services. For I&C Customers, the Smart Assistant provides the customer energy insights, customized recommendations and savings tracking. For big energy consumers, we develop tailored monitoring projects, using the cutting edge IoT devices, cloud architectures and AI software based technologies. In the Atelier project we studied the main demand side facilities and developed and architecture of energy measurement and data communication, to keep real time track of the main sources of energy consumption within the project.

Stakeholders analysis (LOCAL ECOSYSTEM)

Developer (if relevant) Who has developed this solution?	IBERDROLA CLIENTES
Operator Who is operating this solution?	Mondragon University/Digipen/Kunsthal/ Tecnalia

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Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?			Mondragon University/Digipen/Kunsthal/ Tecnalia
Implementer Who is implementing this solution?			IBERDROLA CLIENTES
Financer How / By whom has the implementation of this solution been financed?			IBERDROLA CLIENTES
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?			TECNALIA
Business model patterns			
Iberdrola affords CAPEX and OPEX costs and charges the added-value services to the third party who is benefiting from them.			
BARRIERS / ENABLERS _ PESTEL STUDIES			
Political	No major barriers	**Technical**	Limited compatibility with existing infrastructure
			Limited data sharing
			Other: Limited implementation of smart devices linked to the energy consumption
Economic	Lack of business models	**Environmental**	No major barriers
Social	Lack of citizen/consumer awareness	**Legal**	No major barriers
POTENTIAL FOR REPLICATION		**EXPECTED IMPACTS**	
Adaptation needs		**Benefits**	**Co-benefits**
Is it the solution very site-specific?	NO	Reduce energy consumption	Reduce energy needs
Does the developer export the solution to other locations?	YES	Higher efficiency in energy consumption	Energy management optimization
Are there other developers in other locations/countries?	YES	Attenuation of the electricity bill	Reduce GHG emissions
Does its implementation depend on a specific business model (such as the creation of an ESE)?	NO	High access to energy data	Increase access to clean, affordable, and secure energy
Does its implementation depend on existing specific regulation (such as Energy Communities legislation)?	YES	Potential inputs for future decarbonisation solutions	Increased carbon sequestration capacity(explaining that this through indirect solutions such as NBS)

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Do you think that the solution is highly replicable?	YES		**Other:**

Relevant Publications / Presentations / Services / Products to this Solution

Reference applications of this Solution	
Mercamadrid (Madrid)	Sendaviva – Navarra
Flowserve – Pozuelo de Alarcón	GE Renewable Energy - Noblejas
Vodafone Headquarters – Madrid	

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SPEC CARD	Category 2: ENERGY MANAGEMENT & ENERGY EFICIENCY 2.1 - Digitalization 2.1.2 - Smart lighting, power LED		
Title	**Graphical Detail**		
COA-S2.1.2 LED Lighting			
City / Country	**Project**	**Technical Partner Name**	
City of Amsterdam	ATELIER	Edwin Oostmeijer	
Implementation Time	< 6 months	**Initial Investment (€)**	

Detailed description - What is Solution? How does it work?
LED lighting will be the main lighting technology in the Poppies buildings, significantly reducing (>50%) the lighting energy needs over conventional energy saving lighting. It allows for great flexibility in design.

Stakeholders analysis (LOCAL ECOSYSTEM)	
Developer (if relevant) Who has developed this solution?	Edwin Oostmeijer, various suppliers
Operator Who is operating this solution?	Edwin Oostmeijer
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	Users of the buildings
Implementer Who is implementing this solution?	Edwin Oostmeijer
Financer How / By whom has the implementation of this solution been financed?	Is part of construction cost

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Other impacted stakeholder(s) (if relevant) **Who else is impacted by the deployment of this solution?**			Local grid operator
Business model patterns			
Included in normal rent practice			
BARRIERS / ENABLERS _ PESTEL STUDIES			
Political	No major barriers	**Technical**	No major barriers
Economic	High investment costs	**Environmental**	No major barriers
Social	No major barriers	**Legal**	No major barriers
POTENTIAL FOR REPLICATION		**EXPECTED IMPACTS**	
Adaptation needs		**Benefits**	**Co-benefits**
Is it the solution very site-specific?	NO	Reduced electricity need and cost for lighting	Reduce GHG emissions
Does the developer export the solution to other locations?	YES		Reduce energy needs
Are there other developers in other locations/countries?	YES		Financial savings for citizens
Does its implementation depend on a specific business model (such as the creation of an ESE)?	NO		Decrease future maintenance costs
Does its implementation depend on existing specific regulation (such as Energy Communities legislation)?	NO		
Do you think that the solution is highly replicable?	YES		**Other:**
Relevant Publications / Presentations / Services / Products to this Solution			
Various suppliers, e.g. https://www.lighting.philips.co.uk/home?remember_customer_type=professional https://www.sylvania-lighting.com/en-int/			
Reference applications of this Solution			

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SPEC CARD	Category 2: ENERGY MANAGEMENT & ENERGY EFICIENCY		
	2.1 - Digitalization		
	2.1.2 Next generation city smart lighting system		
Title	**Graphical Detail**		
COB-S2.1.2 Next Generation Smart Lighting Systems			
City / Country	**Project**	**Technical Partner Name**	
City of Bilbao	ATELIER	City Council of Bilbao / BilbaoTIK	
Implementation Time	< 6 months	**Initial Investment (€)**	37.133 €

Detailed description - What is Solution? How does it work?

Design and commissioning of a pilot project that allows the smart management of the switch-on and switch-off processes of lightings as well as the efficient management of the processes for checking and verifying correct operation, while at the same time enabling monitoring consumption in real time.

The solution aims to integrate into a single platform:
-Advanced sensorisation and control devices (called nodes), which installed in the lightings allow the integration of multiple Internet of Things solutions.
- Smart hubs that manage the network of nodes and sensors and communicate in real time with users via CMS, control centres, mobile devices, etc.
-Software platform for system management.
The main feature of the system is that it is capable of converting the public lighting network into a broadband data network, thanks to B-PLC technology.

Stakeholders analysis (LOCAL ECOSYSTEM)

Developer (if relevant) Who has developed this solution?	EMARTIN FACILITIES
Operator Who is operating this solution?	City Council of Bilbao/ BilbaoTIK
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	City Council of Bilbao / Citizenship

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Implementer Who is implementing this solution?			EMARTIN FACILITIES
Financer How / By whom has the implementation of this solution been financed?			City Council of Bilbao European fundings (ATELIER)
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?			
Business model patterns			
The investment has been made by the Bilbao City Council but there is funding in the ATELIER project for the amortisation of the equipment. The design and installation of the systems is undertaken by a private company (EMARTIN FACILITIES), which has been awarded the concession. The technical requirements of the intelligent systems were included in a tender document.			
BARRIERS / ENABLERS _ PESTEL STUDIES			
Political	Lack of coordination between teams in charge of the implementation	**Technical**	No major barriers
Economic	No major barriers	**Environmental**	No major barriers
Social	Cultural or context barriers	**Legal**	No major barriers
POTENTIAL FOR REPLICATION		**EXPECTED IMPACTS**	
Adaptation needs		**Benefits**	**Co-benefits**
Is it the solution very site-specific?	NO	Energy consumption savings	Reduce energy needs
Does the developer export the solution to other locations?		Energy efficiency measures application	Energy management optimization
Are there other developers in other locations/countries?	YES	Light pollution reduction	Increase access to clean, affordable, and secure energy
Does its implementation depend on a specific business model (such as the creation of an ESE)?	NO	Efficient and smart management of the operational system (preventive corrections and inspections)	Decrease future maintenance costs
Does its implementation depend on existing specific regulation (such as Energy Communities legislation)?	NO	Continuous access to real data	Allow to know energy consumption patterns
Do you think that the solution is highly replicable?	YES		**Other:**
Relevant Publications / Presentations / Services / Products to this Solution			

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No applicable	
Reference applications of this Solution	
No applicable	

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SPEC CARD

Category 2: ENERGY MANAGEMENT & ENERGY EFICIENCY

2.3 - Smart Home/Building energy managers

2.3.1 Energy Management System

Title	Graphical Detail
COA-S2.3.1 Advanced Energy Management System (EMS)	

City / Country	Project	Technical Partner Name	
City of Amsterdam	ATELIER	Spectral	
Implementation Time	1-3 years	**Initial Investment (€)**	350 k€

Detailed description - What is Solution? How does it work?

An EMS or Energy Management System controls the energy streams in an installation or building and can provide insights in the energy use. Insight can lead to awareness and reduction of energy use. An EMS can further optimize energy streams, e.g. optimize self-consumption of produced electricity, or optimize the economics by selling/buying at a suitable moment

Stakeholders analysis (LOCAL ECOSYSTEM)

Developer (if relevant) Who has developed this solution?	SPECTRAL
Operator Who is operating this solution?	SPECTRAL
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	Republica + Poppies
Implementer Who is implementing this solution?	SPECTRAL
Financer How / By whom has the implementation of this solution been financed?	Subsidies and SPECTRAL investments
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	Grid operator, energy community, citizens

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Business model patterns			
BARRIERS / ENABLERS _ PESTEL STUDIES			
Political	Lack of supportive policies	**Technical**	Lack of knowledge about the solution
	Lack of appropriate responsibilities distribution within different departments		Limited use of existing data
	Limited investment on infrastructure		Need of adapting solutions to different client/user needs or to different situations
	Other:		Other:
Economic	Lack of incentives	**Environmental**	No major barriers
	High investment costs		
	Price variability		
	Other:		Other:
Social	Lack of citizen/consumer awareness	**Legal**	Limited by data privacy and security concerns
	Lack of equitable access or inclusivity		Lack of regulatory support
	Private interests may be against the solution		Lack of data ownership models
	Other:		Other:
POTENTIAL FOR REPLICATION		**EXPECTED IMPACTS**	
Adaptation needs		**Benefits**	**Co-benefits**
Is it the solution very site-specific?	YES	Increase self-consumption possibly	Financial savings for citizens
Does the developer export the solution to other locations?	YES	Deal with congestion capacity limitations	
Are there other developers in other locations/countries?	YES	Reduce costs of energy consumption	
Does its implementation depend on a specific business model (such as the creation of an ESE)?	YES	reduce connection capacity fee	

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Does its implementation depend on existing specific regulation (such as Energy Communities legislation)?	YES		
Do you think that the solution is highly replicable?	YES		**Other:**
Relevant Publications / Presentations / Services / Products to this Solution			
https://www.youtube.com/watch?v=DJGyOVNZ2Zk			
Reference applications of this Solution			
https://spectral.energy/projects/			

