ASCEND

State-of-the-Art Assessment of the Six Solution Packages

Deliverable D5.1

Project: Accelerate poSitive Clean ENergy Districts

Grant Agreement No.: 101096571

Deliverable No.: 5.1

WP: 5

Organization: USG

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Date: 16.04.2024

Status: v1

Version: v1

Dissemination level: Public

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Abstract

This state-of-the-art assessment is part of ASCEND's goal to foster replication as well as upscaling of PCEDs, as it aims to provide the project's internal and external stakeholders (e.g., project partners, city representatives, public sector consultants, urban planners, investors) with a common understanding of the existing elements, patterns, and best practices in relation to the project solution packages (SPs) towards the acceleration of Positive Clean Energy Districts (PCEDs). Its purpose is to give a comprehensive look at ASCEND's six SPs (Technologies & Digital Tools, Energy Communities & Prosumers, Energy-efficient Buildings, Decarbonized Mobility & Freight in public spaces, Citizen-centric Solutions, Urban Developer/Orchestrator), based on modern, innovative technologies and digital tools, funding mechanisms, procurement procedures, business models, as well as governance models and policies. Ultimately, the report's goal is to facilitate ASCEND's further development as it systematizes scientific and empirical data to support informed PCED-related decision-making.

Version History

Date	Person	Action	Status	Dissemination
2024-02-09	USG	First draft completed	Draft v.1	AIT & BUD
2024-02-12	AIT	Peer-review completed	Draft v.1	USG
2024-02-26	BUD	Peer-review completed	Draft v.1	USG
2024-03-27	USG	Integration of comments	Final draft	SPL & ODY
2024-04-05	ODY	Quality check	V.1	SPL
2024-04-16	SPL	Final review	V.1	CINEA

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Project Partners

Partners	Country	Abbreviation
SPL LYON CONFLUENCE	FR	SPL
METROPOLE DE LYON	FR	GLY
COMMUNE DE LYON	FR	LYS
HESPUL ASSOCIATION	FR	HES
URBAN PRACTICES	FR	UP
ENERTECH	FR	ETC
LANDESHAUPTSTADT MUNCHEN	DE	LHM
STADTWERKE MUENCHEN GMBH	DE	SWM
MUENCHNER GESELLSCHAFT FUER STADTERNEUERUNG MBH	DE	MGS
GWG Gemeinnützige Wohnstätten- und Siedlungsgesellschaft mbH	DE	GWG
UNICCORN GMBH	DE	UNC
TECHNISCHE UNIVERSITAET MUENCHEN	DE	TUM
ISARWATT EG	DE	IW
AVANCIS GMBH	DE	AVC
SPECTRUM MOBIL GMBH	DE	STA
UNTERNEHMERTUM GMBH	DE	UTUM
MUNICIPALITY OF ALBA IULIA	RO	AIM
VILLE DE CHARLEROI	BE	CHA
IGRETEC	BE	IGC
AGÊNCIA DE ENERGIA DO PORTO	PT	PEN
EMPRESA DE AGUAS E ENERGIADO MUNICIPIO DO PORTO EM	PT	AEP
FUNDACAO DE SERRALVES	PT	SRV
ASSOCIACAO PORTO DIGITAL	PT	APD
CESKE VYSOKE UCENI TECHNICKE V PRAZE	CZ	CVUT
OPERATOR ICT AS	CZ	OICT
PRAZSKA DEVELOPERSKA SPOLECNOST	CZ	PDS
BUDAPEST FOVAROS ONKORMANYZATA	HU	BUD
BKK BUDAPESTI KOZLEKEDESI KOZPONT ZARTKORUEN MUKODO RESZVENYTARSASAG	HU	BKK
ENERGY CITIES	BE	ENC
STOCKHOLMS STAD	SE	STK
AIT AUSTRIAN INSTITUTE OF TECHNOLOGY GMBH	AT	AIT
FUNDACION CARTIF	ES	CAR
UNIVERSITE DU LUXEMBOURG	LU	UoL
BLUE-SIGHT CONSEIL	FR	BLS
DATEN-KOMPETENZZENTRUM STÄDTE UND REGIONEN GMBH	DE	DKSR
CIVIESCO SRL	IT	CIV
TWENTY COMMUNICATIONS SRO	SK	TWE
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List of Acronyms

Acronym	Description
CD	Cockpits and Dashboards
CCPR	Concession contracts with private companies
CCPU	Concession contracts with public companies
CDP	Competitive dialogue procedure
CEC	Citizen Energy Communities
CM	City Mission
CPN	Competitive procedure with negotiation
D_Rev_ADV	Third-party Advertising
D_Rev_DM	Data Monetization
D_Rev_SM	Subscription Model
D_Rev_UF	Usage Fee
D_Sav_PO	Process optimization savings
DC	Design contest
DEG	Distributed Energy Generation
DT	Digital Twins
E_Rev_ET	Energy trading
E_Rev_P2P	Peer-to-peer trading
E_Rev_SF	Service fee
E_Rev_SG	Services to the grid
E_Sav_EX	Excess of energy injected into the grid
E_Sav_RC	Reduced or no consumption
E_Sav_SC	Self-consumption
EPC	Energy Performance Contracting
ESCOs	Energy Services Companies
G	Gamification
IBS	ICT-based services
IP	Innovation partnership
LHC	Lighthouse City
M_Rev_ADV	Third-party Advertising
M_Rev_SM	Subscription Model
M_Rev_UF	Usage Fee
MO	Management and Optimization (with AI)
MC	Multiplier City
NCP	Neighborhood Coordination Platform
PCED	Positive and Clean Energy District
PCP	Online platforms for citizen participation
PCS	Public charging systems for EV

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PreCP	Pre-commercial procurement
REC	Renewable Energy Communities
RFP / RFI	Requests for Proposals / Requests for Information
SGT	Smart Grid Technologies
SP	Solution Package
SPV	Special Purpose Vehicle
UDP	Urban Data Platforms
UP	Unsolicited Proposals
VPP	Virtual Power Plant
WC	Web of Contracts

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1. Executive Summary

The current global climate and energy crisis require a profound energy transition across Europe. Positive Clean Energy Districts (PCEDs) will play a significant role in achieving net zero objectives by **implementing and scaling up state-of-the-art solutions and technologies**. In this context, ASCEND (Accelerate poSitive Clean ENergy Districts) aims at creating PCEDs and turning them into a default solution in European cities to mitigate the effects of climate change and enable citizens to live in inclusive, resilient, and smart communities.

This state-of-the-art assessment is part of ASCEND's goal, as it aims to provide the project's internal and external stakeholders (i.e. project partners, city representatives, public sector consultants, urban planners, investors) with a common understanding of the existing elements, patterns, and best practices in relation to the project solution packages (SPs). Its purpose is to give a comprehensive look at ASCEND's six solution packages (SPs), based on modern, innovative **technologies and digital tools, funding mechanisms, procurement procedures, governance models and policies, and business models**. Ultimately, the report's goal is to facilitate ASCEND's further development as it systematizes scientific and empirical data to support **informed decision-making for Positive Clean Energy Districts (PCED)**.

The report's structure considers the business model analysis as an umbrella concept, since all its aspects come into play when assessing the long-term sustainability and upscaling strategies behind each PCED solution. The research methodology combines a systematic literature review with semi-structured interviews with experts from ASCEND's partner cities, namely **two Lighthouse Cities (Munich and Lyon)** and **six Multiplier Cities (Prague, Porto, Budapest, Alba Iulia, Stockholm, Charleroi)** to capture the state-of-the-art of ASCENDs six SPs:

- **SP1:** Technologies & Digital Tools
- **SP2:** Energy Communities & Prosumers
- **SP3:** Energy-efficient Buildings
- **SP4:** Mobility & Freight
- **SP5:** Citizen-centric Solutions
- **SP6:** Urban Developer/Orchestrator

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Figure 1: ASCEND Lighthouse Cities and Multiplier Cities

At this stage of the project, the interviews carried out with Lighthouse Cities (LHCs) and Multiplier Cities (MCs) provided still limited information about the funding mechanisms explored by the cities to fund and scale up their solutions. The current approaches amongst ASCEND cities are heterogeneous in project maturity and depth in financial analysis expertise. While some are at an early stage of development and do not have a clear analysis of the financial parameters to be able to quantify the whole need of capital or their financing strategy, other initiatives seem to strongly rely on the city budget and grants. A few of them expressed the goal to leverage and attract private investments to scale up their current projects, but they had experience mainly with grants so far. Part of the initiatives, mainly focused on energy efficiency renovation of buildings, relies on the capability of private individuals/entities to privately fund the investment which is only partially supported by National grant schemes in a few cases.

When comparing the interview results with the business model approach employed, based on the St. Gallen Business Model Navigator (see Figure 2), cities' main focus seems to be on the **value proposition** and **target customer aspects**, rather than on how they can **deliver and capture this value** from the perspective of **financial sustainability and diversification to fulfil their upscaling potential**.

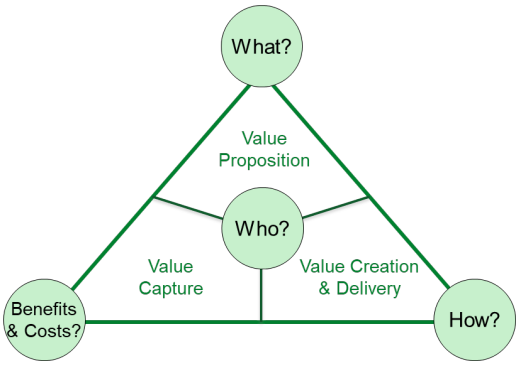

Figure 2: Magic Triangle by Gassmann et al. (2020)

Among the key findings of this study are:

- **Most of the solutions require a broker, an intermediary** capable of connecting the dots, facilitating access to the service, and combining different public funding sources.
- Regulation and permitting are the main barriers.
- **PCED and its portfolio of interventions look increasingly like a service model,** where an orchestrator organises and combines the different actors of the value chain and the different fundings to provide and guarantee a service.
- Data is a key lever and essential to plan and evaluate PCEDs.
- However, **digital transformation at the municipality level seems to lag** and is not being addressed accordingly. Solutions like Digital Twins or serial refurbishment requiring 3D models face barriers due to the end-user resistance to embrace these tools.
- **A certain reluctance is strangely coming from the digital aspect of the PCEDs**. Governance is very well established, but cities seem to be very shy to envision the adoption of a more distributed or open-source approach (opening the platform to a community of developers) or to allow for instance credits for citizens to build applications or projects.
- **Most of the solutions lack substantial elements and data to scale.** They are designed and managed to satisfy pilots of a specific size but are not scalable by design. There is a lack of basic data to understand and build business models, creating financing schemes that can

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support and enable growth. City strategies often pile up grand designs and objectives without addressing the conditions (human, competencies, organisation, finances, resources, ecosystem capability) to scale them.

Finally, this state-of-the-art report will inform ASCEND's next activities in supporting cities in reaching a higher projects' maturity with the view to **upscale their current initiatives towards accelerating PCEDs.** This will be possible only if the technical development is supported by enhanced **financial and risk assessment expertise** and acknowledgement of **non-monetary benefits** triggered by the implementation of PCED.

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2. Introduction

2.1 Aim of the report

This report provides a comprehensive overview of the state-of-the-art regarding ASCEND's six SPs. It goes beyond a detailed account of the *status quo* of the ASCEND partner cities, which has been covered in other works (see D2.1 and D3.1). Instead, it focuses on the state-of-the-art, defined as **"very modern and using the latest ideas and methods"** (Cambridge Dictionary, 2023). The report aims to equip both internal project stakeholders and external bodies such as city representatives, public sector consultants, and investors with a common understanding of the state-of-the-art in relation to the SP. This is crucial for further development within the ASCEND project and for informed decision-making processes along the construction of Positive Clean Energy Districts (PCEDs). Within the ASCEND project, the six SPs aim to cover different aspects throughout the **entire lifecycle** of the district that need to be considered for the **replication of the PCED model**. This document presents an analysis of these SPs from **five standpoints** (technologies and digital tools, funding mechanisms, procurement procedures – incl. PPPs and SPV, governance models and policies, business models), adding additional analytical layers to the study.

2.2 Scope and structure

As this report settles for the assessment of the state-of-the art of ASCEND's six SPs, evaluated from different standpoints, the following section aims to clarify the notion of a SP. Moreover, the five standpoints that served as a guiding framework for the assessment are introduced, followed by an overview of the structure of the report.

2.2.1 Solution package as a unit of analysis

A SP is defined as a **bundle of different solutions** that fall under a certain topic area like digital infrastructures and ICT (Information and Communication Technology) tools or mobility and freight. ASCEND's six SPs embody the **essential pillars of a PCED**. Moreover, they can be separated into **"enabling"** and **"use-case-centered" SPs**. Figure 3 visually reflects this distinction, where SP1 (Digital Infrastructures) and SP6 (Urban Orchestrator) can be viewed as "enabling" solution packages because they include solutions that function as tools enabling the establishment and operation of a PCED. On the other hand, SP2, SP3, SP4 and (partially) SP5 have a more use-case-centered character. They include concrete mobility, energy community, refurbishment, and citizen-centered solutions, for example, that can be implemented in a district.

This distinction of ASCEND's SPs has implications for the present state-of-the-art analysis. When it comes to assessing the SPs from different standpoints (e.g., a technological or business model standpoint), the extent of the results yielded from the analysis can vary. Since SP1 and SP6 include mostly enabling tools for other SPs, the concept of business models may have different applications than the "use-case-centered" SPs in terms of how value can be created, delivered, and captured out of the solutions and their use cases.