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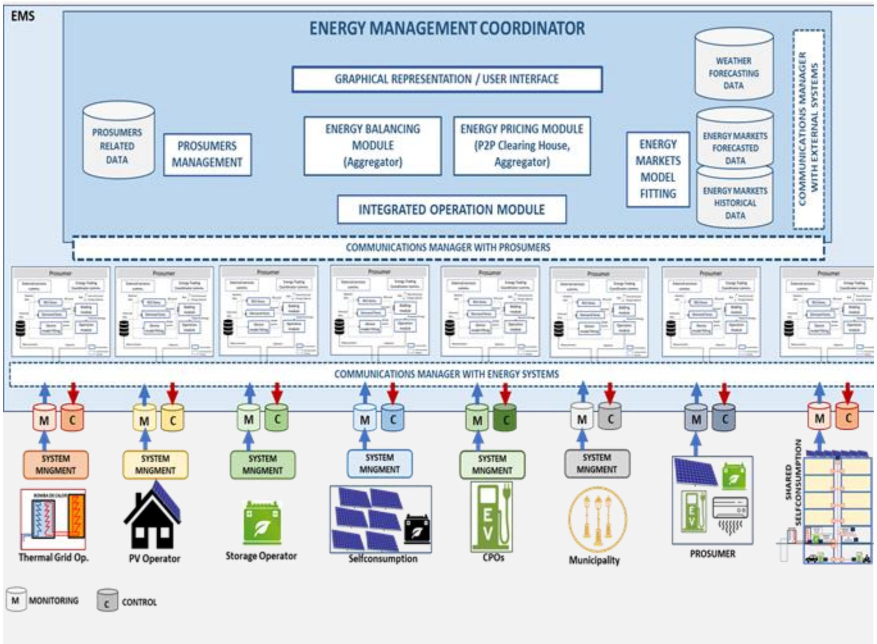
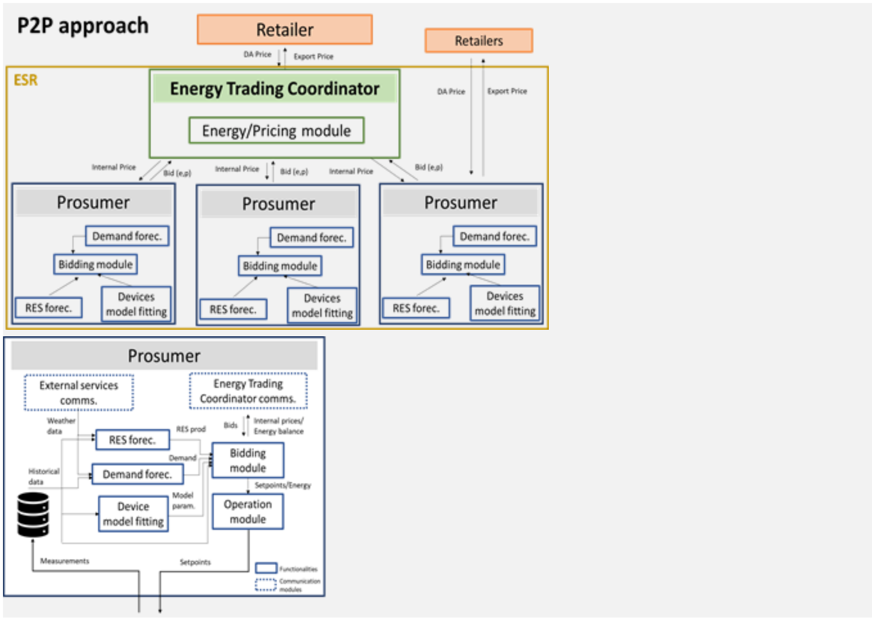
SPEC CARD

Category 2:
ENERGY MANAGEMENT & ENERGY EFICIENCY

2.3 - Smart Home/Building energy managers

2.3.1 Energy Management System

Title	Graphical Detail
COB-S2.3.1-A Energy Management System	 

City / Country	Project	Technical Partner Name

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 864374.

City of Bilbao	ATELIER	TECNALIA	
Implementation Time	1-3 years	**Initial Investment (€)**	Not applicable
Detailed description - What is Solution? How does it work?			
The EMS is conceived as a Peer to Peer, in this case also "Prosumer To Prosumer", (P2P) framework in which energy transactions between the prosumers are managed by a higher-level Energy Management Coordinator (EMC) according to the energy and economic criteria applied at two levels: the level of the prosumer (who applies their priorities on the conditions for the exchange and trade of energy) and the level of the EMC that applies higher-level criteria to optimize and manage the energy interchange between prosumers applying also both, energy and economic criteria respecting the exchange conditions defined by the prosumers. The development of this EMS implies the implementation of two modules: a) A Prosumer reference implementation wrapping and completing the different energy systems deployed in the ATELIER Bilbao demonstration with a shell that will provide them with functionalities and interfaces to be able to participate in the P2P framework and to be easily adaptable for the different resources involved. b) An implementation of the EMC as described above.			
Stakeholders analysis (LOCAL ECOSYSTEM)			
Developer (if relevant) Who has developed this solution?			TECNALIA
Operator Who is operating this solution?			TO BE DEFINED
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?			Prosumers as members of an energy community exchanging energy on Prosumer to Prosumer (P2P) basis
Implementer Who is implementing this solution?			TECNALIA for demonstration purposes
Financer How / By whom has the implementation of this solution been financed?			Some components, from other European projects (Coordinet, eNeuron), completed and adapted in ATELIER
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?			Energy retailers, ESCOs and emerging aggregators
Business model patterns			
Energy exchange on a Prosumer to Prosumer (P2P) framework basis Basic business actors are the Prosumers owning the energy resources (RE generation, manageable loads, energy storage) that sell or buy energy to other prosumers belonging to the energy community. A Coordination level clears the offers and demands of energy among the Prosumers and the related prices proposed by these Prosumers Energy market prices are part of the references for the prices managed inside the P2P community and the reasoning for the clearing processes.			
BARRIERS / ENABLERS _ PESTEL STUDIES			

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Political	Lack of supportive policies	**Technical**	No major barriers
	Low awareness among policy makers		
	Other: The transposition of the Independent Aggregator role to the Spanish regulation		Other:
Economic	No major barriers	**Environmental**	No major barriers
Social	No major barriers	**Legal**	No major barriers
POTENTIAL FOR REPLICATION		**EXPECTED IMPACTS**	
Adaptation needs		**Benefits**	**Co-benefits**
Is it the solution very site-specific?	NO	Maximization of the Prosumers' energy use and exploitation	Provide users with energy management capabilities
Does the developer export the solution to other locations?	NO	The local use of the energy provides allows flexibility services to be deployed	Enhance stability of the urban infrastructure
Are there other developers in other locations/countries?	YES	The possibility of stablishing local energy markets	Enhance citizen participation, connectivity and community
Does its implementation depend on a specific business model (such as the creation of an ESE)?	YES		
Does its implementation depend on existing specific regulation (such as Energy Communities legislation)?	NO		
Do you think that the solution is highly replicable?	YES		**Other:**
Relevant Publications / Presentations / Services / Products to this Solution			
Not defined yet			
Reference applications of this Solution			
Some reference modules related to the Prosumer implementation have been tested in the CoordiNet project			

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SPEC CARD	Category 2: ENERGY MANAGEMENT & ENERGY EFICIENCY 2.3 - Smart Home/Building energy managers 2.3.1 - Energy Management System	
Title	**Graphical Detail**	
COB-S2.3.1-B Smart metering		
City	**Project**	**Technical Partner Name**
City of Bilbao	ATELIER	i-DE
Implementation Time		**Initial Investment (€)**

Detailed description - What is Solution? How does it work?

A smart meter is a metering device that remotely records your real electricity consumption every hour. They make it easier to optimise the supply for each home depending on the particular consumption needs and habits. They enable remote meter reading. Faster changes to contractual terms and conditions, which can be done remotely without a technician having to travel to the meter room (subscription, cancellation, modification or reconnection). Faster changes to power capacity and rates, which can mean savings for the customer. More efficient Grid management and, therefore, fewer incidents and shorter supply down times in the event of a breakdown.

Stakeholders analysis (LOCAL ECOSYSTEM)

Developer (if relevant) Who has developed this solution?	i-DE+manufacturers (e.g.ZIV)
Operator Who is operating this solution?	i-DE
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	Customers

Implementer Who is implementing this solution?			i-DE
Financer How / By whom has the implementation of this solution been financed?			Regulator
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?			-
Business model patterns			
Regulatory model			
BARRIERS / ENABLERS _ PESTEL STUDIES			
Political	**No major barriers**	**Technical**	**Lack of knowledge about the solution**
Economic	**No major barriers**	**Environmental**	**No major barriers**
Social	**Limited access to digitalization skills and capacity**	**Legal**	**No major barriers**
POTENTIAL FOR REPLICATION		**EXPECTED IMPACTS**	
Adaptation needs		**Benefits**	**Co-benefits**
Is it the solution very site-specific?	NO	Energy consumption supervision	Reduce energy needs
Does the developer export the solution to other locations?	YES	High & on time access to energy data consumption	Allow to know energy consumption patterns
Are there other developers in other locations/countries?	YES	More control over the electricity bill	Financial savings for citizens
Does its implementation depend on a specific business model (such as the creation of an ESE)?	NO		
Does its implementation depend on existing specific regulation (such as Energy Communities legislation)?	YES		
Do you think that the solution is highly replicable?	YES		**Other:**
Relevant Publications / Presentations / Services / Products to this Solution			
Reference applications of this Solution			
All electric customers			

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 864374.