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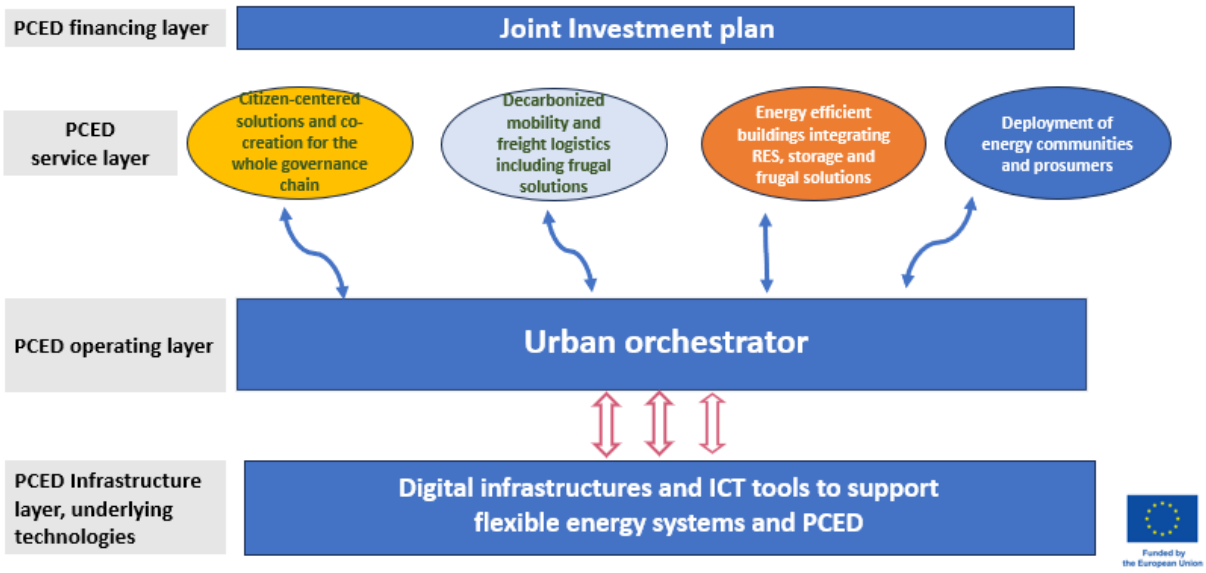

Figure 3: PCED layers and their respective solutions

2.2.2 Five standpoints to guide the assessment of the solution packages

The assessment of the state-of-the-art of the six SPs was carried out based on the following five standpoints:

1) Technologies and digital tools
2) Funding mechanisms
3) Procurement procedures, incl. PPPs and SPV
4) Governance models and policies
5) Business models

Together, these standpoints allow to assess the central elements that characterise the diverse solutions bundled in the SPs. Moreover, the five standpoints are the main source of scaling barriers and drivers. The five standpoints used as guiding factors for the state-of-the-art assessment differ in character and relevance for the respective ASCEND SPs. In this regard, standpoint 5 (business model) plays a special role. Considering the definition of business models followed in this report and outlined in section 3.1, **business models combine and connect the other four standpoints**. Thus, the business model standpoint serves as an umbrella concept, whereas the standpoints 1, 2, 3, and 4 can be seen as components of business models. This is why after an overview on the general findings for each standpoint (see section 4), this report uses the business model concept as a guiding framework to summarize the findings that the state-of-the-art assessment of the six SPs produced with regards to the other four standpoints (see section 5).

2.2.3 The structure of the report follows the six solution packages

The remaining part of this report (sections 3 - 6) is structured as follows:

Section 3: Definitions and methodologies for the state-of-the-art assessment.

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Section 4: Detailed analysis of the five standpoints, identifying key patterns and examples relevant to PCEDs.

Section 5: In-depth examination of the state-of-the art of each SP, using the business model concept as a guiding framework to summarize the results. This includes the integration of identified state-of-the-art technological, funding, procurement, and governance patterns outlined in section 4 with SP-specific business models and state-of-the-art examples from ASCEND cities. In addition, a baseline assessment of the SPs cost-effectiveness and scaling drivers and barriers that were identified through the process are presented.

Section 6: Reflections on key findings, lessons learned and outlook into the next steps of ASCEND based on the state-of-the-art assessment.

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3. Definitions and methodology

Definition: Business model

A business model depicts **how organizations,** whether they are private companies or public entities like cities, **create, deliver, and capture value.** This value can be **economic, social, or environmental** (Teece, 2010; Gassmann et al., 2019; Geissdoerfer et al. 2018; Giourka et al., 2019). In this document, we use the term "business model" for **both private and public organizations**. For public organizations, a business model is mainly about how they provide **public services** and how these services are paid for. It includes a variety of elements such as the technology used, the way products and services are bought (procurement), how the services are funded, how operating models are defined (procurement/concession/internal exploitation, performance contract, outsourcing to external organisations, direct implementation by the cities etc.), the rules and policies they follow, and how they are organized. Therefore, the business model concept helps them in **delivering valuable public services effectively and efficiently** (Maktabifard et al. 2023; Loan Market Association, 2018; Net Zero Cities, 2022; Oker-Blom, 2023).

Definition: Cost-effectiveness

Cost-effectiveness is a measure used to evaluate **how efficient an intervention or project is in achieving its objectives compared to the resources employed or the costs incurred to realize it** (Net Zero Cities, 2020). In essence, cost-effectiveness seeks to answer the question: **"Do we achieve the best possible results with the resources at our disposal?"** It means assessing whether the implementation of clean and sustainable energy solutions in the neighbourhood (such as installing solar panels or sustainable mobility systems) makes an efficient use of resources, i.e., whether the benefits obtained outweigh the costs incurred.

Cost-effectiveness must be considered from the outset in the design of business models within ASCEND. This involves understanding how project actions and interventions will influence costs and benefits over time and how these will impact the overall business model's efficiency. The cost-effectiveness analysis can help identify opportunities to make the business model more efficient and sustainable.

However, it is important to highlight that, in the context of ASCEND, PCED Cost Effectiveness is not related to the cost effectiveness of only one solution but to a portfolio of coordinated solutions, deployed by various stakeholders. It's a **systemic approach, where technologies, behavioural and financial aspects should be paired,** and it is **challenging to measure** as several factors need to be considered. Who is paying what and who can reap the rewards between:

- Inhabitants, owners, tenants, worker, tourists
- Public authorities, local and national governments who frequently subsidize stakeholders by various means
- Investors (large or small, real estate developers, energy or district heating which rarely reach sound return on investment.

Usually, a cost effective PCED is considered as a **just and fair PCED prioritising local inhabitants, tenants and owners** through different subsidies and incentives. But it's only one side of the coin: in fact, it is also necessary to consider the perspective of the **supply side** (investors, energy companies, techno providers) and build a **sound business case** in order not to decrease PCEDs cost effectiveness for the whole society and become heavily dependent on public funds and grants. Indeed, the actors who are the most capable of scaling PCEDs are struggling to find an economic return.

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Thus, cost effectiveness definition should not only be: “Do we achieve the best possible results with the resources at our disposal?" But **"Do we orchestrate the different stakeholders efficiently with the right amount of public funding at our disposal, triggering more private investments of different levels (inhabitants, private players) so what we have done not only outweigh the costs but is sustainable and scalable?"** (Becchio et al., 2018; Kalaycıoğlu and Yılmaz, 2017; Tuominen et al. 2015)

Methodology:

For the purpose of this report, a combination of **qualitative research methods** was deployed to collect both **primary and secondary data**. Secondary data was collected through a review of relevant scientific and grey literature on business models for smart cities, particularly positive energy districts. The databases employed were Web of Science and Google Scholar, using the following keywords:

"business model”, “public model”, "sustainable business model", in combination with “digit”, “energy community”, “tenant energy”, “energy sharing”, “energy efficient building”, “energy efficient renovation”, “energy efficient refurbishment”, “energy efficient construction”, “sustainable mobility”, “sustainable freight”, “green mobility”, “green freight”, “citizen participation”, “citizen cent*”, “urban orchestrator” + "interviews with city representatives", "smart city", "positive energy district"*

From the initial search results, 62 sources proved relevant for further analysis, of which 50 are referenced in the text of the present report. The insights generated through this analysis allowed to complement the findings of the primary data collection and were clustered along the five standpoints used for this assessment, namely technologies and digital tools, business models, funding mechanisms, procurement, governance and policies. Specifically, they represented a **broader perspective** on the topic and produced a more general overview of the state-of-the-art of the six solution packages.

To complement these overall findings, **primary data** on the state-of-the-art of ASCEND’s six solution packages was collected among the project’s partner cities. Initially, a **questionnaire template** (see Annex) was sent to the city experts, so they could describe solutions implemented in their cities that can be considered state-of-the-art. This template included questions covering each of the five standpoints, namely technologies and digital tools, funding mechanisms, procurement, governance and policies, business models, as well as general questions along with questions on scaling. These questions were included to derive solution descriptions and identify scaling drivers and barriers. In total, information on **18 state-of-the-art concrete solutions** could be collected. Table 1 (below) provides an overview of the solutions studied throughout this process.

After receiving the completed questionnaires, **in-depth semi-structured video interviews** were conducted with the respective city experts to validate and clarify the questionnaire responses in more detail. All video interviews were recorded and transcribed. Together with the template responses, they were used as the basis for **one-page write-ups** for each of the solutions (see Annex), which were then reviewed by both the ASCEND team working on the state-of-the-art assessment and the city experts. This step supported the subsequent data analysis since it allowed to ensure that the most relevant pieces of information were extracted from the interviews.

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	Munich	Lyon	Multiplier City
SP1	Digital Twin	CMS Urban Data Platform	**Prague:** Urban data platform (Golemio)
SP2	Photovoltaics Tenant Electricity Project	YDEAL Confluence	**Porto:** Asprela + Sustentável
SP3	Refurbishment with prefabricated elements	Super-efficient buildings	**Budapest:** Heat exchanger with potable water
SP4	Mobility Points	Micro hub	**Alba Iulia:** Car charging infrastructure
SP5	Climate Council	Building Operating System (BOS)	**Stockholm:** Scaling Smart City Solutions
SP6	Integrated Neighbourhood Approach	SPL Lyon Confluence	**Charleroi:** Igretec

Table 1: PCED solutions according to ASCEND's solution packages

In sum, combining primary and secondary data analysis approaches allowed to produce a **comprehensive overview on the state-of-the-art of ASCEND's six solution packages** with regards to the **technologies and digital tools, funding mechanisms, procurement, governance models and policies, and business models** employed. While the data gathered through the systematic literature provided an overview and allowed to extract general findings on the state-of-the-art beyond ASCEND's partner cities, including concrete solution examples from the eight partner cities enabled to illustrate how state of the art solutions can be implemented in practice in different contexts, and visualize opportunities and challenges ahead. Figure 4 provides a visual representation of the research methodology adopted for this report as it summarizes the most relevant steps of both the secondary and primary data analysis conducted.

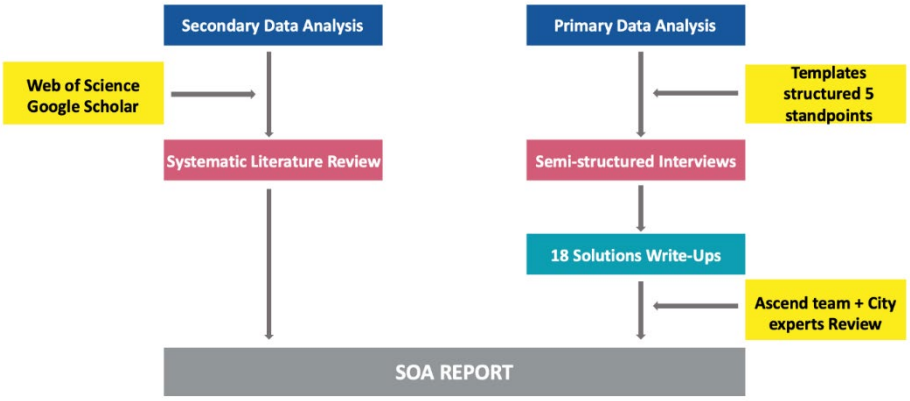

Figure 4: Methodological approach

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4. General state-of-the-art overview

In this section, the five standpoints employed for the assessment of the six solution packages will be presented in more detail. In this regard, the results of literature reviews and expert interviews allowed to identify the **most prominent examples** when it comes to existing **technologies and digital tools (standpoint 1), funding mechanisms (standpoint 2), procurement procedures (standpoint 3), and governance models and policies (standpoint 4)** in the context of PCEDs. These state-of-the-art examples are hereafter referred to as patterns because they were found to reoccur and play an important role in several of ASCEND's SPs.

Importantly, as **business models (standpoint 5)** are used as an **umbrella concept** that **combines the different patterns of the other standpoints**, we followed a slightly different approach in this regard. In the context of PCEDs, a lot of different value propositions and business model configurations are possible. When it comes to digital tools or procurement procedures, for example, it is useful for decision-makers to have an overview of the most prominent examples. However, with the business model concept, the value lies in its flexibility to account for very different configurations of value creation, delivery, and capture mechanisms. Consequently, we decided against unsystematically listing different business model patterns in this section. Instead, we present a short outline of relevant scientific articles regarding the business models for PCEDs as well as on the broader smart city context and provide concrete examples of state-of-the-art business models in section 5.

4.1 Overview of state-of-the-art technologies and digital tools including risk assessment in terms of technical and operational capability

Technology and digital tools play a crucial role in the implementation of a PCED. Due to technological advances in recent years, several different technologies and tools have emerged that can be used by city representatives and decision-makers who want to implement a PCED. The following table (Table 2) summarizes the state-of-the-art technologies and digital tools that are most relevant in the context of PCEDs based on the analysis conducted for this report.

Technologies & digital tools		
Model	**Acronym**	**Description**
Urban Data Platforms	UDP	Digital infrastructure designed to collect, manage, and analyse data related to urban environments and cities. These platforms leverage technology, data analytics and connectivity to generate insights into different aspects of urban life, processes, and services. The data can come from different sources and encompass information on energy consumption, demand, generation, as well as demographics and more.
Cockpits and Dashboards	CD	Interactive dashboards, maps, and visual representations of urban data can be used in PCED to make information more accessible to policymakers, city planners, and the public.