<table>
<tr><td rowspan="3">SPEC CARD</td><td colspan="3">Category 3:
INTEGRATED INFRASTRUCTURES</td></tr>
<tr><td colspan="3">3.1 - Energy storage</td></tr>
<tr><td colspan="3">3.1.1 Power storage (electromechanical storage)</td></tr>
<tr><td>Title</td><td colspan="3">Graphical Detail</td></tr>
<tr><td rowspan="2">COA-S2.1.1 Li-ion electricity storage</td><td colspan="3"></td></tr>
<tr><td colspan="3">Electricity storage in a (micro) grid enables matching production and demand for electricity. It can be used for peak shaving, limitation of the required capacity of an electricity connection and the development of ancillary grid services.</td></tr>
<tr><td>City / Country</td><td>Project</td><td colspan="2">Technical Partner Name</td></tr>
<tr><td>City of Amsterdam</td><td>ATELIER</td><td colspan="2">Republica</td></tr>
<tr><td>Implementation Time</td><td></td><td>Initial Investment (€)</td><td>about 700000 EUR</td></tr>
<tr><td colspan="4">Detailed description - What is Solution? How does it work?</td></tr>
<tr><td colspan="4">Electricity storage in a (micro) grid enables matching production and demand for electricity. It can be used for peak shaving, limitation of the required capacity of an electricity connection and the development of ancillary grid services. As such it can help avoiding congestion of the electricity grid. Some services, e.g. primary reserve control, need a minimum power capacity of the connection. The installed battery has a capacity of 1.2 MWh. It is often mentioned that any market needs a capacity to store the product that is traded for proper matching of supply and demand. This has long been very limited for electricity. Still, batteries are an expensive solution, so for storing e.g. variable amounts of electricity by e.g. renewable energy generators, possibilities like storage in the form of heat (for low temperature heating) or hydrogen are also used. The hydrogen route still suffers from the conversion efficiencies but it has large potential capacity and storage lifetime.</td></tr>
<tr><td colspan="4">Stakeholders analysis (LOCAL ECOSYSTEM)</td></tr>
<tr><td colspan="3">Developer (if relevant) Who has developed this solution?</td><td>ATEPS</td></tr>
<tr><td colspan="3">Operator Who is operating this solution?</td><td>SPECTRAL</td></tr>
<tr><td colspan="3">Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?</td><td>Republica</td></tr>
<tr><td colspan="3">Implementer Who is implementing this solution?</td><td>SPECTRAL</td></tr>
<tr><td colspan="3">Financer How / By whom has the implementation of this solution been financed?</td><td>Republica</td></tr>
</table>

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 864374.

Other impacted stakeholder(s) (if relevant) **Who else is impacted by the deployment of this solution?**			Inhabitants, grid operator
Business model patterns			
Various uses of the battery are envisaged, e.g. day and night cycle operation, increasing the amount of self-consumption, or managing the imbalance. Some are more attractive than others and they sometimes cannot be combined			
BARRIERS / ENABLERS _ PESTEL STUDIES			
Political	No major barriers	**Technical**	Space issues (quality issues, difficulty to find space, etc.)
Economic	High investment costs	**Environmental**	The solution is not always environmentally feasible
	Long pay-back time		
	Price variability		
	Other:		Other:
Social	No major barriers	**Legal**	Lack of regulatory support
POTENTIAL FOR REPLICATION		**EXPECTED IMPACTS**	
Adaptation needs		**Benefits**	**Co-benefits**
Is it the solution very site-specific?	NO	Contribution to the penetration of more renewables in society	Increase access to clean, affordable, and secure energy
Does the developer export the solution to other locations?	YES	e.g. to wind farms	Reduce GHG emissions
Are there other developers in other locations/countries?	YES		Financial savings for citizens
Does its implementation depend on a specific business model (such as the creation of an ESE)?	YES		Enhance stability of the urban infrastructure
Does its implementation depend on existing specific regulation (such as Energy Communities legislation)?	YES	It seems to depend. In Amsterdam the Republica battery is part of an energy cooperation and this has applied for an exemption regulation, enabling experiments. but individual households can have batteries without a specific regulation	

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Do you think that the solution is highly replicable?	YES		**Other:**
Relevant Publications / Presentations / Services / Products to this Solution			
https://www.rvo.nl/sites/default/files/2018/05/Samenvatting%20Republica%20Papaverweg.pdf			
Reference applications of this Solution			

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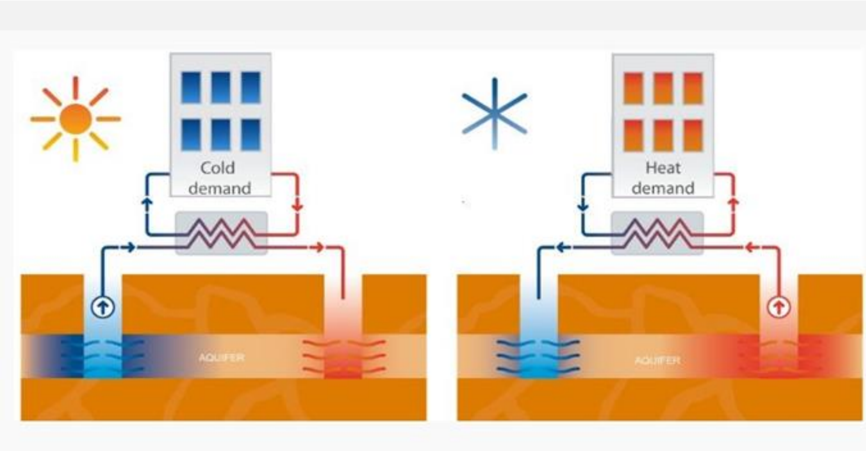
SPEC CARD	Category 3: INTEGRATED INFRASTRUCTURES 3.1 - Energy storage 3.1.2 - Thermal storage	
Title	**Graphical Detail**	
COA-S3.1.2 Aquifer thermal energy storage		
City / Country	**Project**	**Technical Partner Name**
City of Amsterdam	ATELIER	
Implementation Time	1-3 years	**Initial Investment (€)**

Detailed description - What is Solution? How does it work?

Aquifer Thermal Energy Storage (ATES) is a renewable energy technique whereby winter cold is stored underground and used to cool offices, hospitals, municipal buildings and shopping malls during the summer. It is used in the Republica and Poppies buildings. The heat that is released in the cooling process is also stored in the same aquifer, but in the warm well. The heat can then be used to heat buildings during winter time. Although in practice the temperature differences may be small, heat pumps can enhance thermal performance and direct cooling can be delivered through the groundwater.

Stakeholders analysis (LOCAL ECOSYSTEM)

Developer (if relevant) Who has developed this solution?	Republica, Edwin Oostmeijer
Operator Who is operating this solution?	Republica, Edwin Oostmeijer
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	Users of the buildings
Implementer Who is implementing this solution?	Republica, Edwin Oostmeijer
Financer How / By whom has the implementation of this solution been financed?	Part of the financing of the entire building

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Other impacted stakeholder(s) (if relevant) **Who else is impacted by the deployment of this solution?**			
Business model patterns			
In Republica there will be a heat company operating the system			
BARRIERS / ENABLERS _ PESTEL STUDIES			
Political	No major barriers	**Technical**	No major barriers
Economic	No major barriers	**Environmental**	No major barriers
Social	No major barriers	**Legal**	Law compliance is necessary
POTENTIAL FOR REPLICATION		**EXPECTED IMPACTS**	
Adaptation needs		**Benefits**	**Co-benefits**
Is it the solution very site-specific?	YES		Reduce GHG emissions
Does the developer export the solution to other locations?	YES	The law compliance means e.g. that in the long run, the temperature of the underground should not change	Reduce energy needs
Are there other developers in other locations/countries?	YES		
Does its implementation depend on a specific business model (such as the creation of an ESE)?	NO		
Does its implementation depend on existing specific regulation (such as Energy Communities legislation)?	NO		
Do you think that the solution is highly replicable?	YES		**Other:**
Relevant Publications / Presentations / Services / Products to this Solution			
https://www.iftechnology.com/			
Reference applications of this Solution			
https://www.iftechnology.com/project/houthaven-amsterdam/			
https://www.iftechnology.com/project/technical-university-of-eindhoven/			

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SPEC CARD	Category 3: INTEGRATED INFRASTRUCTURES		
	3.2 - District Heating & Cooling Facilities		
	3.2.2 Low Temperature District Heating		
Title	**Graphical Detail**		
COB-S3.2.2 District heating-geothermal ring			
City / Country	**Project**	**Technical Partner Name**	
City of Bilbao	ATELIER	COB	
Implementation Time		**Initial Investment (€)**	

Detailed description - What is Solution? How does it work?

5th Generation District Heating and Cooling where the thermal energy is going to be provided by shallow geothermal system: groundwater wells and boreholes, and hydrothermal support

Stakeholders analysis (LOCAL ECOSYSTEM)

Developer (if relevant) Who has developed this solution?	TELUR
Operator Who is operating this solution?	Mondragon University
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	Mongradon University, Digipen University, dwellings
Implementer Who is implementing this solution?	Telur/Viuda de Sainz
Financer How / By whom has the implementation of this solution been financed?	Municipality

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Other impacted stakeholder(s) (if relevant) **Who else is impacted by the deployment of this solution?**			Dwelling owners
Business model patterns			
The existing rental agreement with Beta II university building facilitates the connection to the geothermal boreholes. Mondragon University affords the operational costs			
BARRIERS / ENABLERS _ PESTEL STUDIES			
Political		**Technical**	Need of adapting solutions to different client/user needs or to different situations
	Other: Agreement between all the interested parties		**Other:** not real comparisson with ASHP because they use nominal COP for calculations
Economic	High investment costs	**Environmental**	No major barriers
Social	Lack of citizen/consumer awareness	**Legal**	
	Other: Approach to residential buildings is seen as critical		**Other:** Lack of specific regulation for this technology for new operation models
POTENTIAL FOR REPLICATION		**EXPECTED IMPACTS**	
Adaptation needs		**Benefits**	**Co-benefits**
Is it the solution very site-specific?	NO	Avoid natural gas combustion	Reduce GHG emissions
Does the developer export the solution to other locations?	YES	Higher efficiency in thermal supply	Reduce the use of non-renewable resources
Are there other developers in other locations/countries?	YES	Attenuation of the electricity bill	Financial savings for citizens
Does its implementation depend on a specific business model (such as the creation of an ESE)?	NO	Production of heating and cooling with the same equipment	Decrease future maintenance costs
Does its implementation depend on existing specific regulation (such as Energy Communities legislation)?	YES		
Do you think that the solution is highly replicable?	YES		**Other:**

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Relevant Publications / Presentations / Services / Products to this Solution	
Reference applications of this Solution	
Universiry of Deusto (Bilbao)	Lehendakaritza building (Vitoria-Gasteiz, Araba)
ITP Aero (Barakaldo, Bizkaia)	TTT Bergara (Bergara, Gipuzkoa)
Neiker Arkaute (Vitoria-Gasteiz, Araba)	Universiry of Deusto (Donostia, Gipuzkoa)

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SPEC CARD	Category 3: INTEGRATED INFRASTRUCTURES 3.3 - Electromobility integration 3.3.1 EV chargers	
Title	**Graphical Detail**	
COA-S3.3.1 Republica EV chargers		
City / Country	**Project**	**Technical Partner Name**
City of Amsterdam	ATELIER	
Implementation Time	1-3 years	**Initial Investment (€)**

Detailed description - What is Solution? How does it work?