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Digital Twins	DT	Virtual representation of a physical object, process, or system that uses data, machine learning and analysis to simulate its behaviour, and can be updated in real-time as the physical object or system changes. It allows for testing new measures and technologies before implementation and can provide a better overview of information. When applied to PCED, digital twins can be used to support different use cases in planning, management, and monitoring.
Management and Optimization (with AI)	MO	Advanced analytics tools that leverage on modelling, machine learning algorithms, and AI can help identify patterns and relationships to serve as basis for planning. They may also incorporate predictive analytics to forecast urban trends, challenges, and opportunities.
Smart Grid Technologies	SGT	Smart grid technologies, including advanced metering, real-time monitoring, and control systems, enable energy communities to optimize energy use, manage demand, and balance supply and demand efficiently.
Gamification	G	Introduction of gaming elements to induce motivation and behaviour change. For example, development of gamified applications that challenge users to reduce energy consumption. Users can compete with neighbours, earn points, or receive rewards for achieving energy-saving goals.
ICT-based services	IBS	Can be used to deliver services or have a direct communication point to citizens through online platforms. Some emerging applications include smart grids, smart homes, building automation, remote device controlling etc.
Online platforms for citizen participation	PCP	Social applications and online platforms can act as channels for directly engaging citizens and for e.g. elective representatives or other policy makers. Citizens can then share their thoughts and ideas, request services, file reports etc.

Table 2: Technologies and digital tools

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4.1.1 Risk assessment in terms of technical and operational capability

While technologies and digital tools can greatly support the realization of PCEDs, their implementation is associated with different risks. On the one hand, these risks can influence the choice of the most suitable technologies and digital tools in the first place. However, the respective risks also need to be managed throughout the PCED operation itself. To lay a foundation for city representatives and decision-makers, Table 3 assesses what types of risk need to be considered and managed for the respective technologies and digital tools outlined above. Specifically, seven different types of risks are presented and allocated to the state-of-the-art technologies and digital tools:

Risks for each solution:	Data availability/ Data access	Hardware dependence (e.g., sensors)	Vendor lock-in (e.g., by entering contracts with service providers)	Inter-operability limitations	Competencies and skills (e.g., in city team)	Ethical concerns (e.g., AI-based decision-making)	Data quality
Urban Data Platforms	x		x	x	x		
Cockpits and Dashboards	x	x	x	x	x		x
Digital Twins	x	x	x	x	x		x
Energy Management and optimisation	x	x	x	x	x	x	x
Smart grid technologies		x		x	x	x	
Gamification	x				x	x	x
ICT-based services	x	x	x	x	x	x	x
Online platforms for citizen participation	x				x		x

Table 3: Risk Assessment – Technologies and Digital Tools

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4.2 Overview of state-of-the-art funding mechanisms and monetization strategies

The implementation of individual or combined SPs in city districts can be accompanied by economic benefits for the project promoter, represented by the city or other potential actor. **Regardless of the not-for-profit or for-profit nature of the project promoter, direct or indirect economic effects exist** and could be represented:

- By an **increased or new revenue stream** generated by the assets or services produced by the SPs; or
- By **cost savings** decreasing the promoter's operating costs of the implemented activities compared to the previous scenario without SPs (e.g., savings coming from optimized internal processes, more efficient use of money, etc.).

For this report, both effects are considered as monetization strategies applicable to SPs and can include a large variety of economic items depending on the projects' characteristics. Based on the interviews carried out with ASCEND cities and the desk research focused mainly on the outcomes of other EU funded Smart Cities projects, a list of monetization strategy categories is defined in the following table (Table 4). The table includes the monetization strategy related to i) the energy assets included in the SP (highlighted in purple); ii) the digital tools supporting the SP (highlighted in yellow) and iii) the mobility assets involved in the SP (highlighted in grey). An acronym was allocated to each category to recall them easily in the following paragraphs focused on the existing business models for each SP (see section 5).

Revenues streams		
Model	**Acronym**	**Description**
Energy trading	E_Rev_ET	Capability to participate in the energy market. Management of energy assets with the view to exploit energy trading opportunities.
Services to the grid	E_Rev_SG	Capability and availability to provide services locally to the grid operator.
Peer-to-peer trading	E_Rev_P2P	The excess of locally produced energy is sold amongst peers of the neighbourhood. Potential revenues for the prosumer depend on the contract in place.
Service fee	E_Rev_SF	A third-party contractor owns the energy asset (i.e., production, storage, distribution), and consumers pay a fee for the received service.
Subscription Model	D_Rev_SM	The urban data platform manager sells an "all-you-can-eat" subscription for services provided via the platform. It can be a fixed fee irrespective of the level of usage.
Usage Fee	D_Rev_UF	The urban data platform manager receives a fee from users in the form of pay-as-you-go payment.
Data Monetization	D_Rev_DM	The urban data platform manager and/or the service providers exploiting the platform sell captured data to companies for marketing purposes or other usage.

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Third-party Advertising	D_Rev_ADV	In case the digital service provider is a public body, they can receive revenues by selling advertising on public asset space in exchange for the provided digital services.
Subscription Model	M_Rev_SM	The owner / manager of the shared mobility assets (charging points, e-cars, e-bikes, e-scooters, etc.) sells an “all-you-can-eat" subscription for the use of their assets. It can be in addition to a usage fee mode.
Usage Fee	M_Rev_UF	The owner / manager of the shared mobility assets (charging points, e-cars, e-bikes, e-scooters, etc.) receives a fee by users in the form of pay-as-you-go payment for each of their assets. It can be correlated to the time of usage or km travelled.
Third-party Advertising	M_Rev_ADV	The owner / manager of the shared mobility assets (charging points, e-cars, e-bikes, e-scooters, etc.) can sell advertising spaces on their own assets.
Cost savings		
Self-consumption	E_Sav_SC	The installed energy assets owned by the promoter allow to withdraw a decreased volume of energy from the national grid, prioritizing their own self-consumption onsite.
Reduced or no consumption	E_Sav_RC	Energy efficiency measures including remote control of energy assets and improvements in thermal insulation of buildings can drastically reduce energy consumption.
Excess of energy injected into the grid	E_Sav_EX	In the framework of certain Feed-In-Tarif mechanisms, the energy supplier recognises a reimbursement or saving on the energy bill calculated on the quantity of excess energy injected into the grid.
Process optimization savings	D_Sav_PO	The services provided via the platform generate savings linked to an enhanced performance of internal processes, i.e., based on an increased availability of data, shared collaborative tools, etc.

Table 4: Funding Mechanisms and Monetization Strategies

4.3 Overview of state-of-the-art procurement procedures

Given the deep and rapid challenges that cities are increasingly facing, and the fact that many of the potential solutions are being delivered or supported by digital technologies (G20_Report, 2021), new public procurement approaches are needed. This is the case because **traditional purchasing practices and complex procurement rules are often not suited to the purchase of innovative technologies and services**. By using effective procurement procedures, public authorities can accelerate the market introduction and upscaling of novel solutions that address today’s environmental and climate challenges (e.g., energy, mobility, transport, climate adaptation and mitigation). Moreover, this can help innovative suppliers to increase the technological readiness of their solutions. The following patterns of innovative procurement approaches were found through the review of scientific literature and case descriptions provided by other EU-funded project deliverables and ASCEND consortium partners.

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According to the Smart_Cities_Marketplace (2023) report, "**public procurement refers to the process by which public authorities purchase goods, works or services**." (p. 5) The same report mentions that in the EU alone, purchases via public procurement represent around 14% of GDP and have an annual value of approximately €2 trillion, thus making it a powerful tool for boosting jobs, stimulating growth and investment as well as supporting innovation, resource and energy efficiency, along with social inclusion.

As Manika (2020) indicates, the revised European procurement rules of 2014 have highlighted the crucial role of innovation as an important factor for smart, sustainable, and inclusive growth. Moreover, the revised rules have broadened the possibility of public procurers to purchase innovation, meaning (i) attracting innovative suppliers in the procurement process, (ii) purchasing innovative products, and (iii) adopting innovative methods in the tender process itself. Thus, it allows developing the **flexibility to experiment**, and the **ability to re-invent public-private partnerships**. Despite the proven benefits of innovative procurement, public authorities, driven mainly by a risk-averse behaviour (i.e., following traditional tender procedures under solely budgetary considerations), have hesitated to introduce innovation, mainly due to their lack of expertise and knowledge of innovative procurement processes (G20_Report, 2021; Manika, 2020). To illustrate the variety of procurement procedures that exist and are potentially relevant for the realization of PCEDs, Table 5 provides an overview of the most prominent patterns identified through the literature review.

Procurement procedures		
Model	**Acronym**	**Description**
Requests for Proposals / Requests for Information	RFP / RFI	Traditional procurement procedures that outline solution requirements and budget (RFP) or gather input on what the industry can offer in a particular area (RFI). One-way process with focus on individual city challenges (Folliot-Lalliot & McKeen, 2019).
Concession contracts with public companies	CCPU	Local authorities create local public development companies, of which they hold the entire capital, authorized to carry out any development operation exclusively on behalf of their shareholders and on their territory under SPLAs (Local Public Development Companies) (Folliot-Lalliot & McKeen, 2019).
Concession contracts with private companies	CCPR	Local authorities develop a special development concession as an umbrella contract granting the management of a whole town project to a private investor. The development concession is a public contract by which a public authority entrusts to a private developer with the carrying out of development operations (Folliot-Lalliot & McKeen, 2019).
Unsolicited proposals	UP	As local governments are particularly courted by start-ups and innovative companies looking for new markets and sources of data, these companies may actively approach them with proposals.
Web of Contracts	WC	The realization of PCED projects may require a web of contracts, with one main operator in charge of the whole project along with several subcontracts and related contracts with companies, including startups as well as energy providers. Moreover, other contracts signed with

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		groups of citizens/users involved in local services may be necessary. All these contracts need to be coordinated and monitored.
Competitive dialogue procedure	CDP	A two-phase tender procedure (dialogue phase and bidding phase) that allows a controlled interaction between the public purchaser and the bidders. Firstly, the public authority set out its needs and requirements in the contract notice. In the dialogue phase, the public authority may discuss all aspects of the contract with the bidders, including the economic conditions, and will continue the dialogue until it can identify the solutions which can meet its needs. When the dialogue phase is over, the bidders will submit their final tenders based on the solutions presented and specified during the dialogue phase (European Commission, 2020).
Competitive procedure with negotiation	CPN	A procedure under which public authorities, following the advertisement of the contract opportunity, enter into a negotiation with the shortlisted bidders who may be invited by the public authority to submit their initial tenders. The initial and all subsequent tenders submitted by shortlisted bidders will be the basis for negotiations with the public authority. This procedure may take place in successive stages to reduce the number of tenders to be negotiated by applying the award criteria specified in the contract notice. At the end of the negotiations, the public authority will ask the remaining tenderers to set a common deadline to submit any new or revised tenders (European Commission, 2020).
Innovation partnership	IP	This procedure combines the procurement of research and development with the subsequent acquisition of the resulting supplies, services or works in a single contract. During this procedure, public authorities can negotiate with the suppliers/service providers to jointly identify the most promising way to set up the research and development endeavour. The procedure starts with the selection of suitable partners to research and develop a new solution and ends with the selection of the partner that will provide the final solution (European Commission, 2020).
Pre-commercial procurement	PreCP	The PCP method is applied when, following market consultation, the public buyer concludes that there is no solution available in the market to satisfy the city's needs. PCP consists of procuring research and development (R&D) services with several suppliers before commercialization and may include the development of prototypes or limited volumes of first products or services in the form of a test series (European Commission, 2020).
Design contest	DC	This procedure is mostly used in the fields of town and country planning, architecture and engineering or data processing. It allows competition for the selection of a plan or design by a jury that judges the designs submitted. The outcome of the procedure may be the award of the design contract, prizes, or both (European Commission, 2020).

Table 5: Procurement Procedures

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4.4 Overview of state-of-the-art governance models and policies

Developing PCEDs also requires a paradigm shift and profound changes in current governance practices towards a more systemic and interconnected approach. One of the key challenges to achieve such systemic changes is **overcoming the gap between technological progress**, in terms of innovative technologies and solutions already available on the market, **and the capacity of city administrations to adopt and mainstream these solutions**.

The Scalable Cities Task Group on Replication defines governance as "**the framework of rules, procedures, roles and responsibilities that constitute decision-making processes and project management**", both at the level of individual projects and at the level of the municipal organisation (Borsboom-van Beurden et al., 2023, p.4). For years, governance changes were expected to happen as a by-product of other activities, but isolated and individual projects, disconnected from key actors and decision makers in the city, cannot effectively contribute to systemic changes in governance.

As Einstein already remarked, “problems cannot be solved with the same mindset that created them”. Complex systems such as cities cannot be changed by following the same rules that created them. As such, despite the uniqueness of local situations and contexts, specific barriers and obstacles pertinent to climate-neutrality trajectories in cities are quite common, and point to six broad categories of relevant aspects of smart city-oriented governance (Borsboom-van Beurden et al., 2023):

1) Adopting a **long-term strategic city vision**, to promote long-term territorial transformation planning, and to pilot smart city solutions.
2) Transforming **municipal organisations** – from a silo-approach towards strategies to deal with complex and cross-cutting issues through multidisciplinary teams for climate-neutral transitions.
3) Ensuring **participation, co-creation** with stakeholders and **citizen-driven innovation**.
4) Establishing **collaborations between public and private stakeholders**, securing suitable business models, finance, and procurement.
5) Adjusting **regulatory frameworks** to current needs.
6) Creating a **learning environment** within and between cities to boost organisational transformation and systemic change.

This section provides an overview of the state-of-the-art governance models and policies in the PCED context. Specifically, three different models of governance for a PCED are outlined in Table 6 that are particularly relevant in the context of PCEDs:

Governance models		
Model	**Acronym**	**Description**
City Mission	CM	The city coordinates the deployment of a PCED. The format can vary. A single department can work across projects and departments with a sustainability vision. This is the case in Stockholm, for example, with the Development administration in charge of urban development projects and coordinating, for instance, the development of the Royal Sea Port. The Royal Sea Port has its own team of around 10 to 15 people. The Lyon Metropole paved the way for this

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		organisation by creating similar missions in strategic urban areas, settled in the district, organising the local governance, and coordinating with the Lyon Metropole Departments. The City of Munich will create a Mission for Harthof development as well by gathering the main departments.
Special Purpose Vehicle	SPV	A public in-house company oversees developing or redeveloping the urban area. Public shareholders can fully own the company (like SPL Lyon Confluence, IGRETEC for Charleroi) or partially (Wien 3420 aspern development). SPVs can act with more agility and flexibility than the city department and stay in the realm of the municipality. They can set up partnerships with private partners, frequently developers. They usually control the land, which gives them an important lever for negotiations.
Neighbourhood Coordination Platform	NCP	Residents or local organisations take the initiative or actively participate in the district transformation**.** Cities4PED gave one example in Rotterdam (Bospolder Tussenddijken in Rotterdam), although this is more related to civic actions and organisations than developing a PCED. However, it shows the capacity of the citizens and civic organisations to design a future act and take ownership without waiting for the signal from the municipality. ElectriCITY in Stockholm is another example of a neighbourhood coordination platform. To become more innovation and business-driven, an innovation platform for the Hammarby Sjostad District was created. The business association is gathering 70 members and setting up various projects such as electricity microgrids and e-vehicles.

Table 6: Governance Models

4.5 Overview of state-of-the-art business models

In this section, we outline the state-of-the-art regarding business models in the context of PCEDs, drawing on insights from the systematic literature review conducted. While the literature on business models specifically for PCEDs is limited, valuable insights from the broader field of smart city business models exist. These insights can be transferred to the PCED context and set the basis for the development of business models for PCEDs. In this regard, it is important to understand that business models are not rigid structures but adaptable frameworks for the creation, delivery, and capture of environmental, social, and economic value (Timeus et al., 2020). This adaptability is critical in the context of PCEDs, as there exists no “one-size-fits-all” solution. PCEDs can be seen like a Lego game, with different components or more or less standardized building blocks (like energy generation, building renovation, energy performance standards, and citizen participation) united by a standard connector (e.g., urban orchestrator) capable of assembling the different pieces of the construction. The result could be different from one district to another. For ASCEND, these building blocks are referred to as SPs. Hence, different combinations of different digital tools, financial instruments, and procurement processes, for example, can contribute to the realization of the diverse value

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propositions that the different SPs for a PCED usually encompass. This is why there do not exist state-of-the art business models for a PCED as a whole. Instead, different business models are relevant for the different SP as building blocks (Lego bricks) of a PCED. Hence, we will show relevant business models for each SP in section 5 in addition to the general business model insights derived from the literature review presented in this section.

In general, smart city business models, as defined by Timeus et al. (2020), focus on organizing services in a way that is **economically viable, socially inclusive, and environmentally sustainable**. Shetty et al. (2019) describes them as architectural designs that strategically use governance, customer relationships, marketing, and revenue to improve citizens' quality of life. While these models are not traditionally focused on economic benefits, they contribute significantly to improving the well-being of citizens. They are central to making cities smarter and integrating aspects such as leadership, technology, and regulatory frameworks to create societal value, capture that value, and plan financial investments. Tantau & Santa (2021) highlight their role in improving the quality of life, mitigating climate change, and promoting innovation and job creation in the IT sector. Moreover, business models for smart cities are essential to systematically assess the most relevant aspects of investment propositions while stimulating and fostering communication and engagement of relevant stakeholders who could potentially promote the replication and large-scale roll-out of smart city solutions.

Therefore, business models are an essential **tool to attract the support of private investors** in building successful smart cities and PCEDs. However, the business model should **not only focus on profit generation but also on non-financial values**, which can be co-created with actors in a network (Giourka et al., 2019; Walravens and Ballon, 2013). Understanding the various stakeholders involved and their value perception is important to design a sustainable business model (Uden et al., 2021). Qureshi & Keen (2005) assert that business models are a vehicle for addressing how to balance value between the customer and the provider. This view of business models is also suited to e-government solutions, as it involves balancing between improving citizen-centric service delivery and adapting and re-engineering organizational practices (Janssen et al., 2008). Moreover, in principle, this idea can also be transferred to the PCED context. PCEDs, which consist of **different urban blocks (Lego bricks)** with different uses and residents, are an integral part of strategic plans at the city level for which public funding is required. The +CityxChange (2023) project emphasizes that PCEDs involve stakeholders with different interests. While institutional goals may focus on energy consumption and generation, stakeholders such as residents and property owners may place more emphasis on quality of life and increasing the value of their assets.

Despite these findings, there are still **few specific business models** for energy-positive neighbourhoods. The innovation for PCEDs lies not in creating new models, but in **effectively combining existing models** to meet their unique needs and stakeholder ecosystems (Häkkinen et al., 2019). Hence, in section 5, several examples of state-of-the-art business models potentially relevant for the respective SP are presented.

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5. State-of-the-Art Business Models of the six solution packages

This section thoroughly examines the state-of-the-art of the six SPs of ASCEND, using the **business model concept as a guiding framework.** It describes state-of-the art PCED solutions for each SP identified based on the systemic literature review along with the interviews conducted and shows the business models behind. Moreover, the **patterns from the four other standpoints (1, 2, 3, and 4) are allocated to the different value propositions**. This approach illustrates how PCED-related value propositions, state-of-the-art technologies and digital tools, funding mechanisms, procurement, and governance patterns can be combined to comprehensive business models in each SP. In addition, practical examples from ASCEND cities, showcasing innovative solutions in the PCED context, are presented. Finally, SP cost-effectiveness, scaling drivers, and barriers are discussed.

5.1 SP1 – Technologies and Digital Tools – State-of-the-Art Business Models Overview

Based on the systematic literature review and the empirical data collected, this section presents an overview of **state-of-the-art business models** that could be identified for SP1. Different technologies and digital tools, funding mechanisms, procurement procedures and governance models are allocated to each of these models identified to show how they could be combined in the context of the different business models. Moreover, highlights from concrete **state-of-the-art examples from ASCEND's lighthouse and multiplier cities** are presented including a short description and analysis of the elements that make them state-of-the-art solutions:

Subscription-based platforms (Digital Twin or Urban Data Platform as a service): This business model centers around the offering of a cloud-based platform where clients can manage their digital twins or data-based models (Possible digital tools: DT, UDP). Typical revenue models associated with this type of business model are based on a subscription basis, meaning clients receive access to the platform subject to a fee payment (D_Rev_SM; D_Rev_UF). This kind of pay-per-use approach results in decreased initial investment costs for its users. Other benefits are that the subscription models can ease the process of finding and comparing service providers (Ala-Juusela & Tuerk 2022, Khan et al 2021). Yet, other monetization strategies can be applied to realize this business model depending on the possibility of exploiting datasets (according to users' consent) for analytics purposes and introducing advertising that can be visible to the users (D_Rev_DM; D_Rev_ADV). Depending on the offered services, optimization of processes can be derived from the increased use of digitalisation (D_Sav_PO), e.g. a digital twin of an urban district can simulate various aspects such as traffic flow, energy consumption, and waste management. Thanks to this digital replica of the city, planners and decision-makers can analyze different scenarios and optimize processes for efficiency. Regarding the governance of these subscription-based platforms, different models are possible. They can be managed by an in-house IT department of the city or a public company (CM, SPV). They can be procured directly from a public/private company and later hosted by the city (RFP / RFI, CCPU, CCPR).

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Facility management: Based on technologies such as IoT and cloud computing, cities can realize remote facility management and save energy, e.g., through smart street lighting, waste management, smart parking, and traffic management (Zhang et al., 2020). In general terms, thanks to the digitalization of processes and monitoring, revenues from data monetization and cost savings from process optimization can represent the monetization strategy of this business model (D-Rev_DM; D_Sav_PO), together with savings on the energy bill as a result of the improved facility management (E_Sav_RC). Consequently, even if the aim is not to generate revenue out of the facility management itself, this model can help to optimise public services and avoid unnecessary investment or maintenance. Possible digital tools: UDP, MO, CD). Possible procurement procedures: RFP / RFI, CCPU, CCPR, UP). Possible governance models and policies: CM, SPV).

Traffic management and optimization: This business model is about using data as a basis for real-time traffic management to reduce congestion and promote more sustainable urban mobility. Moreover, the model can also entail the provision of smart transportation services, like parking guidance information systems, transit-based information systems, smart payment systems, e-parking, and automated parking (Anthopoulos et al. 2018, Kim & Yang 2021). Beyond traditional smart transportation services, the emphasis can be on enhancing public transport and non-motorized personal mobility options. This includes advanced public transit scheduling systems, real-time passenger information, bike-sharing programs, and pedestrian navigation aids. Smart payment systems for public transport, integrated multi-modal transport apps, and incentives for walking and cycling are also integral to this model. Revenue can be generated by charging transportation companies for using the systems (D_Rev_SM; D_Rev_UF). Other monetization strategies can be applied depending on the possibility to exploit datasets (according to users' consent) for analytics purposes. Depending on the offered services, optimization of processes can be derived from the increased use of digitalisation, bringing cost savings due to more efficient use of money and time (D_Sav_PO). Possible digital tools: digital twin, urban data platform. Possible procurement procedures: RFP / RFI, CCPU, CCPR, UP. Possible governance models and policies: CM, SPV.

Real estate development: Offering real estate developers the opportunity to get insights into property values and urban development potential through data-based models like digital twins. (Possible digital tools: DT, UDP) Revenue can be generated with a pay-per-use model or a subscription (D_Rev_SM; D_Rev_UF). Linked to the commercial use from real estate developers, advertising and targeting the specific category of users can also be a potential monetization strategy (D_Rev_ADV). The digitalisation of services and processes between the public administration and the private developers can be translated into cost savings due to more efficient procedures for both parties involved (D_Sav_PO). Possible procurement procedures: RFP / RFI, CCPU, CCPR, UP. Possible governance models and policies: CM, SPVs owning the land.

Predictive maintenance: Partnering with infrastructure companies to provide predictive maintenance services for city infrastructure based on urban data models (Possible digital tools: UDP, CD). The same kind of monetization strategies as outlined for the previous use case can be applied for the Predictive Maintenance case (D-Rev_SM; D_Rev_UF; D_Rev_ADV; D_Sav_PO). Possible procurement procedures: RFP / RFI, CCPU, CCPR, UP. Possible governance models and policies: CM, SPV.

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Tourism models: This model entails creating virtual tours and immersive experiences for tourists or citizens. In this way, they can explore cultural landmarks or historical sites, for example. Revenue can be generated from partnerships with tourism organizations via subscription model or usage fee (D-Rev_SM) or ticket sales (D_Rev_UF). Linked to the touristic domain, advertising targeting the specific category of users could generate revenues (D_Rev_ADV), as well as dataset exploitation (according to users' consent) for analytics purposes (D_Rev_DM). (Possible digital tools: UDP, CD). Possible procurement procedures: RFP / RFI, CCPU, CCPR, UP. Possible governance models and policies: CM, SPV.

Public information: For this business model, the city can act as provider of digital government-related data, improving transparency and enhancing interaction between community managers and residents (Zhang et al. 2020, Janssen et al. 2008). The digitalisation of services and processes between the public administration and citizens / local businesses can be translated into cost savings due to more efficient use of money and time from both parties involved (D_Sav_PO). (Possible digital tools: USP, Cockpits and Dashboards). Possible procurement procedures: RFP / RFI, CCPU, CCPR, UP. Possible governance models and policies: CM, SPV.

Virtual Power Plant (VPP): The VPP is an IT structure that integrates different types of distributed energy sources, flexible consumers, and energy storage with each other and with other market segments in real time through a smart grid. The VPP has positive effects on the electricity grid, ensuring energy security, improving grid stability and reliability, optimizing energy resources use, lowering the load-demand response, regulating frequency, using operational reserves, and managing peak demand. Different members of the energy community own different assets needed for renewable energy production and storage. Together, these assets create a virtual power plant able to efficiently optimize energy generation, distribution, and consumption. The monetization strategy linked to a VVP includes I) economic savings for the capability to consume energy at the best tariff based on the dispatching optimization of energy assets: self-consumption or energy storage discharging during peak price periods; withdraw from the grid during low price times (E_Sav_SC); ii) potential revenues from selling electricity to the grid in case the VVP is participating in energy markets (E_Rev_ET); iii) monetization for provision of services to the grid (frequency and load balancing) or demand-response services to help controlling grid congestion (E_Rev_SG) (Ropuszynska-Surma & Weglarz, 2018). Possible monetization strategies: SA, ET, SG, P2P. Possible digital tools: UDP, CD, MO, G, DEG. Possible procurement procedures: WC, CCPR, when providing energy to the grid. Possible governance models and policies: CM, NCP, SPV.

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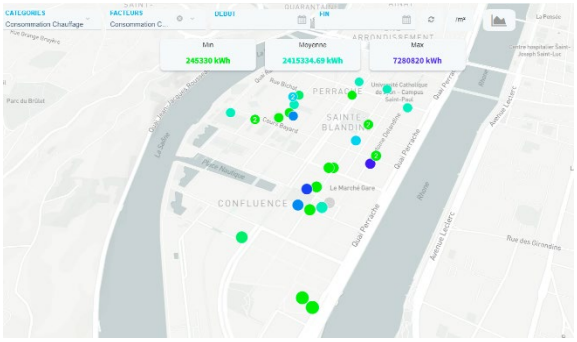
5.1.1 State-of-the-art implementation examples

Within the scope of SP1, three concrete state-of-the-art implementation examples were analysed in connection to the topic of digital infrastructure and ICT tools, namely CMS Urban Data Platform/Lyon, Digital Twin/Munich and Golemio/Prague). These examples show how state-of-the-art business model patterns introduced above can be combined and implemented while responding to local realities and needs. The solution descriptions in the Annex feature more detailed descriptions of these state-of-the-art solutions along with the technologies and digital tools, business models funding mechanisms, procurement procedures, and governance models and policies employed.