The amount of electric vehicle charging point in the parking facilities of Republica will be 25% to 50% (of about 95 parking spaces. Smart/flexible charging points will be integrated with the smart-grid EMS, assisting in managing the load of the building on the grid.
The amount of electric vehicle charging point in the parking facilities of Poppies will be approximately 25% (of about 45 parking spaces. Smart/flexible charging points will be integrated with the smart-grid EMS, assisting in managing the load of the building on the grid.

Stakeholders analysis (LOCAL ECOSYSTEM)

Developer (if relevant) Who has developed this solution?	
Operator Who is operating this solution?	Republica/Poppies
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	Inhabitants and renters within Republica/Poppies
Implementer Who is implementing this solution?	Republica/Poppies

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Financer **How / By whom has the implementation of this solution been financed?**			Investors in Republica/Poppies
Other impacted stakeholder(s) (if relevant) **Who else is impacted by the deployment of this solution?**			Local grid operator
Business model patterns			
Sell electricity at an attractive price to the users, Determined by the Republica energy community and Poppies inhabitants			
BARRIERS / ENABLERS _ PESTEL STUDIES			
Political	No major barriers	**Technical**	No major barriers
Economic	No major barriers	**Environmental**	No major barriers
Social	No major barriers	**Legal**	No major barriers
POTENTIAL FOR REPLICATION		**EXPECTED IMPACTS**	
Adaptation needs		**Benefits**	**Co-benefits**
Is it the solution very site-specific?	NO		Enhance stability of the urban infrastructure
Does the developer export the solution to other locations?	YES		Financial savings for citizens
Are there other developers in other locations/countries?	YES		Energy management optimization
Does its implementation depend on a specific business model (such as the creation of an ESE)?	NO		Provide users with energy management capabilities
Does its implementation depend on existing specific regulation (such as Energy Communities legislation)?	NO	But the fact that the chargers are in a microgrid makes it possible that prices are determined by the users (of course the total bill needs to be paid	
Do you think that the solution is highly replicable?	YES	But without the smart grid special circumstance.	**Other:**
Relevant Publications / Presentations / Services / Products to this Solution			
Reference applications of this Solution			

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SPEC CARD	**Category 3: INTEGRATED INFRASTRUCTURES**
	3.3 - Electromobility integration
	3.3.2 Electromobility hub

Title	Graphical Detail
COA-S3.3.2 Electromobility hub	 An electromobility hub is a place where different modes of electric transportation are being offered. these are e.g. electric vehicles, mopeds, cargo bikes or e-bikes. Apps are usually offered for reservation, checking availability and unlocking

City / Country	Project	Technical Partner Name	
City of Amsterdam	ATELIER	Municipality of Amsterdam	
Implementation Time	6-12 months	**Initial Investment (€)**	By electromobility provider, based on tender, amount unknown

Detailed description - What is Solution? How does it work?

An electromobility hub is a place where different modes of electric transportation are being offered. these are e.g. electric vehicles, mopeds, cargo bikes or e-bikes. Apps are usually offered for reservation, checking availability and unlocking. In Amsterdam the hubs are developed bottom-up. This means on initiative of inhabitants and on a neighbourhood scale

Stakeholders analysis (LOCAL ECOSYSTEM)

Developer (if relevant) Who has developed this solution?	Municipality of Amsterdam together with shared electromobility provider HUUB
Operator Who is operating this solution?	Originally HUUB, now Hely
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	Inhabitants of a floating dwellings community, later it opened up to a

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			wider public of interested citizens
Implementer Who is implementing this solution?			HUUB
Financer How / By whom has the implementation of this solution been financed?			HUUB
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?			Non participating citizens
Business model patterns			
Commercial activity			
BARRIERS / ENABLERS _ PESTEL STUDIES			
Political	No major barriers	**Technical**	No major barriers
Economic	Long pay-back time	**Environmental**	No major barriers
	High investment costs		
Social	No major barriers	**Legal**	No major barriers
POTENTIAL FOR REPLICATION		**EXPECTED IMPACTS**	
Adaptation needs		**Benefits**	**Co-benefits**
Is it the solution very site-specific?	NO	Reduction of amount of cars	Financial savings for citizens
Does the developer export the solution to other locations?	YES	In Amsterdam there are now multiple competing providers	
Are there other developers in other locations/countries?	YES		
Does its implementation depend on a specific business model (such as the creation of an ESE)?	NO	The key is here to strike the right balance between financial attractiveness for both provider and user, the availability of vehicles (in competition with financial attractiveness for provider) and frequency of use	
Does its implementation depend on existing specific regulation (such as Energy Communities legislation)?	NO		

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Do you think that the solution is highly replicable?	YES		**Other:**
Relevant Publications / Presentations / Services / Products to this Solution			
https://www.crow.nl/over-crow/nieuws/2021/november/aantal-elektrische-deelauto-s-ruim-verdubbeld			
https://www.parool.nl/amsterdam/in-amsterdam-is-de-deelauto-wel-populair-met-zo-weinig-parkeerplek-zoeken-mensen-alternatieven~b26408d6/?referrer=https%3A%2F%2Fwww.google.com%2F			
Reference applications of this Solution			
-		-	

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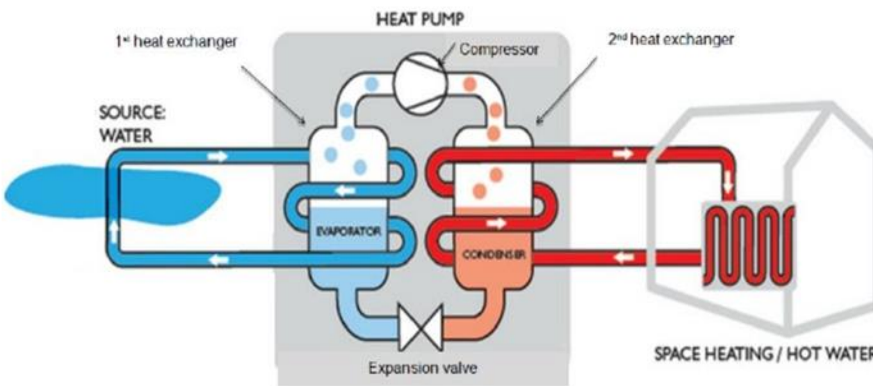
SPEC CARD	Category 3: INTEGRATED INFRASTRUCTURES	
	3.4 - Heat pumps	
	3.4.3 Water-water Heat pumps	
Title	**Graphical Detail**	
COA-S3.4.3-A Republica Heat pumps		
City / Country	**Project**	**Technical Partner Name**
City of Amsterdam	ATELIER	Republica, Edwin Oostmeijer
Implementation Time	< 6 months	**Initial Investment (€)**

Detailed description - What is Solution? How does it work?

Heat pumps (1.2 MWth in total, plus booster pumps) are used in Republica for heating of the dwellings. The combination of the heat pumps with the use of subsoil heat stored in the summer period enhances the coefficient of performance of the system. The heat pumps are smart grid ready, which means that they can be controlled externally. In combination with the smart microgrid and the electricity storage, this enables management of the electrical load within the buildings and delivery of flexibility services. In order to cost-effectively engineer the capacity of the heat pumps the system is back-upped by District Heating for periods of extreme cold.

Heat pumps are used in Poppies for heating of the dwellings. The combination of the heat pumps with the use of subsoil heat stored in the summer period enhances the coefficient of performance of the system. The heat pumps are smart grid ready, which means that they can be controlled externally in order to deliver energy services and optimize the balance of local supply and demand.

Stakeholders analysis (LOCAL ECOSYSTEM)

Developer (if relevant) Who has developed this solution?	Republica, Edwin Oostmeijer
Operator Who is operating this solution?	Republica, esco or Vaanster, Edwin Oostmeijer
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	Users of the building

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<table>
<tr><td colspan="3">Implementer Who is implementing this solution?</td><td>Republica, esco or Vaanster, Edwin Oostmeijer</td></tr>
<tr><td colspan="3">Financer How / By whom has the implementation of this solution been financed?</td><td>Republica, Edwin Oostmeijer</td></tr>
<tr><td colspan="3">Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?</td><td>The direct geographical environment. There is only limited space for Cold and Heat shafts/wells.</td></tr>
<tr><th colspan="4">Business model patterns</th></tr>
<tr><td colspan="4">Ground source heat pumps are an efficient heating solution, in this case installed by the developer.</td></tr>
<tr><th colspan="4">BARRIERS / ENABLERS _ PESTEL STUDIES</th></tr>
<tr><td>Political</td><td>No major barriers</td><td>Technical</td><td>Space issues (quality issues, difficulty to find space, etc.)</td></tr>
<tr><td>Economic</td><td>High investment costs</td><td>Environmental</td><td>No major barriers</td></tr>
<tr><td>Social</td><td>No major barriers</td><td>Legal</td><td>No major barriers</td></tr>
<tr><th colspan="2">POTENTIAL FOR REPLICATION</th><th colspan="2">EXPECTED IMPACTS</th></tr>
<tr><th colspan="2">Adaptation needs</th><th>Benefits</th><th>Co-benefits</th></tr>
<tr><td>Is it the solution very site-specific?</td><td>YES</td><td>up to 50% reduction of GHG emissions compared with natural gas heating)</td><td>Reduce GHG emissions</td></tr>
<tr><td>Does the developer export the solution to other locations?</td><td>YES</td><td>The solution requires a good secondary heat source. If this is not the case, then (usually less efficient) air-water heat pups need to be used</td><td>Reduce energy needs</td></tr>
<tr><td>Are there other developers in other locations/countries?</td><td>YES</td><td></td><td>Improve air quality</td></tr>
<tr><td>Does its implementation depend on a specific business model (such as the creation of an ESE)?</td><td>YES</td><td>An operator pays for the exclusive right for a certain time period.</td><td></td></tr>
<tr><td>Does its implementation depend on existing specific regulation (such as Energy Communities legislation)?</td><td>NO</td><td>One has to transfer the right of 'opstal' to the operating partner, so there is a legal component to it.</td><td></td></tr>
<tr><td>Do you think that the solution is highly replicable?</td><td>YES</td><td></td><td>Other:</td></tr>
<tr><th colspan="4">Relevant Publications / Presentations / Services / Products to this Solution</th></tr>
<tr><td colspan="4"></td></tr>
<tr><th colspan="4">Reference applications of this Solution</th></tr>
</table>