CMS Urban Data Platform is one of the few solutions of this type in France. It serves a very fundamental need of a land developer in charge of monitoring energy and environmental data in the territory it has responsibility for, i.e. the Confluence district. Its governance model is the SPV (Special Public Vehicle), where a public company (SPL Lyon Confluence) operates under public interest, in agreement for data sharing with different stakeholders, not relying on public investment, instead generating revenue through land sales to urban developers. The Real Estate Development business model outlined above is closely related to this solution.	Visualization of heating consumption at La Confluence district / Lyon:  Photo; © SPL Lyon Confluence
The City of Munich has been working on its **Digital Twin** project since 2018 and can be considered a pioneer among cities in Europe, under the Cityies Mission (CM) governance model. Urban digital twins are highly replicable and can be deployed in various scenarios and use cases. Its implementation relies on existing IT infrastructures and capacities regarding geodata / geoinformatics and IT management. Once this knowledge is widely disseminated, with experts from different disciplines contributing data and expertise, digitalization can be increasingly used to support the development of PCEDs.	Munich Digital Twin: city centre shown as 3D model with one example of integrated sensor data measuring air quality: 
The innovation of **Golemio Urban Data Platform** lies in the institutional set up, as it belongs to OICT, an independent and agile city-owned company (SPV) focused on technological and smart city solutions as well as delivering open	Map of the future PCED area in Prague:

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source, scalable, cybersafe, citizen engaging, and user-friendly solutions suitable for decision makers. This set up enables high quality IT talent acquisition and an innovation-oriented business logic at the service of public interest.	

Table 7: ASCEND State-of-the-Art examples for SP1

In terms of technologies and digital tools, the three solutions share that they mainly employ the patterns of Digital Twin (DT), Urban Data Platform (UDP) and Cockpit and Dashboards (CD) and are scalable by design. Revenue stream potentials are not being yet fully explored by these solutions, as they **were not designed from a private profit perspective but rather from a public service delivery orientation under a "pilot" mindset with no intentional upscaling strategies.** All three solutions still heavily rely on public subsidies and internal client base (municipality and municipal departments), rather than on external funding and self-sustaining monetization mechanisms. However, potential revenue streams relate to the subscription-based model, meaning clients receive access to the platform subject to a fee payment (D_Rev_SM; D_Rev_UF), and cost savings due to more efficient procedures and use of time and money (D_Sav_PO). While CMS and Golemio operate under the SPV governance model and CCPU procurement procedure, Munich's Digital Twin is fully operated in house, under the Cities Mission governance approach.

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5.1.2 Baseline-assessment of cost-effectiveness

The cost-effectiveness analysis aims at evaluating the employed resources vs. the overall benefits (monetary and non-monetary benefits) brought by each specific project. In the case of SP1, the main items to be assessed in the analysis include:

Employed resources	Benefits

• Development costs for DT architecture including:
  • Preparation and Deployment of Data Platform
  • Integration data processing framework & API management
  • Deployment of Geodata infrastructure (Backend)
  • Preparation and deployment of virtual city model (Frontend)
  • Preparation of models and simulation tools
  • deployment of right and roles (privacy concept)
  • Data connection to the Digital Twin
• Cost of sensors and other equipment to be used for monitoring and optimization depending on use cases.
• Operational costs of the digital twin, including:
  • Cloud costs for Data Platform
  • Cloud costs for Geodata infrastructure
  • Operation and maintenance of DT infrastructure
  • Personal costs (Digital Twin Team, including developers)
• DT operational management (incl. data management, data security, management of licenses, etc.).
	• Enhanced capacity in urban planning by the city planner.
	• Increased involvement of citizens: information sharing about urban infrastructure; involvement in future urban development projects (i.e. consultation); guarantee of transparency.
	• Open availability of data and information for private interlocutors, social housing companies, real estate developers, architectural firms.
	• Cost abatement (indirect and direct impact) brought by each specific use case: CO2 reduction, energy reduction thanks to process optimization.
	• Customization of divers and additional use case according to the challenges of the city.
	• Dynamically updated database; capitalization of data for different use cases.

Table 8: Baseline-assessment cost-effectiveness SP1

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5.1.3 Scaling drivers & barriers

Scaling drivers:

- **Technological advancements:** Technological advancements like artificial intelligence (AI) increase both the efficiency and effectiveness of existing digital infrastructure and tools. Moreover, new technologies allow to develop new ways to create value for citizens.
- **Prevalence of digital technology in society:** As digital technologies are becoming more prevalent among the population, the inhibition threshold for using them to obtain public services is also falling. This drives faster and more widespread adoption of business and public models around urban platforms and e-governance services for example.
- **Public-private partnerships:** Public-private partnerships allow public institutions to benefit from the specific technological expertise and capabilities of the private sector. Therefore, they allow to overcome barrier around the shortage of in-house IT personnel that many public institutions face, as well as rendering technical legitimacy compared to the municipal IT department
- **Interoperability and standardization:** The integration and interoperability of different digital systems within the district can enhance their effectiveness and scalability. Standardization of data formats and communication protocols facilitates the collaboration between different systems

Scaling barriers:

- **Data privacy concerns:** User concerns regarding data privacy constitute a considerable barrier to the implementation and adoption of technology-based business and public models. To overcome this barrier, clear and transparent communication on data collection and usage is essential.
- **Digital divide:** Certain groups of citizens, e.g., elderly people who are not used to using digital infrastructure and tools or low-income citizens, might not have access to the public services offered through business and public models that are based on digital technology. Given the importance of preventing any discrimination against individual population groups through technology-based business and public models, digital models can often only be introduced in parallel with existing, still analogue solution offerings. Ensuring low-access barriers to digital infrastructure and technology education can help to overcome this barrier.
- **Technological obsolescence:** Due to the rapid pace of technological development, the digital solutions and technologies underlying business and public models may become obsolete. This hinders scaling efforts of digital solutions as actors might fear that the technology underlying the solutions, that they invest in, may be outdated rather than state-of-the-art once they have scaled them.

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5.2 SP2 – Energy Communities & Prosumers – State-of-the-Art Business Models Overview

Below are the state-of-the-art business models identified for SP2, their respective potential technologies, funding mechanisms, governance and procurement models, as well as highlights from examples from ASCEND's Lighthouse and Multiplier cities to illustrate how the business models can be implemented and adapted to different city contexts:

Jointly owned production systems / District Energy System: An energy community that produces and sells renewable energy. For this, the energy community owns and operates renewable energy production systems, such as photovoltaic systems, solar thermal, wind turbines, energy storage systems and others. Costs, benefits, and responsibilities are shared among the participants. The production of electricity or heat generated by the jointly owned production systems can be used for self-consumption (E_Sav_SC) and/or sold to the local grid represented by the electricity grid or local district heating system (E_Sav_EX). In case the self-consumption is foreseen, the related revenues generated correspond to electricity savings, correlated to the local retail electricity prices, to the load factor of the equipment, the number of operational hours per year and the optimisation of demand side management. For the portion in excess, the revenues depend on the potential remuneration scheme (if technically and legally possible) regulated by the National authorities supervising the local grid management and operations and could have different forms (savings or reimbursement on electricity bills). Possible digital tools: UDPs, CD, SGT, G, IBS, DEG. Possible procurement procedures: WC, CCPR, when providing energy to the grid. Possible governance models and policies: NCP.

Energy sharing: Members of an energy community share renewable energy among each other. Surplus energy may be sold to the grid and depending on the regulation in place (e.g., Feed-In-Tarif mechanisms), the energy supplier recognises a reimbursement or saving on the energy bill (E_Sav_EX). Possible digital tools: UDP, MO, SGT, G. Possible procurement procedures: WC, CCPR, when providing energy to the grid. Possible governance models and policies: NCP.

Local distribution grid: The energy community owns and operates a distribution grid. The members collectively own and manage the microgrid infrastructure. Revenue may come from user fees, energy sales in case the energy community has the capability to participate in the energy market (E_Rev_ET) or in case peer-to-peer trading is possible (E_Rev_P2P), and grid services (E_Rev_SG). Possible digital tools: UDP, SGT, DEG. Possible procurement procedures: WC, CCPR. Possible governance models and policies: NCP.

Roof or land renting model: Building owners are enabled to use a renewable energy installation without having to buy it. The installation is owned or financed by another party, usually a financial institution. The contractor offers to lease the roof or plot for up to 20-25 years (E_Rev_SF) and, in exchange, installs and maintains renewable energy devices, typically solar panels. Building owners do not have to make upfront investments and they could benefit from the electricity supply produced by the system (E_Sav_SC) on a freely basis or based on other agreed contractual terms. The contractor benefits from financial incentives like feed-in tariffs (E_Sav_EX) or, if technically feasible, can participate in the energy market (E_Rev_ET). Commercial, industrial, and retail buildings can

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provide the real estate needed for these systems and are therefore viewed as excellent candidates for roof rental. Leasing energy-related improvements is a common and cost-effective way for state and local governments to finance upgrades and then use the energy savings to pay the investments (Ahlers et al. 2020, Ala-Juusela & Tuerk 2022, Liu et al. 2023, Perez & Auriault 2017). Possible digital tools: UDP, SGT, DEG. Possible procurement procedures: WC,
CCPR. Possible governance models and policies: NCP.

Citizen Energy Communities (CEC), Renewable Energy Communities (REC): a legal entity which is based on voluntary and open participation, effectively controlled by shareholders or members that are natural persons, cooperatives, local authorities, participating municipalities, or small- and microenterprises. They perform the same activities as any other retailer or energy producer company. The cooperative is committed to driving a change to the current energy model to promote a 100% renewable model. The cooperative only supplies energy to its members, who can participate in financing collective renewable energy projects to produce their own energy. Consumers are thus both members and co-owners, integrating various stages of the value chain. On the production side, the cooperative promotes collective financing for renewable energy installations. Thanks to this contribution, members benefit from a yearly discount on their bills. Monetisation strategies: E_Sav_SC; E_Sav_EX). Low cost, high decision power, optimized infrastructure via sharing of assets (Ahlers et al. 2020, Ala-Juusela & Tuerk 2022). Possible digital tools: UDP, SGT, DEG. Possible procurement procedures: WC, CCPR. Possible governance models and policies: CM, SPV, NCP.

Communities as energy service companies (ESCOs): Non-profit-based service delivery, e.g. the solar-as-a-service, heat-as-a-service may combine heat and power projects, or a mixed solar-as-a-service (E_Rev_SF) and renovation approach (E_Sav_RC). Communities could also offer mobility services, such as car sharing, which could be combined with revenues from flexibility markets or from optimization of charging patterns. Revenues may be generated by peak shaving (E_Sav_SC), grid services (aggregation of small-scale flexibilities) (E_Rev_SG); storage (minimize renewable curtailment or using parked cars rather than peak plants) (Ala-Juusela & Tuerk, 2022). When technically and regulatory feasible the Community can participate in the energy market (E_Rev_ET) or sell energy to individuals from other communities (E_Rev_P2P). Possible digital tools: UDP, SGT, DEG. Possible procurement procedures: WC, CCPR/CCPU. Possible governance models and policies: CM, SPV, NCP.

5.2.1 State-of-the-art implementation examples

Within the scope of SP2, three concrete state-of-the-art implementation examples were analysed in connection to the topic of energy communities and prosumers, namely **YDEAL Confluence/Lyon**, **Photovoltaics Tenant Electricity Project/Munich** and **Asprela+Sustentável/Porto**. These examples show how state-of-the-art patterns introduced above can be combined and implemented while responding to local realities and needs. The solution descriptions in the Annex feature more detailed descriptions of these state-of-the-art solutions along with the technologies and digital tools, business models funding mechanisms, procurement procedures, and governance models and policies employed.

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The **YDEAL Confluence** solution demonstrates how the electricity produced by a roof-top PV system can be shared between a large group of users (150) of a 5 buildings complex. The 5 PV systems are property of the **owners' association** (Le Soleil d'Ydeal Confluence), set up for this purpose (Neighbourhood Coordination Platform – NCP – governance model), and the production data from the PV system is managed by the DSO. The solution combines elements of the Citizen Energy Communities (CEC)/Renewable Energy Communities (REC) and Jointly Owned Production Systems/District Energy System business models, which requires cooperation with a Distribution System Operator (DSO) for smart meters installation. The solution is in pilot mode to understand the business model viability, to be soon replicated in the Lyon ASCEND PCED.	Ydeal (September 2020) :  Photo: © SPL Lyon Confluence / Laurence Danière Ydeal (2022) :  Photo: © SPL Lyon Confluence / Vladimir de Mollerat du Jeu
Isarwatt is a Munich-based **energy cooperative** formed by 22 housing companies that has already implemented 53 plants in and around Munich, demonstrating a high level of replicability of the solution. It operates under the Neighbourhood Coordination Platform – NCP – governance pattern, and the Citizen Energy Communities (CEC)/Renewable Energy Communities (REC) business model. Scalability would depend on Isarwatt operating capacity and access to larger sums of loans from its associates, which according to Isarwatt is favourable, as the housing companies increasingly need their services, and due to availability of many suitable rooftops for PV installation. The solution can be considered a best practice as it represents a pioneer and unique governance model, being a cooperative	Tenant electricity project with photovoltaic system from Isarwatt eG in Freiham / Munich: 

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offering a complementary service to housing companies in need of clean energy solutions. Isarwatt installs, owns and maintains the PV plant and acts as a full electricity provider.	
The **Social Housing Complex of Agra do Amial** and the local school host the first Portuguese **renewable energy community (REC)** fully promoted by a municipality, under a Cities Mission governance model as the orchestrator of a multi-stakeholder arrangement. This is a state-of-the-art solution as it tests a set of technical solutions that were not tested together before in Portugal (FOAK). The innovative approach combines production, storage, and e-mobility, and the potential impact on energy poverty alleviation. Also, the wide range of stakeholders involved renders the project highly collaborative and resilient. Finally, the overall project combines sustainable mobility actions, energy efficiency, renewable energy, circular economy, and citizen involvement, based on innovation and new business models, setting the foundations for a positive energy district. Although the solution's main target is Agra do Amial inhabitants, the municipality has an investment plan to replicate it across the 50 social housing districts of Porto as well as all the municipal facilities. Part of the solution is replicable to the remaining social housing neighbourhoods in the city. Storage and charging infrastructures can be replicated subject to private investment. Financially, the solution is replicable through the recovery and resilience plan and through ESCO models.	Social Housing Complex of Agra do Amial neighbourhood:  

Table 9: ASCEND State-of-the-Art examples for SP2

The three solutions employ similar technologies and digital tools, namely Urban Data Platform (UDP), Smart Grid Technologies (SGT) and Distributed Energy Generation (DEG). In terms of monetization models, they relate mainly to the Self-consumption (E_Sav_SC) and Excess of energy injected into the grid (E_Sav_EX) patterns. Another commonality among the three solutions is that all models require the cooperation with the DSO and a broker to manage the value chain and the funding scheme being a blended finance consisting of a combination of grants, tax rebates and fees.

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5.2.2 Baseline-assessment of cost-effectiveness

The cost-effectiveness analysis aims at evaluating the main employed resources vs. the overall benefits (monetary and non-monetary benefits) brought by each specific project. In the case of SP2, the main items to be assessed in the analysis include:

Employed resources	Benefits
• Capex of individual assets included in the system (I.e. generation units, energy storage, sensors, digital infrastructure for blockchain contracts). • Operations & Maintenance. • Legal and contractual support for management of the energy community	• Savings on the energy bills for members. • Sale of excess energy into the energy market • Peer-to-peer sales. • Monetization from provision of services to the grid. • Monetization from demand-response services. • Savings in CO2 emissions and/or air pollutants - Increase independence from energy import • Stability to the grid and integration of distributed RES • Active citizens in the energy transition and decarbonisation mission

Table 10: Baseline-assessment cost-effectiveness SP2

5.2.3 Scaling drivers & barriers

Scaling drivers:

- **Growing public awareness:** Due to energy supply insecurities and high energy prices, public awareness of energy-related topics has increased, and citizens tend to be more open towards new approaches that enable them to become more independent. This openness constitutes an important driving factor for institutions aiming to implement energy communities, for example, as resistance in the population against these new approaches is rather low.
- **Trend towards supportive policies:** While not all current regulatory frameworks can be considered favourable when it comes to new approaches like energy communities, several governments have committed to exploring options to introduce more favourable policies in this regard.

Scaling barriers:

- **Current regulatory frameworks:** In many countries, current regulatory frameworks pose barriers for the introduction of energy community solutions. Especially regarding topics like grid connection, energy sharing, and energy sales, current regulations are often complex.
- **Upfront costs:** Depending on the infrastructure already in place and the subsidies available, the establishment of energy communities can come with high upfront costs. Thus, financial schemes are needed to scale the solution.
- **Citizens often do not know how to initiate an energy community and what it takes to do so.** Other factors that tend to pose challenges for citizens relate to the question of the right size of an energy community or if they should invest in energy storage as well. Merging housing associations can be a strategy to scale the demand.

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5.3 SP3 – Energy-efficient Buildings – State-of-the-Art Business Models Overview

The following section outlines the state-of-the-art business models associated with SP3. Each of these business models incorporates an aggrupation technologies and digital tools, funding mechanisms, procurement procedures and governance models functioning in cohesion. Furthermore, this section provides an overview of the state-of-the-art in the chosen examples from ASCEND´s lighthouse and multiplier cities, accompanied by a description and analysis of their key elements.

Energy Performance Contracting (EPC): Energy performance contracts with ESCOs to improve energy efficiency of public buildings and industrial facilities through the implementation of a variety of energy efficiency measures. The ESCO receives a performance-based remuneration in relation to the savings it achieves. Revenues are contractually defined between the parties and the amount of the remuneration is correlated with the costs savings in the energy bills (E_Sav_RC) (Ahlers et al. 2020, Ala-Juusela & Tuerk, 2022). According to the way the energy savings and performance guarantee are measured, EPC can use:

- Guaranteed savings (Alokananda Nath, Sabine Schneider, Rahul Ingle. Energy Performance Contract (EPC) - Guaranteed savings, https://netzerocities.app/resource-2362, accessed on 22 December 2023)
- Shared savings (Alokananda Nath, Sabine Schneider, Rahul Ingle. Energy Performance Contract (EPC) - Shared savings, https://netzerocities.app/resource-2363, accessed on 22.12.2023)
- Related payments (Sabine Schneider, Rahul Ingle. Energy Performance Contract (EPC) - Related savings, https://netzerocities.app/resource-2364, accessed on 22.122023)
- Immediate payments (Sabine Schneider, Rahul Ingle. Energy Performance Contract (EPC) - Immediate savings, https://netzerocities.app/resource-2365accessed on 22.122023)

Possible monetization strategy: E_Rev_SF , E_Sav_RC. Possible digital tools: UDP, SGT, DEG. Possible procurement procedures: WC, CCPR/CCPU. Possible governance models and policies: CM, SPV.

Energy-efficient retrofitting consulting: Energy-efficiency audits are offered to assess the current energy efficiency status of buildings. Based on the results of these audits, recommendations are provided to the building owners and inhabitants to support their efforts in making the buildings more energy efficient. This model is also suitable for municipalities that want to support energy-efficient retrofitting. In this regard, municipalities can establish departments specializing in energy-efficient building retrofitting and delivering consulting services to its citizens. The service can be offered to the citizens with no or customised monetization strategy, while the citizens implementing the energy efficiency measures will be remunerated by their own reduced consumption (E_Sav_RC). Possible digital tools: Digital Twins, Management and Optimization. Possible procurement procedures: not applicable, as there is no external buying/contracting process. Possible governance models and policies: CM, SPV.

Development and enforcement of green building standards: Introduction of a set of standards that require new construction or major renovations of buildings to meet certain energy-efficiency criteria. Such a model can also include offering training on the green building standards for real estate developers and architects, for example. At the moment, some of the main Green Building

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standards that offer formal courses are Well Building Standards (https://www.wellcertified.com/), Breeam (https://bregroup.com/products/breeam/) and Green Globes (https://thegbi.org/). The remuneration strategy varies depending on the actors involved: the introduction of such measures can trigger new energy efficiency consulting and training services for professionals of the building sectors; they can be accompanied by tax rebate for citizens investing in energy efficiency measures and benefiting from savings on energy bills (E_Sav_SC; E_Sav_RC). Possible digital tools: n/a. Possible procurement procedures: not applicable, as there is no external buying/contracting process. Possible governance models and policies: CM, SPV.

One-stop-shop: A single actor offers full-service holistic renovation packages including consulting, independent energy audit, renovation work, follow-up (independent quality control and commissioning) and financing (Ahlers et al. 2020, Ala-Juusela & Tuerk, 2022). The supplier of the service is remunerated according to the customized provided service by the client that can be supported by specific grants or subsidized financing. The client will then benefit from energy efficiency savings or self-consumed energy in case of installation of local generation unit (E_Sav_SC; E_Sav_RC). Possible digital tools: n/a. Possible procurement procedures: WC, CCPR/CCPU. Possible governance models and policies: CM, SPV, NCP.

Lifecycle Contracting: Holistic approach, one single contractor for the whole process: construction, operation, renovation. (Ala-Juusela & Tuerk, 2022). The monetization strategy is the same as the previous business model: remuneration of the contractor for the provided service; energy efficiency savings or self-consumed energy in case of installation of local generation unit (E_Sav_SC; E_Sav_RC). Possible digital tools: n/a. Possible procurement procedures: WC, CCPR/CCPU. Possible governance models and policies: CM, SPV, NCP.

5.3.1 State-of-the-art implementation examples

The state-of-the-art solutions selected to illustrate energy-efficient buildings (SP3) good practices are: (i) Refurbishment with prefabricated elements/Munich, (ii) Super-efficient buildings/Lyon, and (iii) Heat Exchanger with Potable Water/Budapest. These examples show how state-of-the-art patterns introduced above can be combined in different ways according to local realities and needs. The solution descriptions in the Annex feature more detailed descriptions of these state-of-the-art solutions along with the technologies and digital tools, business models funding mechanisms, procurement procedures, and governance models and policies employed.

MGS, a publicly owned subsidiary of GWG (responsible for social housing in Munich), is introducing a social urban renewal solution by using prefabricated elements for the facade and roof of private and public buildings under the SPV governance model. Their role is to raise awareness and advise owners to refurbish their buildings to a high efficiency standard replacing non-RES for RES, thus representing the Energy-	

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efficient Retrofitting Consulting business model, where the citizens implementing the solution will be remunerated by their own reduced consumption (E_Sav_RC). **Refurbishment with prefabricated elements** leads to highly efficient buildings with more precise construction, less onsite time and construction costs. The solution is innovative as it possibly combines facade elements with PV systems and greenery, a technology still in its early days. The solution is highly replicable and scalable, subject to the availability of specialized planning and construction players. In terms of scalability, construction costs decrease as the demand increases due to the economy of scale of the prefabricated elements.	 Photo: Gumpp & Maier GmbH  Photo: ©Ingrid Scheffler GWG Städtische Wohnungsgesellschaft
At the Lyon Confluence district, the solution aims to massify the production of **energy-efficient buildings**. Lyon Metropolis has granted a concession to the developer SPL Lyon Confluence (SPV), who serviced the land and built the infrastructures (e.g., public spaces, networks), before selling the serviced plots to real estate developers, who were then required to comply with a set of specifications concerning construction and energy performance levels to be achieved. The solution is closely related to the Development and Enforcement of Green Building Standards business model, where the monetization strategy relates mainly to savings in energy bills. The replicability of the solution implies control of land ownership, creation of an SPL capable of managing a long-term project, and strong political will to achieve the goals. The massification strategy shall reduce construction costs, which remain a barrier to the massive replication of these solutions.	Aerial view of the future B1-C1 North islets (2020):  Photo: © SPL Lyon Confluence / Stéphane Boitat

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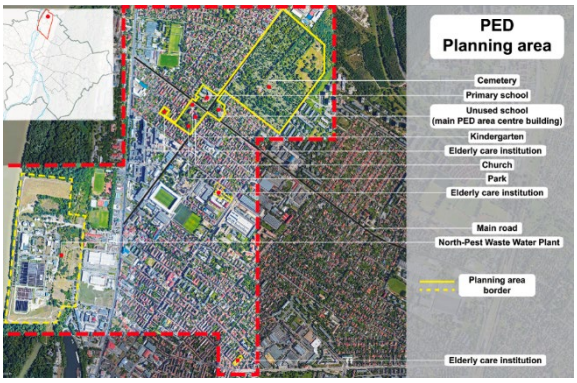
	Project selected for blocks B1 - C1 North (Sept 2021):  Photo: © NEXITY / Alexandre Besson (2021) - Asylum (2020)
Budapest Waterworks (BW), a publicly owned water utility service provider (SPV), has designed an innovative technology aimed at harnessing the **excess heat capacity of potable water**, by integrating a heat exchanger for drinking water into standard heat pumps, providing heating and cooling for surrounding buildings. The business model pattern employed is the Energy Performance Contracting (EPC), where remuneration is correlated with the costs savings in the energy bills (E_Sav_RC). This heating technology can be replicated to other locations, subject to local availability of the heat source and the necessary water pipe dimension and minimum flow rate close to the target building. For the upscaling, the manufacturing process could be optimized with standardized sections with various diameters, resulting in lower manufacturing costs and time. The solution is highly innovative as there are no other heat exchangers using the excess heat capacity of drinking water, without posing water quality risk and causing pressure loss in the pipe network. The technology provides sustainable heating technology, which coupled with solar panels, can potentially reach zero emission. The technology is more efficient than conventional heating systems and reduces the operation cost of heating/cooling.	Map of future PCED / Budapest:  Heat pump: 

Table 11: ASCEND State-of-the-Art examples for SP3

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While the business model patterns vary among the three solutions, the necessary technologies and digital tools are common, such as Urban Data Platform, Digital Twins, Smart Grid Technologies and Management and Optimization (with AI). An additional commonality refers to the SPV governance model, which indicates that specialized in-house companies with public interest prove to be a successful model in terms of expertise, agility and coordination/monitoring of the construction/renovation process of energy efficient buildings at scale on behalf of the municipality. Possible procurement models are Web of Contracts (WC), Concession Contract with Private/Public Companies (CCPR/CCPU). The monetization strategy of savings in energy bills is also similar for the 3 state-of-the-art solutions.

5.3.2 Baseline-assessment of cost-effectiveness

The cost-effectiveness analysis aims at evaluating the main employed resources vs. the overall benefits (monetary and non-monetary benefits) brought by each specific project. In the case of SP3, the main items to be assessed in the analysis include:

Employed resources	Benefits
• Capex of the renovation works using both traditional renovation approach and prefabricated modules. • Consulting fees linked to the support of architects or engineers supervising the renovation works. • Costs of financing in case of loans or other kind of financial support different from subsidies. • Leasing fees in case the contractor is covering upfront investment (more common for heating installations).	• Specific subsidies schemes in place depending on the National regulation. • Additional coverage by grants in case of prefabricated approach in specific countries (ie. Germany). • Cost savings on energy bills. • Improved comfort (e.g. air quality, noise, etc.). • Increase in property value. • Neighbourhood regeneration. • Potential Feed-in-Tariff benefits in case of installation of local energy generation units.

Table 12: Baseline-assessment cost-effectiveness SP3

5.3.3 Scaling drivers & barriers

Scaling drivers:

- **Energy efficiency policies:** Policies introduced by the government that provide a clear regulatory framework encouraging energy-efficient construction and renovation can be a crucial driver for energy-efficient and more sustainable building and renovation practices.
- **Cost saving potential:** Especially in times of high energy costs, both public and private building owners have an incentive to invest in energy-efficient building renovation and construction as lower energy consumption results in reduced operational costs.
- **Improved building materials:** new building materials, technologies, and processes are important factors that enable large-scale, energy-efficient building renovation and construction. Using prefabricated elements, for example, can considerably lower the time necessary to complete construction work and, therefore, also reduce the upfront costs.