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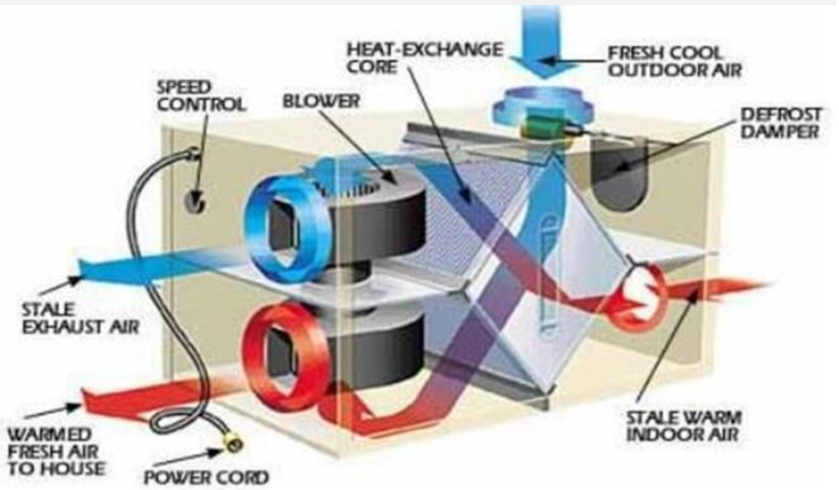
SPEC CARD	Category 3: INTEGRATED INFRASTRUCTURES 3.5 - Heat recovery 3.5.1 - Mechanical ventilation with heat recovery	
Title	**Graphical Detail**	
COA-S3.5.1 Balanced ventilation with heat recovery		
City / Country	**Project**	**Technical Partner Name**
City of Amsterdam	ATELIER	Republica, Edwin Oostmeijer
Implementation Time	6-12 months	**Initial Investment (€)**

Detailed description - What is Solution? How does it work?

The Republica and Poppies buildings will have mechanical ventilation with heat recovery. Efficiency of heat recovery is 96%. There is a mix of collective and individual heat recovery. Ventilation is partly time-controlled, partly CO2-controlled. In high-performance buildings, mechanical ventilation is using heat recovery to minimize heat losses.

Stakeholders analysis (LOCAL ECOSYSTEM)

Developer (if relevant) Who has developed this solution?	Republica, Edwin Oostmeijer
Operator Who is operating this solution?	Republica, Edwin Oostmeijer
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	Users of the building
Implementer Who is implementing this solution?	Vink Bouw, Edwin Oostmeijer
Financer How / By whom has the implementation of this solution been financed?	Republica, Edwin Oostmeijer

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Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?			
Business model patterns			
BARRIERS / ENABLERS _ PESTEL STUDIES			
Political	No major barriers	**Technical**	No major barriers
	Other:		**Other:** A good design is important to minimize noise issues. Frequent filter cleaning is important for health reasons
Economic	No major barriers	**Environmental**	No major barriers
Social	No major barriers	**Legal**	No major barriers
POTENTIAL FOR REPLICATION		EXPECTED IMPACTS	
Adaptation needs		Benefits	Co-benefits
Is it the solution very site-specific?	NO	Contributes to the energy performance of buildings by minimizing heat losses	Reduce GHG emissions
Does the developer export the solution to other locations?	YES		Reduce energy needs
Are there other developers in other locations/countries?	YES		
Does its implementation depend on a specific business model (such as the creation of an ESE)?	NO		
Does its implementation depend on existing specific regulation (such as Energy Communities legislation)?	NO		
Do you think that the solution is highly replicable?	YES		**Other:**
Relevant Publications / Presentations / Services / Products to this Solution			
Reference applications of this Solution			

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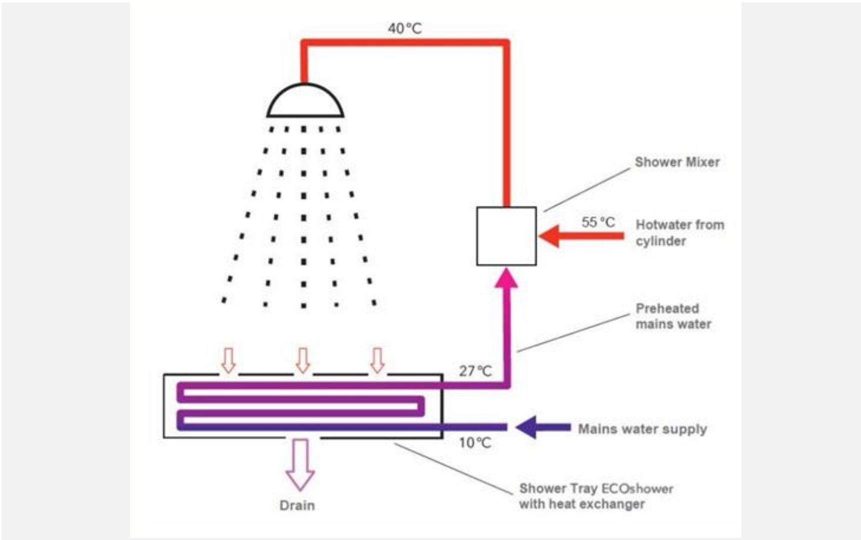
SPEC CARD

Category 3:
INTEGRATED INFRASTRUCTURES

3.5 - Heat recovery

3.5.2 - Shower drain water heat recovery systems

Title	Graphical Detail
COA-S3.5.2 Shower drain water heat recovery	

City / Country	Project	Technical Partner Name	
City of Amsterdam	ATELIER		
Implementation Time	6-12 months	**Initial Investment (€)**	

Detailed description - What is Solution? How does it work?

Shower drain water heat recovery systems (proposed is DSS wtw 900/4) in the residential part of Republica buildings 1 and 2, building 3 (fully residential) and in the hotel (building 4) as well as in the Poppies building. Heat recovery factor is 0.48. This innovation will reduce the heat required for domestic hot water by almost 50%. With improved insulation of buildings, the reduction of heat use for domestic hot water becomes more important and is valuated in the Dutch EPC (Energy Performance Coefficient) of Buildings.
For Poppies an innovative douche system will be used, called The Meed Energeyser. Poppies uses the MEED Energeyser. This system collects the water that flows from the shower head in a shower tray with a molded reservoir and pumps it upwards through a cleaning filter. In this way the water is pushed towards a patented heat exchanger. This piece of innovative technology extracts the energy from the waste water and thus heats up the cold supply water. A compact built-in boiler then brings the water to the desired temperature, which can be set via the mixer tap.

Stakeholders analysis (LOCAL ECOSYSTEM)

Developer (if relevant) Who has developed this solution?	Republica, Edwin Oostmeijer, various suppliers
Operator Who is operating this solution?	Republica, Edwin Oostmeijer

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 864374.

Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?			Building users (residents, hotel operator)
Implementer Who is implementing this solution?			Vink Bouw, Edwin Oostmeijer
Financer How / By whom has the implementation of this solution been financed?			Included in the construction cost of Republica, Edwin Oostmeijer
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?			
Business model patterns			
Investment cost recovery through lower energy bills			
BARRIERS / ENABLERS _ PESTEL STUDIES			
Political	No major barriers	**Technical**	No major barriers
Economic	No major barriers	**Environmental**	No major barriers
Social	No major barriers	**Legal**	No major barriers
POTENTIAL FOR REPLICATION		**EXPECTED IMPACTS**	
Adaptation needs		**Benefits**	**Co-benefits**
Is it the solution very site-specific?	NO	Up to 50% reduction of heat requirements for showering	Reduce GHG emissions
Does the developer export the solution to other locations?	YES	The solutions can be applied in both multi storey buildings as single storey apartments	Reduce energy needs
Are there other developers in other locations/countries?	YES		Financial savings for citizens
Does its implementation depend on a specific business model (such as the creation of an ESE)?	NO		
Does its implementation depend on existing specific regulation (such as Energy Communities legislation)?	NO		
Do you think that the solution is highly replicable?	YES		**Other:**
Relevant Publications / Presentations / Services / Products to this Solution			
See e.g. https://recoupwwhrs.co.uk/, https://www.milieucentraal.nl/energie-besparen/duurzaam-warm-water/douche-wtw/			
https://www.meed-solutions.com/het-product			

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 864374.

Reference applications of this Solution	

SPEC CARD	Category 4: RES ALTERNATIVE URBAN ENERGY SOURCES 4.2 - Electric use 4.2.1 - Solar PV		
Title	**Graphical Detail**		
COA-S4.2.1-A Republica PV panels			
City / Country	**Project**	**Technical Partner Name**	
City of Amsterdam	ATELIER	Republica/Poppies	
Implementation Time	1-3 years	**Initial Investment (€)**	about 500000 EUR

Detailed description - What is Solution? How does it work?

As much as possible, the available roof space on Republica will be covered with PV panels, for a total of 219 kWp. It intends to fulfil to a large part the electricity needs for the buildings
The roofs of the Poppies buildings will be extensively covered with PV panels. Besides, facades, and terraces are used for deploying PV (total 228 kWp, partly building integrated). The efficiency is raised by the measures to keep the roof cool.

Stakeholders analysis (LOCAL ECOSYSTEM)	
Developer (if relevant) Who has developed this solution?	Republica/Poppies
Operator Who is operating this solution?	Republica/Poppies
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	Users of the buildings
Implementer Who is implementing this solution?	Vink Bouw/Poppies
Financer How / By whom has the implementation of this solution been financed?	Republica development/Poppies

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 864374.

Other impacted stakeholder(s) (if relevant) **Who else is impacted by the deployment of this solution?**			Local grid operator
Business model patterns			
To be paid back by the reduced electricity cost for the building users. With 2022 prices, this should be possible within about 7 years			
BARRIERS / ENABLERS _ PESTEL STUDIES			
Political	No major barriers	**Technical**	No major barriers
Economic	No major barriers	**Environmental**	No major barriers
Social	No major barriers	**Legal**	No major barriers
POTENTIAL FOR REPLICATION		**EXPECTED IMPACTS**	
Adaptation needs		**Benefits**	**Co-benefits**
Is it the solution very site-specific?	NO	Depends on use of roof. About 400000 kWh of renewable electricity	Financial savings for citizens
Does the developer export the solution to other locations?	NO		
Are there other developers in other locations/countries?	YES		
Does its implementation depend on a specific business model (such as the creation of an ESE)?	YES	You need to know the price offered for 'returning' the electricity.	
Does its implementation depend on existing specific regulation (such as Energy Communities legislation)?	NO	One has to transfer the right of 'opstal' to the operating partner, so there is a legal component to it.	
Do you think that the solution is highly replicable?	YES		**Other:**
Relevant Publications / Presentations / Services / Products to this Solution			
Reference applications of this Solution			
Amsterdam Johan Cruijff Arena, The Edge etc......			

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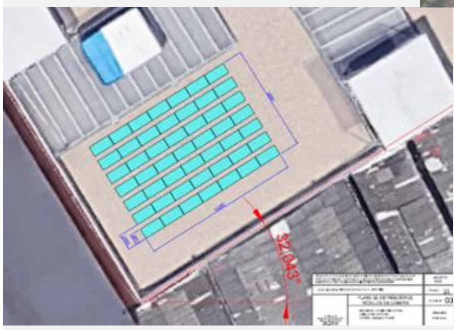
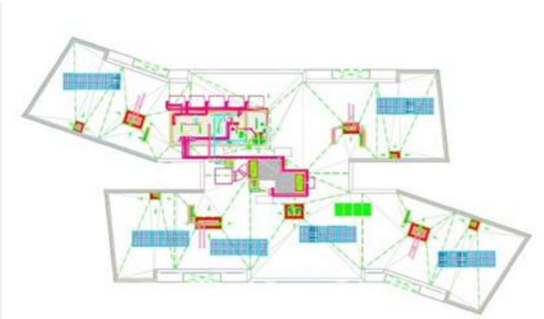
SPEC CARD	Category 4: RES ALTERNATIVE URBAN ENERGY SOURCES
	4.2 – Electric use
	4.2.1 – Solar PV
Title	**Graphical Detail**
COB-S4.2.1 Bilbao PV Panels	  

City / Country	Project	Technical Partner Name
City of Bilbao	ATELIER	IBERDROLA CLIENTES
Implementation Time		**Initial Investment (€)**

Detailed description - What is Solution? How does it work?

Energy from the sunlight is absorbed by the PV cells in the panel. This energy creates electrical charges that move in response to an internal electrical field in the cell, causing electricity to flow. PV Installation on the roof collect energy from the sun, an inverter converts the direct current (DC) electricity generated by the solar panels into alternating current (AC) electricity. This AC power flows from the inverter through the wires into your generation meter. From the generation meter it's distributed to the building as renewable energy. Community solar provides homeowners, renters, and businesses equal access to the economic and environmental benefits of solar energy

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generation regardless of the physical attributes or ownership of their home or business. Shared self-consumption consists of an energy system that allows several participants to consume energy from the same photovoltaic installation. In fact, more than one solar plant can supply electricity to consumers.			
Stakeholders analysis (LOCAL ECOSYSTEM)			
Developer (if relevant) Who has developed this solution?			IBERDROLA CLIENTES
Operator Who is operating this solution?			Mondragon University/Jaureguizar
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?			Mondragon University/Jaureguizar
Implementer Who is implementing this solution?			IBERDROLA CLIENTES
Financer How / By whom has the implementation of this solution been financed?			IBERDROLA CLIENTES
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?			Mondragon University/Jaureguizar
Business model patterns			
Iberdrola affords CAPEX and OPEX costs and charges the added-value services to the third party who is benefiting from them.			
BARRIERS / ENABLERS _ PESTEL STUDIES			
Political	Low awareness among policy makers	**Technical**	Lack of knowledge about the solution
			Limited compatibility with existing infrastructure
Economic	High investment costs	**Environmental**	No major barriers
	Lack of business models		
	Lack of incentives		
Social	Lack of citizen/consumer awareness	**Legal**	Need of specific permissions or licenses
POTENTIAL FOR REPLICATION		**EXPECTED IMPACTS**	
Adaptation needs		**Benefits**	**Co-benefits**
Is it the solution very site-specific?	NO	Reduce energy consumption	Reduce energy needs

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Does the developer export the solution to other locations?	YES	Higher efficiency in energy consumption	Energy management optimization
Are there other developers in other locations/countries?	YES	Attenuation of the electricity bill	Reduce GHG emissions
Does its implementation depend on a specific business model (such as the creation of an ESE)?	NO	Renewable energy	Increase access to clean, affordable, and secure energy
Does its implementation depend on existing specific regulation (such as Energy Communities legislation)?	YES	Decarbonisation solutions	Increased carbon sequestration capacity(explaining that this through indirect solutions such as NBS)
Do you think that the solution is highly replicable?	YES		**Other:**
Relevant Publications / Presentations / Services / Products to this Solution			
Reference applications of this Solution			
Iberdrola Solar Community in Giner de los Ríos School (Cáceres)		Solar Community in Villanueva de la Condesa City Council (Valladolid)	
ola Solar Community in Parroquias San José and Santa Teresa for the Bishopric of Bilbao (Barakaldo)			
Solar Community in Zumarraga City Council (Guipúzcoa)			

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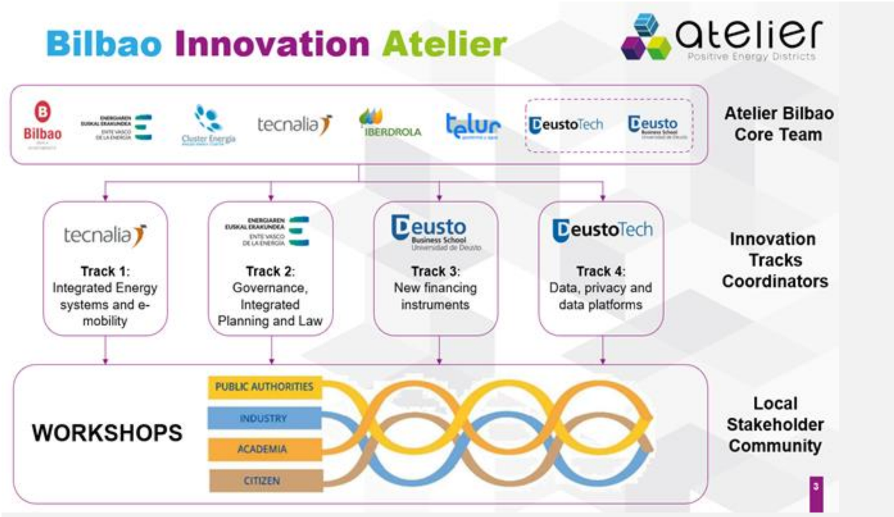
SPEC CARD

Category 5:
POLITICAL, SOCIAL, ECONOMICAL INTERVENTIONS

5.2 - Social innovation

5.2.1 - Innovation Atelier

Title	Graphical Detail		
COB-S5.2.1 - Innovation Atelier	 **Bilbao Innovation Atelier** intends to be a meeting forum for Bilbao Lighhouse partners and the local stakeholders community to foster open innovation in PEDs, disseminate the progress on the development of ATELIER smart urban solutions and showcase its results and deliver useful feedback and best-practices to upscale the solutions to other Bilbao districts and to support replication at the Fellow cities.		
City / Country	**Project**	**Technical Partner Name**	
City of Bilbao	ATELIER	CEPV, COB, TEC, EVE, IBE, TEL, DEU	
Implementation Time	>3 years	**Initial Investment (€)**	Rough estimate of 120h per workshop by the lead partner
Detailed description - What is Solution? How does it work?			

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Bilbao Innovation Atelier is the structure to materialize the interaction among ATELIER and Bilbao stakeholders and citizens. CEPV catalyses, on the grounds of its broad experience within the energy field, this concept. Thus, on-purpose discussions among the relevant stakeholders are being designed and carried out, through 2**4 workshops during 5 years**. The workshops are adapted to the objectives pursued for each project stage: getting feedback from specific stakeholder groups, sharing and discussing results, etc.
In that process, the **4 Innovation tracks** (*see picture above*) are the working fields for building knowledge, and sharing experience and good practices.
Innovation Tracks' coordinators are responsible to motivate the Workshops, as the mechanisms to facilitate communication and active participation. However, the whole coordination is brought through **Atelier Bilbao Core Team**, in order to optimize the overall outcomes and to achieve:
• the optimal involvement of the different Areas of the City Council
• the appropriate and coherent targeting to the relevant stakeholders and citizens
COB, CEPV, EVE, IBE, TEL, DEU and TEC constitute Atelier Bilbao Core Team. Stable coordination with CAR, whose participation is focused to extend achievements to the Fellow Cities, is ensured through regular participation in the Core Team meetings.

Stakeholders analysis (LOCAL ECOSYSTEM)	
Developer (if relevant) Who has developed this solution?	CEPV
Operator Who is operating this solution?	Bilbao Atelier Core Team
Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?	Stakeholders involved in Bilbao energy transition (quadruple helix)
Implementer Who is implementing this solution?	Bilbao Atelier Core Team
Financer How / By whom has the implementation of this solution been financed?	ATELIER project
Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?	Basque Industry stakeholders in the Energy, ICT, Mobility value chains; Bilbao citizens

Business model patterns
First stage: - BIA Core Team constituted based on the Basque Energy Cluster working groups methodology - Core Team members: COB, EVE, TEC, IBE, TELUR, DEU, CEPV - Further involvement of Bilbao Council Areas upon COB consideration - WG Coordination and management by CEPV ensures a stable framework for the Bilbao Innovation Atelier beyond the project timeframe Second stage: - Check possibility to involve other Public Authorities (such as the Basque Government or the County Councils) - Check possibility to establish an independent legal entity to manage the activity of the Bilbao Innovation Atelier

BARRIERS / ENABLERS _ PESTEL STUDIES			
Political	Lack of coordination between differents administrative levels or between different departments	**Technical**	Need of adapting solutions to different client/user needs or to different situations

	Low awareness among policy makers		
Economic	Lack of business models	**Environmental**	No major barriers
	Lack of financial resources		
Social	Lack of citizen/consumer awareness	**Legal**	Lack of regulatory support
POTENTIAL FOR REPLICATION		**EXPECTED IMPACTS**	
Adaptation needs		**Benefits**	**Co-benefits**
Is it the solution very site-specific?	YES	Higher development and adoption speed for digital-based solutions towards Bilbao energy transition	Increase access to clean, affordable, and secure energy
Does the developer export the solution to other locations?	YES	Increased citizen awareness on the solutions to be deployed and the benefits they can bring	Enhance citizen participation, connectivity and community
Are there other developers in other locations/countries?	YES	Greater potential for industrial collaboration opportunities among the stakeholders in the energy/mobility/ICT value chains	Boost local business (km 0)
Does its implementation depend on a specific business model (such as the creationg of an ESE)?	NO	Better connection between the industrial/scientific stakeholders and the Municipality Areas	Improve access to information
Does its implementation depend on existing specific regulation (such as Energy Communities legislation)?	NO		Raise awareness/behavioural change
Do you think that the solution is highly replicable?	YES		**Other:**
Relevant Publications / Presentations / Services / Products to this Solution			
8 workshops held so far in the framework of Bilbao Innovation Atelier			

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Article published in the EKONOMIAZ basque biannual magazine "The opportunity for smart city projects at municipal scale: Implementing a positive energy district in Zorrozaurre", where details on the Bilbao Innovation Atelier are provided
Reference applications of this Solution
Unknown. Parallel approach in Amsterdam in the framework of ATELIER

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Annex 3 – Adaptation needs exercise

Li-ion electricity storage: Adaptation needs (in relation to the analysed technology) for Bratislava

Stakeholders to involve/ Local ecosystem in your city
– ZSE Energia, a.s., Slovak electricity and gas supplier – Slovak Battery Association
Business model in your city
We are not aware of any business model
Technical barriers in your city
We are not aware of any barriers
Non-technical barriers (regulation/ legislation) in your city
There is no regulation/legislation regarding the Li-ion electricity storage so far.