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Scaling barriers:

- **High upfront cost:** Initial expenses can be high when it comes to energy-efficient renovation and construction. Factors like the shortage of qualified personnel or of certain building materials can further increase the costs and hinder large-scale projects.
- Long payback periods: The payback periods of energy-efficient building projects can be comparably long, which is an impeding factor in the decision of building owners regarding whether to invest in such a project. For this reason, a vibrant real estate market can be beneficial, so extra costs due to environmental performance can be offset, or other incentive strategies.
- **Regulatory barriers:** When it comes to renovation of public buildings, for example, strict rules may apply that may either make energy-efficient renovation very complex and costly or even prevent these projects from being realized at all.
- **Mindset:** 3D planning is not standard for urban planners, architects and building owners. Also, there is still a shortage of manufacturers of new materials and technologies (e.g. only 2 manufacturers of prefabricated elements in Munich area)

5.4 SP4 – Mobility & Freight – State-of-the-Art Business Models Overview

In terms of Mobility & Freight, an additional set of state-of-the-art business models can be considered, in association with the most suitable technologies, funding mechanisms, governance and procurement models. The following section describes the different business models identified and illustrates possible implementation combinations through the solutions studied in Munich, Lyon and Alba Iulia.

Public electric vehicle charging infrastructure: Installation and operation of public electric vehicle charging stations to provide electric vehicle charging infrastructure also at places where private providers may choose not to be active due to low economic attractiveness (e.g., in low-income or rural areas). The charging stations can either be operated by a public body like the municipality itself or private providers can be incentivized via partnerships or sponsorships, e.g., through low revenue compensation, to operate them themselves (Kim & Yang, 2021). Possible monetization strategies include pay-per-use models structured as flat fee or per kWh or correlated to the time of charging (M_Rev_UF); long term subscription models proving benefits for users (M_Rev_SM); advertising fee to rent spaces on the assets (M_Rev_ADV). Possible digital tools: UDP, CD, MO, SGT. Possible procurement procedures: RFI, CCPR/CCPU. Possible governance models and policies: CM, SPV.

Smart charging (SC) or **vehicle-to-grid (V2G)** can complement demand response from buildings by adjusting the charging load or even discharging the car battery depending on the energy system needs. This can create a revenue stream for car owners (E_Rev_SG). In this way, electric mobility and flexibility services can thus be combined (Ahlers et al., 2020). Possible digital tools: UDP, CD, DT, SO. Possible procurement procedures: RFI, CCPR/CCPU. Possible governance models and policies: CM, SPV.

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Mobility as a Service (MaaS): To ensure that shared-mobility solutions are accessible for all of the citizens, independent of their income-level or whether they live in rural areas, a public institution can offer shared-mobility services on its own. As an alternative, a public body can provide (financial) incentives for private providers to ensure a just distribution of the shared-mobility offerings across different locations. On-demand short-term e-car / e-bike / e-scooter rentals with the vehicle owned and managed either by a private fleet operator or a public entity, typically a municipality. The business model offers two different rental possibilities: the classic modality, in which customers must deliver the e-car / e-bike / e-scooter in the same parking area where they started the rental, and the one-way rental, in which the customer can deliver the vehicle in another area (Ahlers et al. 2020, Anthony 2023). Carsharing models can be distinguished between cooperative, business-to-consumer and peer-to-peer (P2P) (Bocken et al., 2020). The monetization strategies include usage fee models structured as flat fee or per kWh or correlated to the time of usage (M_Rev_UF) or long-term subscription models (M_Rev_SM) or a combination of both; advertising fee on the shared mobility assets can exist (M_Rev_ADV). Possible digital tools: UDP, CD, IBS. Possible procurement procedures: RFI, CCPR/CCPU, WC. Possible governance models and policies: CM, SPV.

Zero-emission freight zones: Designated zones or districts where only zero-emission delivery vehicles can enter. Alternatively, charge entrance fees to delivery service companies that enter without zero-emission delivery vehicles. Through this also private companies are incentivized to invest in a zero-emission delivery fleet. Possible digital tools: UDP, CD. Possible procurement procedures: CCPR/CCPU, WC. Possible governance models and policies: CM, SPV.

5.4.1 State-of-the-art implementation examples

Three Mobility & Freight (SP4) solutions were selected as state-of-the-art examples: (i) Mobility Point/Munich, (ii) Micro Hub/Lyon, and (iii) Car charging infrastructure/Alba Iulia. These examples show how state-of-the-art patterns introduced above can be combined and implemented in different local realities and contexts. The solution descriptions in the Annex feature more detailed descriptions of these state-of-the-art solutions along with the technologies and digital tools, business models, funding mechanisms, procurement procedures and governance models and policies employed.

Led by the City of Munich and co-designed with local stakeholders, the **Mobility Point** solution is a positive pull-measure as it offers multiple convenient clean energy alternatives to reduce private car ownership, keeping citizens and visitors mobile. It proves to be a highly replicable and scalable solution due to its simplicity, low cost and fast implementation. There are 200 Mobility Points planned for the city of Munich under a MaaS business model, where a public body provides incentives for private providers to ensure a just distribution of the shared-mobility offerings across different locations. The monetization strategies include usage fee	Mobility Point with stele and sharing bikes and cars at Kolumbusplatz:  Photo: © LHM, Dobner Angermann

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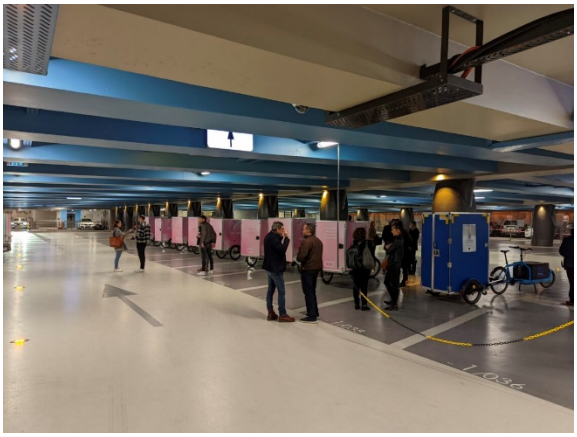
models structured as flat fee or per kWh or correlated to the time of usage (M_Rev_UF) or long-term subscription models (M_Rev_SM) or a combination of both, depending on the provider. Urban Data Platform, Cockpits and Dashboards, ICT-Based Services are the related technologies and digital tools required.	
The **Micro Hub** offers a low-carbon storage area and a transfer zone for goods and parcels in Lyon. Facilitating the shift from heavy, polluting vehicles to lighter, low-carbon transport means significantly reducing the carbon footprint of urban logistics. The Micro Hub model has proven successful and replicable in other settings, such as the Cordeliers car park in Lyon and in Madrid. The main reason behind that is the business model (the closest being the "Zero Emission Freight Zones" business model, in this case as a result of a partnership between SPL/SPV and LPA/parking lot manager) that can be realized in existing infrastructure, in this case a parking lot, meaning that no major investment is required. By optimizing existing infrastructure and promoting low-carbon transportation methods, it offers a sustainable and efficient solution for city-center deliveries, setting a precedent for similar initiatives globally. The monetization strategy includes the rental of logistics space, between the logistics company and the hub owner or manager, in this case SPL.	Launch of the urban logistics experiment in the Marché Gare Park (April 14, 2022):  Photo: © SPL Lyon Confluence / Rights reserved  Photo: © LPA / Rights reserved
The Romanian municipality of Alba Iulia is leading the installation of a **network of electric car chargers** for private and public electric vehicles, in addition to private initiatives, given the increasing numbers of hybrid and fully electric cars, which imposed a rapid development of local electric transport infrastructure. In technical terms, the solution is similar to other solutions installed in other European cities. However, related solutions like	

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flexible applications for users, flexible invoicing of electricity allowing integration of local prosumers and local energy production can be areas of innovation. The solution is 100% scalable and replicable since there are a lot of electric cars coming into the cities and there is the need for this type of infrastructure at the local level. A close relationship with electricity grid companies, a competent private operator to install and maintain the equipment, easiness of use, availability and promotion are crucial success factors. This solution adopts the Public Electric Vehicle Charging Infrastructure business model. Possible monetization strategies include pay-per-use models structured as flat fee or per kWh or correlated to the time of charging (M_Rev_UF); long term subscription models proving benefits for users (M_Rev_SM). Urban Data Platforms, Cockpits and Dashboards, Management and Optimization, Smart Grid Technologies	Public electric car charger / Alba Iulia: 

Table 13: ASCEND State-of-the-Art examples for SP4

While in Lyon the governance model adopted is a SPV-public sector partnership, on behalf of the municipality, in Munich and Alba Iulia, the initiatives follow the City Mission governance model, in collaboration with private providers. The solutions demonstrate three different types of business models and different types of necessary technologies and digital tools, despite some common ones such as urban data platforms, cockpits and dashboards. The monetization strategies are also similar in the three cases, as the services are paid by the users either on a pay-per-use or subscription basis.

5.4.2 Baseline-assessment of cost-effectiveness

The cost-effectiveness analysis aims at evaluating the main employed resources vs. the overall benefits (monetary and non-monetary benefits) brought by each specific project. In the case of SP4, the main items to be assessed in the analysis include:

Employed resources	Benefits
Shared and electric mobility: - Capex for shared e-cars, e-bikes or other assets. - Capex for charging points. - Capex for local energy generation units (i.e. Small PV installations for charging points).	**Shared and electric mobility:** - Fees from subscription model or usage fees to have access to the service. - Revenues from advertising spaces on the mobility assets and charging units. - Depending on local regulation, free parking for e-cars owners.

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- Operating costs in case of externalisation of services (i.e. Management of charging points or mobility assets). - Costs of financing in case of loans or other kind of financial support different from subsidies. **Logistic Hub:** - Capex for the acquisition of the logistics hub area (if not already owned) by the project promoter. - Low operating costs (e.g. Cleaning, security, etc.). - Administrative costs for the management of contracts.	- Decreased congestion of vehicles in the urban environment. - Encouraging use of electric vehicles rather than fossil fuels ones. - Reduced ownership of private vehicles. - Improves air quality. - Reduces commuting times. - Improves physical and mental health. **Logistic Hub:** - Contractualised remuneration to logistics hubs owners renting parking or other areas to logistics companies or other service providers. - Reduced carbon footprint of logistics in urban centers. - Easier logistics deliveries and stops in dense urban areas. - Increased road safety due to lower circulation of heavy polluting lorries and vehicles in general. - Reduced noise pollution - Improves air quality.

Table 14: Baseline-assessment cost-effectiveness SP4

5.4.3 Scaling drivers & barriers

Scaling drivers:

- **Government incentives and regulation:** Decarbonized mobility and freight solutions are increasingly supported by incentives that make their adoption more attractive for citizens. Moreover, regulation that limits the use of fossil fuel powered mobility solution serves as a push factor to encourage citizens to switch to more sustainable offerings.
- **Enabling technologies:** Digital platforms and real-time location data, for example, increase the attractiveness of shared mobility solutions, as they ease travel planning for the citizens.

Scaling barriers:

- **Dispersed settlements:** Low population density makes it unattractive for private mobility providers to operate in these areas. The same can hold true for areas where the medium income level is comparably low. This often requires additional financial incentives by public bodies to incentivize them to introduce their services also in sparsely populated or low-income areas.
- **Car-dominated mobility behaviour:** Due to the fact that individual combustion cars have long been the dominant mode of transportation for many citizens, it requires changes in these established behaviours. To evoke a change of citizens' car-dominant mobility behaviour towards more sustainable modes of transportation, infrastructure expansion alone may not be sufficient. Instead, it may require regulations that restrict fossil fuel powered vehicle usage

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5.5 SP5 – Citizen-centric Solutions – State-of-the-Art Business Models Overview

Citizen-centric solutions can also be structured under a business model mindset, even though a monetization strategy does not always exist or doesn't represent the primary objective. These models are driven by the city's need to create meaningful connections with citizens with the scope to generate stronger engagement and facilitate the co-development process in the urban environment. The final aim of this approach is to lead with change, not profit. Nevertheless, some direct or indirect benefits can be generated depending on the implemented business model. For instance, enhanced collaboration with citizens could bring savings linked to enhanced performance of internal processes (D_Sav_PO) in the municipality or the establishment of reward mechanisms could be redeemed in businesses in the local community contributing to local economy or compensation could be awarded to citizens taking sustainable actions. The following state-of-the-art business models associated with SP5 were identified:

Community-driven social ventures: In the context of this model, public bodies can provide opportunities for citizens to connect with each other, e.g., via online platforms, and initiate community-driven projects. Such a solution can also integrate crowdfunding options, which enable the citizens not only to recruit fellow citizens to collaborate in the project but also to invest money to support the realization of these projects, giving the "energy citizen" an active role (Mihailova et al., 2022). Possible digital tools: UDP, IBS, G, PCP. Possible procurement procedures: n/a. Possible governance models and policies: NCP.

Citizens as democratic participants: Participation is a spectrum that consists of three main steps: non-participation, consultation (gathering of ideas but no impact on decision-making) and co-decision (with decision making shared between officials and citizens). By being involved in the decision process, the citizens can learn about difficult technical problems and become experts in matters of public relevancy. Moreover, the public servants are also learning from the citizens about the reasons why a policy might be unpopular and how to avoid this. Democratic participation of citizens is also cost-effective as it reduces the risk of litigation or, in a PCED, useless investments that will not be helpful or used by the public (Simonofski et al., 2019). Possible digital tools: PCP. Possible procurement procedures: n/a. Possible governance models and policies: NCP.

Citizens as co-creators: Citizens can be co-creators to propose better solutions and ideas and to decrease the risk of failure early in the process. The methods include direct interaction such as focus groups or interviews with experts and users or town hall meetings to encourage feedback and suggestions. In addition, living labs, a methodology that involves the user early in the development process, can be employed when analysing the needs and brainstorming about solutions. Moreover, online platforms and collaboration tools can facilitate the citizen co-creation process (Molinillo et al., 2019; Simonofski et al., 2019). Possible digital tools: online platforms for citizen participation). Possible procurement procedures: n/a. Possible governance models and policies: NCP.

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5.5.1 State-of-the-art implementation examples

Based on the state-of-the-art solutions studied within the scope of SP5, namely Climate Council/Munich, Building Operating System/Lyon and Scaling Smart City Solutions/Stockholm, it could be demonstrated how citizen-participation can be fostered. The solution descriptions in the Annex feature more detailed descriptions of these state-of-the-art solutions along with the technologies and digital tools, business models funding mechanisms, procurement procedures, and governance models and policies employed.