Electromobility hub: Adaptation needs (in relation to the analysed technology) for Bratislava

Stakeholders to involve/ Local ecosystem in your city
In April 2012, the Slovak Association for Electromobility (SEVA) was established, which together with its members organizations - e.g. MyEnergy, a.s. - initiator of the innovative project GreenWay, Západoslovenská energetika, a.s. member of the EON group, Východoslovenská energetika, a.s. member of the RWE group, Slovenské elektrárne a.s., a member of the Enel group and others are intensively engaged promotion and introduction of electromobility.
Business model in your city
We are not aware of any business model
Technical barriers in your city
– Lack of charging stations – Criticism of the location of charging stations
Non-technical barriers (regulation/ legislation) in your city
– Later start of electromobility support in Slovakia. – There is a lack of harmonization of norms and standards. – Currently insufficient infrastructure for charging electric cars. – Lower sensitivity of society to accept ecological, or “innovative” solutions

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 864374.

Republica PV panels: Adaptation needs (in relation to the analysed technology) for Bratislava

Stakeholders to involve/ Local ecosystem in your city
– ZSE Energia, a.s., Slovak electricity and gas supplier – The Slovak Association of the Photovoltaic Industry and RES
Business model in your city
We are not aware of any business model for Bratislava
Technical barriers in your city
The grid is sensitive on energy fluctuation - supply and consumption
Non-technical barriers (regulation/ legislation) in your city
The development is quite slow. Support from current projects can only be used by households in regions outside the Bratislava Self-Governing Region (BSK). The reason why funds were allocated specifically for BSK and other regions is related to the different level of support for projects financed from the European Regional Development Fund, which is primarily intended for financing projects in less developed regions, which BSK does not belong to.

Electromobility hub: Adaptation needs (in relation to the analysed technology) for Budapest

Stakeholders to involve/ Local ecosystem in your city
– Energy Agency of Budapest (going to be set up in the near future) – Municipality of Budapest and Municipality of the district – Electricity Supply Company, DSO – Charging point Operators – E-mobility service providers – BKK – Centre for Budapest Transport – MVM Group (Hungarian Electricity)
Business model in your city
– Private companies operates the services, no public service – E-car-sharing support system to be developed in the near future – RES (PV) integration to the system – Public transport service (trolleybus, hibrid and full electric buses)
Technical barriers in your city
Electricity network improvement needed
Non-technical barriers (regulation/ legislation) in your city
Legal obstacles on public space usage (23 district municipalities)

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Republica PV panels: Adaptation needs (in relation to the analysed technology) for Budapest

Stakeholders to involve/ Local ecosystem in your city
– Energy Agency of Budapest (going to be set up in the near future) – Municipality of Budapest and Municipality of the district – Electricity Supply Company, DSO – Future development company – HSEA Hungarian Solar Energy Association – Citizens/residents – they can form their own energy covenant – Future users of buildings/territory – Property management
Business model in your city
– User owned business model (or prosumers) – Third party proprietary business model – Community shared business model
Technical barriers in your city
– How it will be profitable for the investor and the future property owner – Application on world heritage buildings is not allowed – Application on historically significant buildings and areas is only allowed if the panels are not visible from communal spaces
Non-technical barriers (regulation/ legislation) in your city
– Lack of awareness within the municipal administration and no willingness of compromising on certain issues (architectural considerations conflict with solar panel installation aspects, complex management of energy efficiency of buildings e.g. utility replacements through regulators) – The regulation of solar panel deployment should be amended. – Convincing developers, future investors that the use of solar technology not only reduces costs for future users but also increases the value of the investment.

District Heating – geothermal ring: Adaptation needs (in relation to the analysed technology) for Budapest

Stakeholders to involve/ Local ecosystem in your city
– Energy Agency of Budapest (going to be set up in the near future) – Municipality of Budapest and Municipality of the district – District Heating Company
Business model in your city
The District Heating Company has / could have experience of business model development.
Technical barriers in your city
– In our case, heat is produced in smaller thermal power plants (not locally) and delivered to the place of use via a network. This would be a completely new technology that would have to be developed to interface with the existing system. – We could define more thechnical barriers for sure after the District heating Company had been involved.
Non-technical barriers (regulation/ legislation) in your city
– Agreement between the interested partners, codification of terms of cooperation. – High investment costs. – Lack of specific regulaton for this technology for new operator models.

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Energy Management System (EMS): Adaptation needs (in relation to the analysed technology) for Budapest

Stakeholders to involve/ Local ecosystem in your city
– Energy Agency of Budapest (going to be set up in the near future) – could function as coordinator – Municipality of Budapest and Municipality of the district – Electricity Supply Company – District Heating Company
Business model in your city
– There is not any business model in our city for such a kind of managemant system. – However the Energy Agency should work together with the District Heating Company and the Electricity Supply Company to develop the business model. – The District Heating Company has /could have experience of operating its own energy managemant system.
Technical barriers in your city
Non-technical barriers (regulation/ legislation) in your city
– Lack of supportive policies and lack of awareness among policy makers are also barriers in Budapest. – Estabilisment of Energy Agency of Budapest is a pressing challenge.

Li-ion electricity storage: Adaptation needs (in relation to the analysed technology) for Copenhagen

Stakeholders to involve/ Local ecosystem in your city
– Primarily: Building owners, Potential energy community, Third-party – but potentially also: Electricity supply company and Electricity network company
Business model in your city
– Integrated in the building operation costs – Energy community – Third-party perhaps with several other installations in their portfolio
Technical barriers in your city
Space-requirement irrespective of whether it is placed within the building or outside (what is the size + space and environment requirements?)
Non-technical barriers (regulation/ legislation) in your city
– Fire safety regulations – Noise – (Access for maintenance)

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Electromobility hub: Adaptation needs (in relation to the analysed technology) for Copenhagen

Stakeholders to involve/ Local ecosystem in your city
– Primarily: E-mobility providers Municipality Private/public businesses or organisations including NGO E-mobility/energy community, – But potentially also: Electricity supply company and Electricity network company
Business model in your city
– Integrated part in E-mobility services – Third-party perhaps with several other installations in their portfolio – Energy community
Technical barriers in your city
Space-requirement
Non-technical barriers (regulation/ legislation) in your city
– Fire safety regulations – Risk of vandalism

Republica PV panels: Adaptation needs (in relation to the analysed technology) for Copenhagen

Stakeholders to involve/ Local ecosystem in your city
– Primarily: Building owners, Potential energy community, Third-party – But potentially also: Electricity supply company and Electricity network company
Business model in your city
– Integrated in the building operation costs – Energy community – Third-party perhaps with several other installations in their portfolio
Technical barriers in your city
Roof space not suited for PV
Non-technical barriers (regulation/ legislation) in your city
– (No urgency such as a renovation project that can leverage costs and decisions) – Fire safety regulations – Processing of planning application – Impression of risk (fire and other damage)

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District Heating – geothermal ring: Adaptation needs (in relation to the analysed technology) for Copenhagen

Stakeholders to involve/ Local ecosystem in your city
– Primarily: District heating company District heating network company – But potentially also: Building owners, Potential energy community, Third-party
Business model in your city
– Integrated in the city district heating/cooling system – Energy community – Third-party perhaps with several other installations in their portfolio
Technical barriers in your city
– Very limited locations suited for seawater intake – Very limited ground water intakes – Very limited areas that are suited for the noise associated with air-based heat pumps
Non-technical barriers (regulation/ legislation) in your city
– High risk of underperforming heat sources – Complicated reservation of areas (and cost recovery for un-used area) – No/few well functioning case examples... And thus also limited experience in operation challenges.

Energy Management System (EMS): Adaptation needs (in relation to the analysed technology) for Copenhagen

Stakeholders to involve/ Local ecosystem in your city
– Primarily: Building owners Building operators Energy community
Business model in your city
– Integrated in the building operation costs – Third-party perhaps with several other installations in their portfolio
Technical barriers in your city
Technical compatibility of equipment (meters, sensors, …)
Non-technical barriers (regulation/ legislation) in your city
– Initial permission for data access and perceived risk of data sharing – Sufficient staff for monitoring of data unless outsourced – Bill savings not certain – Lack of awareness among all parties of the inherent nature of testing new solutions such as IT and IA solutions (dialogue and information on interruptions, break-downs and unexpected results need to be “managed purposefully”)

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 864374.

Li-ion electricity storage: Adaptation needs (in relation to the analysed technology) for Krakow

Stakeholders to involve/ Local ecosystem in your city
– Energy entrepreneurs – Energy clusters – Energy communities – Operators of objects with high peak consumption: congress centre, sport stadium – Operators of data centre – Operators of group of neigboring bulidings: academia campus
Business model in your city
– Working as a back-up source – Working as a system security – Working as a energy source during grid services – Crucial component of virtual power plant – Matching supply & demand
Technical barriers in your city
– How to connect it feasible to energy grid (up to system operator) – Space issues
Non-technical barriers (regulation/ legislation) in your city
– Lack of business model – Legislation framework – High costs

Electromobility hub: Adaptation needs (in relation to the analysed technology) for Krakow

Stakeholders to involve/ Local ecosystem in your city
– Power system operator (PSO) – Private companies providing services: delivery, installation of electric vehicle charging stations – Companies which can provide space for investment, e.g. shopping malls, business centers
Business model in your city
– Commercial investment, without the financial participation of the Municipality. Private company as an investor builds and maintains the HUB by itself and afterwards gains profits. – In case of building the HUB on the Municipality property it will be necessary to pay fees for the land use.
Technical barriers in your city
– Lack of available power connection capacity on PSO side – Long distance to potential connection points – Lack of suitable land for investement (the implementation of HUBs in city center is practically impossible due to the intense of buildings and historical character full of UNESCO areas and Cultural Parks. The suburbs are not very attractive to potential investors.
Non-technical barriers (regulation/ legislation) in your city
– Historical character of city (many buildings under the protection of the monument conservator) – No social acceptance , especially when the number of public parking spaces is reduced, due to the new investments

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District Heating – geothermal ring: Adaptation needs (in relation to the analysed technology) for Krakow

Stakeholders to involve/ Local ecosystem in your city
– Entrepreneurs – Developers – Associations of homeowners, cooperatives – Disctrict Heating Company
Business model in your city
Same business model as for the district heating. DH company builds, maintains and finances the investment and sells energy on this same terms as heat from DH grid. Residents pay for the consumption and the ordered power.
Technical barriers in your city
– Existing DH grid is adapted to high parameters – No space for ground water wells, borehole heat exchangers – Lack of available power connection capacity on PSO side needed by HPs
Non-technical barriers (regulation/ legislation) in your city
– Inaccurate national law – High costs

Electromobility hub: Adaptation needs (in relation to the analysed technology) for Matosinhos

Stakeholders to involve/ Local ecosystem in your city
– Municipality – E-Mob provider – DSO – PV provider
Business model in your city
Sharing as a service (low cost)
Technical barriers in your city
No major barriers identified
Non-technical barriers (regulation/ legislation) in your city
– Demand (create demand) – Localization – Availability – Cost of Service

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 864374.

Republica PV panels: Adaptation needs (in relation to the analysed technology) for Matosinhos

Stakeholders to involve/ Local ecosystem in your city
– DSO – Building owners – Investors
Business model in your city
– Energy Service; – Energy cooperative; – Third party financing; – Crowdfunding.
Technical barriers in your city
No major barriers
Non-technical barriers (regulation/ legislation) in your city
Legal issues if considering the creation of an energy community

District Heating – geothermal ring: Adaptation needs (in relation to the analysed technology) for Matosinhos

Stakeholders to involve/ Local ecosystem in your city
– Municipality – Building designers (engineers and architects) – National energy agency – Building contractors and promoters – Dwelling owners
Business model in your city
Energy Service
Technical barriers in your city
– Lack of experience with district heating/cooling networks; – Low energy demands for heating and cooling in the residential sector; – Large infrastructure.
Non-technical barriers (regulation/ legislation) in your city
– Lack of specific regulation; – End user engagement.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 864374.

Electromobility hub: Adaptation needs (in relation to the analysed technology) for Riga

Stakeholders to involve/ Local ecosystem in your city
Involved municipal departments: - City Development Department & Traffic Department – urban mobility planners, other involved in urban spatial planning - Riga Municipal public transport operator "Rīgas satiksme" – municipal public transport - Riga Digital Agency – data collection, processing and repository Government institutions: - Ministry of Transport of the Republic of Latvia; - Regulatory + policy makers/politicians (on local (municipal), regional, national levels)
Business model in your city
– To achieve the commitment to reduce the overall GHG emissions in Riga city by 70% by 2030 compared to 1991 and by 25% compared to 2019 *(source: Riga SECAP-2030)*, Riga City Municipality is taking decisive steps – among other, the municipality has made a strong political commitment to establish a low emission zone (LEZ) in Riga city centre (this idea stems from the data collection/analysis within the elaboration the new Riga SECAP-2030). Currently the municipal fleet of Riga City Municipality structures consists of over 2000 vehicles, of those 99.5% are fossil-fuelled cars (90% diesel, 8% gasoline, 2% LPG) and only 0.5% are e-cars. Also, the usage of the municipal transport fleet is highly inefficient – municipal structures do not share their vehicles, do not analyse the routes and possibilities of combining rides. Large part of municipal transport fleet has very low average daily mileages. – Our potential business model would be a municipal electromobility hub established by the municipality which primarily ensures smooth municipal transport services/operations and offers e-cars for rent to anyone when they are available (e.g., when the municipal offices are closed, during the weekends and public holidays) as well as supports social functions – e-cars could be used to provide seniors with basic social services, etc.
Technical barriers in your city
– The major barrier would be to find a suitable site for the electromobility hub in ATELIER pilot site or in close proximity to it, as this part of Riga city centre consists of its historical territories with no large municipal land plots available, with narrow streets infrastructure, also Riga Commercial Port is in a close proximity to ATELIER pilot site, making it challenging to adapt the infrastructure and plan strategically commuting to/from the port. – Infrastructure reconstruction projects are complex, and implementation takes a long time, which is connected with the complex structure of engineering networks under the streets of Riga, and not all historical constructions have been technically correctly documented in the past - it complicates large infrastructure reconstruction projects.
Non-technical barriers (regulation/ legislation) in your city
– **Administrative:** Land ownership issues in the focus area (ATELIER pilot site and neighbouring territories; – **Legal:** analysis of legal framework needed, possible need for amendments in municipal regulations, etc.

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Republica PV panels: Adaptation needs (in relation to the analysed technology) for Riga

Stakeholders to involve/ Local ecosystem in your city
– **Developer:** In the ATELIER pilot site, the developer could be large industry companies (e.g., National Energy Company «LATVENERGO», tet.lv or other) or Skanstes PED stakeholders (e.g., Entertainment Hall or Sports Centre). Energy Community (EC) principles could also be used to support the business model. – **Operators:** Same as developer – **Customers or users:** can use for their own needs, can sell to the network – **Financier:** Can raise some public funds and combine with own finance or use loans (one of the main challenges). – **Other affected stakeholders:** Local network operator
Business model in your city
– Due to steady rise of energy prices, payback period becomes considerably shorter(!). – Produced electricity could be used by producers or sold to the grid. In case when electricity is used by producer or EC participants, the savings could be bigger, its depends on the energy prices in the market. – EC model should be considered – slow forming process, as in Latvia establishment/operation of EC is at early stage. – The first investment could be a problem. National or municipal funds for such initiative are not available or not sufficient. External financing would be needed. – In July 2022, amendments were made to the Electricity Market Law with the aim of promoting public involvement in the production of electricity obtained from renewable energy resources. The law defines guidelines for adapting the existing net system to the needs of users and, in addition, for the introduction of a new net system, determining the production capacity reservation fee, building energy communities, as well as ensuring the safe use of connections and network operation. The detailed procedure for implementing the changes determined by the amendments to the law is still being developed by the responsible institutions.
Technical barriers in your city
– To connect a power station with a higher production capacity (up to 500 kW) the permission of the Ministry of Economy must first be obtained; – Due to the large demand for connecting power plants and increasing production capacity, a deficit of free distribution system capacities has currently developed in part of Latvia's territory; – Area have a potential of 943.18 kWh/year/kWpeak installed is obtained, with a tilt of 35º and azimut of 0 (this is OK).
Non-technical barriers (regulation/ legislation) in your city
– **Political:** The «Law on Energy Communities» will soon be approved and a series of changes to related laws will be made to promote RES production. – **Economical:** Technology prices are rising, lack of first capital, no specific loans available yet (lowest % etc.). – **Social:** No major barriers – **Environmental:** No – **Legal:** Renewable energy production has started in Riga, but there is still a lack of clear and comprehensible procedures at the administrative level. The city is working on it.

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District Heating – geothermal ring: Adaptation needs (in relation to the analysed technology) for Riga

Stakeholders to involve/ Local ecosystem in your city
– Riga Energy Agency – Riga Municipal District heating operator «Rīgas Siltums» – Institute of Physical Energetics (IPE) – the leading institute in Latvia in the field of energy research: i.e., energy efficiency energy-environment interactions – Riga Technical University (RTU) – one of the most advanced engineering study centres in the Baltics
Business model in your city
To be elaborated: there is a need to involve external expertise in defining the concept and the business model for geo thermal ring in Riga. Although the City of Riga is already piloting a few 4th generation District Heating (DH) pilot projects, their development, operation and management are however complex and Riga City Municipality together with its DH operator face several challenges (e.g., operation of 4th generation DH network in harsh winter weather conditions in Riga). The networks of the 4th generation DH are designed to work at lower temperatures and enable a more cost-effective transition away from burning fossil fuels towards heat supplied from local renewables. The 4th generation DH represents a smart city development concept: it provides a low-temperature distribution system that minimises heat loss, integrates energy storage and renewable energy sources, and supplies multiple low energy buildings.
Technical barriers in your city
According to geoDH map, there is no geothermal energy potential. But according to Eihmanis in Riga at around 500 meters depth from the surface 18-19ºC can be found, and at around 1000 m aquifers can be found with a temperature of ~30ºC (Eihmanis, 2000). Thus, although in principle there is not high geothermal potential, ground-source heat pumps could be interesting if these are economically feasible.
Non-technical barriers (regulation/ legislation) in your city
– **Political:** The «Law on Energy Communities» will soon be approved and a series of changes to related laws will be made to promote RES production. – **Economical:** Technology prices are rising, lack of first capital, no specific loans available yet (lowest % etc.). – **Social:** Elimination of energy powerty – **Environmental:** environmental impact assessment is needed – **Legal:** Renewable energy production has started in Riga, but there is still a lack of clear and comprehensible procedures at the administrative level. The city is working on it.

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Energy Management System (EMS): Adaptation needs (in relation to the analysed technology) for Riga

Stakeholders to involve/ Local ecosystem in your city
– **Developer:** If there was a demand, it could be a service provider. However, from a rational point of view, such a system would be most appropriate for a CDH service provider, making it usable by other producers as well, offering such a service. However, in order to make such a decision, Riga municipality can only motivate the CDH service provider. – **Operator:** it depends on developer – **Customers:** Energy consumers and/or producers. Depending on who would develop such a management system.
Business model in your city
– The business model in this case could be determined by whether it is developed by an external technology service provider or by a core CDH service provider. – The management system could be developed by focusing on services, thus expanding both savings and profit opportunities.
Technical barriers in your city
– Limited availability, quality and use of output data for decision-making and further monitoring; – Slow data exchange process (differences between data formats and management). – Data granularity varies from building to building. In the majority of buildings in Riga, energy consumption accounting is up to the building, it is not always possible to obtain hourly data, etc. buildings connected to CDH can apply for paid services, such as installation of allocators, etc. In general, obtaining detailed data is a challenge due to the existing infrastructure, which should be modernized. The pace of modernization is currently slow.
Non-technical barriers (regulation/ legislation) in your city
– 35% of heat energy consumption (in Riga) is made up of decentralized heat supply solutions in the city, for example, an individual gas boiler installed in the building (in the PED as well), it can impact data availability. – There is a lack of clear commitment and follow-up. Such a system could be the responsibility of the main CDH service provider.

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