The **Building Operating System (BOS)** for virtuous behaviour, operated by SPL Lyon Confluence in their headquarters, offers a unique value proposition by combining natural cooling, smart lighting control, and a dedicated application for staff to monitor and control office conditions, improving comfort and reducing energy costs. The solution has been replicated in other buildings within Lyon and is considered state-of-the-art due to its effective integration of technology and user engagement to enhance building energy performance. It stands out for its practical application and potential for wider adoption in urban environments. The key to its success lies in selecting the right companies for deployment and securing adequate financing. Citizens as ICT users is the closest related business model, and the monetization strategy relates to savings in energy bills (E_Sav_RC).	
Based on the findings of an investigation on the reasons why many successful pilot projects do not scale up, the **City of Stockholm**, together with several partners, developed an **upscaling guide and tool** to support the design of pilot solutions at the early stage and upscaling by the end of the pilot project. The aim of the guide is to help pilot initiators to anticipate upscaling strategies in the design phase, bridging the gap between the pilot experimental logic and the mainstream logic of public administration. The upscaling guide and tool are built under the assumption that to upscale, municipalities need the appropriate institutional capacity, as well as the knowledge and the relationship channels	PV installations of the project Sustainable Järva, resulted from the engagement in the national advisory group to change laws that hindered the installation of PVs:  Photo: Svenska Bostäder

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with a broader range of stakeholders, going beyond their local boundaries. As such, a closer relationship with citizens is seen as crucial, especially when the pilot solutions involve lifestyle and mindset changes (deep upscaling). In this sense, one of the tool's sections focuses on citizen consultation and participation from the early stages of the pilot initiatives, which brings inputs and legitimacy for later upscaling. By including this section, the tool ensures that decision makers consider the crucial role of citizen participation for scaling already from the beginning. The business models more closely related to this solution are Citizens as Democratic Participants or Co-creators, depending on the relationship strategy employed by the project leaders. Depending on the specific cases, process optimisation savings could be seen as monetization strategy of these business models (D_Sav_PO)	
Munich's **Climate Council** aims at increasing collaboration and acceptance of the energy transition measures (energy neutrality by 2035) by the civil society, as it has a multistakeholder advisory function to support the city in achieving its climate targets. Thus, it creates value for both the city and the citizens, who will benefit from a cleaner and healthier city environment. The concertation around Munich's climate goals requires human capital and engagement, meaning that the voluntary time of the participants is the main resource involved in the solution. In terms of economic value, better decisions and resolutions of the city council of the city of Munich can potentially generate savings in different areas such as energy, health, mobility (D_Sav_PO). Elements of the "Citizens as democratic participants and co-creators" business models are present in the solution.	Climate Council Meeting / Munich: 

Table 15: ASCEND State-of-the-Art examples for SP5

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5.5.2 Baseline-assessment of cost-effectiveness

Employed resources	Benefits
• Mobile app development costs. • Costs of the ICT infrastructure to store data. • Administrative costs for maintaining the online platform and related services. • Costs linked to security and GDPR compliance. • Voluntary time of the participants. • Costs for communication strategy and campaign.	• Encourage behavioural change. • Encourage citizens to engage with and use sustainable smart city services. • Anticipate and prevent citizens non-acceptance vs. City transformation. • Involve young generation via gamification. • Social benefits – such as increased community interaction. • Savings generated thanks to sharing economy initiatives (eg. Citizens carpooling). • Potential compensation mechanism correlated to sustainable actions. • Indirect economic, environmental, health benefits deriving from sustainable actions.

Table 16: Baseline-assessment cost-effectiveness SP5

5.5.3 Scaling drivers & barriers

Scaling drivers:

- **Supportive technology:** User-friendly platforms can foster the adoption of citizen-centered solutions as they lower the access barrier.
- **Demand for transparency:** Increasingly it can be observed that citizens across different countries demand higher levels of transparency and more accessible government processes. Moreover, especially in matters regarding energy and sustainability, citizens demand a possibility to participate in public decision-making.

Scaling barriers:

- **Bureaucracy:** Complex government processes that may have evolved over time make it difficult to introduce more citizen-centered solutions as this requires to switch from traditional governance- and bureaucracy-focused logics to a citizen-centered ways of thinking and acting.
- **Data privacy concerns: Citizen concerns about data privacy constitute a barrier to the implementation and adoption of citizen-centered solutions based on digital infrastructure and tools.** To overcome this barrier, clear and transparent communication on data collection and usage is essential.

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5.6 SP6 – Urban developer/Orchestrator – State-of-the-Art Business Models Overview

Finally, three main business models associated with SP6 were identified both in the literature and in the three concrete solutions analysed in Lyon, Munich and Charleroi. Being an "enabling" SP, the nature of the analysis is different from the previous SPs, as it can encompass other SPs under its scope, leaving an increased room for innovative combinations between business models and their underlying elements.

Urban service orchestration: An urban orchestrator can coordinate and provide a diverse set of solutions ranging from mobility and freight to urban planning and infrastructure. This role is especially important in the PCED context, where the diversity of the different solutions that need to be integrated requires strong architectures and coordination (Lindgren, 2020; Valter et al., 2020). Possible digital tools: UDP, IBS. Possible procurement procedures: n/a. Possible governance models and policies: CM, SPV.

Urban service consulting: As urban orchestrators tend to be located at the nexus of a variety of urban services, they can possess more dispersed knowledge in different topic areas than single departments of a municipality. Consequently, an urban orchestrator can act as a consultant to municipal departments. Consulting teams within the city can contribute to an improved provision of public services thanks to their expertise (Häkkinen et al., 2019). Possible digital tools: n/a. Possible procurement procedures: n/a. Possible governance models and policies: CM, SPV.

Platform provider: Urban orchestrators can develop and operate urban platforms that integrate various city operations, data, and services. As urban orchestrators tend to orchestrate different urban services, providing a platform that digitally supports their public service provision can be very valuable. For the users of such a platform this comes with the advantage that different services are bundled on one single platform which means they are not required to access different platforms in parallel (Häkkinen et al., 2019; Lindgren, 2020). Possible digital tools: UDP, DT. Possible procurement procedures: RFI, CCPR/CCPU, WC. Possible governance models and policies: CM, SPV)

The Urban Orchestrator is an organisational structure aiming at managing people and assets or services that can have their own monetization strategies. Example of assets, products and services and their monetization strategies have been presented in the previous paragraph dedicated to each Solution Packages. This governance structure could be established within the municipality resources but also as a co-participated external legal entity like a special purpose vehicle (SPV) created to fulfil the specific objectives of a PCED. As mentioned in the very recent report on the State of the European Smart Cities (European Commission, 2024), this kind of model can take clear interface definitions and extensive interdisciplinary support covering governance, finance, technology, and legal issues, including IPR and public procurement regulations. Within their role of multidisciplinary management, Urban Orchestrators can implement monetization strategies depending on the assets they own and manage and depending on the mission they target.

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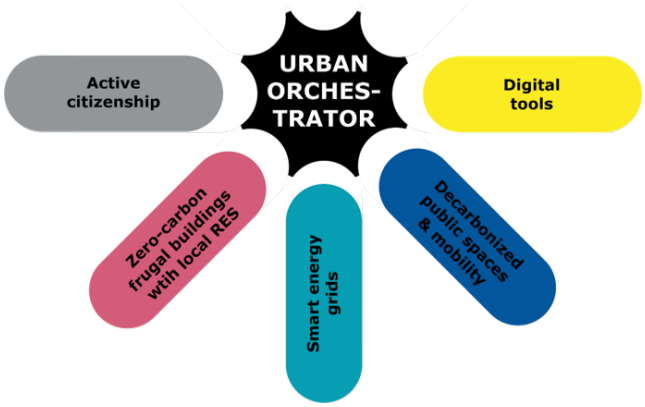

Figure 5: The role of the Urban Orchestrator

5.6.1 State-of-the-art implementation examples

The state-of-the-art solutions selected to illustrate Urban developer/orchestrator (SP6) good practices are: (i) SPL Lyon Confluence/Lyon, (ii) Munich's Neighbourhood Integrated Approach and (iii) Igretec/Charleroi. The solution descriptions in the Annex feature more detailed descriptions of these state-of-the-art solutions along with the technologies and digital tools, business models funding mechanisms, procurement procedures, and governance models and policies employed.

Société Publique Locale Lyon Confluence (SPL Lyon Confluence) represents a pioneering model for urban development, concentrating its effort on the La Confluence district in Lyon, France. Operating under public interest with a public interest mandate, SPL Lyon Confluence exemplifies a blend of agility to market needs and commitment to political objectives, aiming to represent a new approach to urban development and energy efficiency. SPL Lyon Confluence's approach to urban development is a replicable model, as evidenced by the existence of numerous similar Société Publique Locale entities in France. These SPVs are tasked with specific missions like urban development or car park management, suggesting the model's adaptability to various urban contexts. This flexibility and focus on local needs make the approach suitable for replication in other cities aiming for rapid PCED deployment. SPL Lyon Confluence represents an innovative approach to city transformation. Its structure as a SPV allows it to operate with the agility of a private entity while being deeply aligned with public	Marché District (November 2022) :  Photo: © SPL Lyon Confluence / Laurence Danière  Photo: © SPL Lyon Confluence / Laurence Danière

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interests and political objectives. This dual nature enables SPL to navigate complex urban challenges effectively compared to traditional public sector models. By strategically selling land to developers under stringent environmental and societal guidelines, SPL ensures that every aspect of urban development contributes to the overarching goal of creating a sustainable, high-quality living space.	
In the context of 2035 climate neutrality goals by the **Munich City Council,** the German Advisory Council on the Environment assigns the neighbourhood level (Quartier) a central role in climate and environmental protection, becoming the link between higher-level planning and building-related measures. Projects that would be virtually impossible to implement on a city-wide scale can be tailored to the parameters of an individual neighbourhood. The **Neighbourhood Integrated Approach** is led by a neighbourhood manager, in partnership with local stakeholders: climate-neutral building stock, use of renewable energy for heat and power, waste and water management, adaptation to climate change, make them more livable, (greening and unsealing according to the "sponge city" principle), emission-free mobility, circular economy, healthy diets, consumer needs, sustainable education, and social considerations.	
The **IGRETEC initiative**, located in Charleroi, Belgium, exemplifies an innovative urban planning approach. IGRETEC, an **intercommunal association**, aims to revitalize the urban landscape by utilizing a comprehensive skillset from architects, engineers, and lawyers. Its core objectives encompass promoting digital and technological education, particularly targeting NEETs (Not in Education, Employment, or Training), enhancing innovation in energy transition, and supporting the operational transformation of business processes to align with Industry 4.0 standards. IGRETEC's focus on	Quais de Charleroi: 

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digital and technological education and innovation, could be adapted to various urban settings, promoting sustainable urban development. The project's success is underscored by its operational masterplan for areas around Charleroi Centrale train station, demonstrating a commitment to revitalizing urban spaces while meeting the needs of current occupants and stakeholders.	Rives de Charleroi: 

Table 17: ASCEND State-of-the-Art examples for SP6

5.6.2 Baseline-assessment of cost-effectiveness

Employed resources	Benefits
-Human resources of different kinds. -Consultancy costs (eg. Legal, fiscal, etc.). -Assets operations & maintenance. -Provisional funds to guarantee external financing. -Financing costs. -Real estate-related costs (eg. Rental, facility management, etc.).	-Dedicated leadership for PCED. -Prioritisation of public interest in urban development. -Internal budget provided by the municipality. -Revenues for the sale of assets or services. -Speed up and securitization of operations. -Enhanced flexibility and decision-making process vs. Traditional public administration.

Table 18: Baseline-assessment cost-effectiveness SP6

5.6.3 Scaling drivers & barriers

Scaling drivers:

- **Government support:** Urban orchestrator solutions are often initiated by a public body, e.g., municipality, which aims to ensure its future success. A clear vision and dedication to urban orchestration projects can be a crucial driver for their success.

Scaling barriers:

- **Setting up a governance structure:** Gathering the relevant partners and being able to drive the city's departments. Indeed, the logic behind setting up a PCED relies less on the core business of a city (exploiting public services) and more on a logic of exploitation, highly uncertain in its pathways and results. Strong governance leadership is crucial (e.g. the chair of the SPL Lyon Confluence is the Mayor of Lyon), as well as a daily intelligence in the operational relations with the city's department.
- Establishing public-private partnerships and finding pathways to build sustainable business models and financing schemes. See, for instance, the ElectriCITY project or the Lyon Energy Council.

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- **Dealing with citizens and civic organisations (NGOs):** Findings of other SCC projects show many excellent practices, ranging from information co-creation to innovation lab. Challenges are essential and frequently flawed with wrong reasoning, stating citizens must change for the greater good or a grand idea. However, the real challenge for cities is to accept that citizens can act and take ownership (like the Rotterdam example) by developing and implementing ground-breaking projects in a more distributed governance approach.

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6. Reflection and key findings

This state-of-the-art assessment sheds light on the best-practices, opportunities, and challenges of solutions intended to develop and accelerate the implementation of PCEDs across Europe.

In **Lyon**, the solutions seem mature on a technical level but are still in piloting mode as integration between technical, operational, and governance requires time to mature. Lyon district relies heavily on SPV, SPL Lyon Confluence, for the urban area and LPA for the micro-mobility hub. In **Munich**, tools have also been created to support the deployment of solutions from advising, combining finance, and even transforming into an energy provider for Isarwatt. Blended finance gathering grants, tax rebates, and private funding are combined to provide market incentives to households, tenants, or owners to refurbish or create an energy community. Solutions from the **Multiplier Cities** also show that SPVs, or dedicated vehicles created and managed by cities to coordinate the process (e.g., Porto) are used. An in-house company can be established to develop an urban data platform, for example, to overcome a talent attractiveness problem or test and roll out a technical innovation that can provide at lower cost heating and cooling from the water pipe.

We can highlight several commonalities and challenges among the solutions analysed:

- **Most of them require a broker, an intermediar**y capable of connecting the dots, facilitating access to the service, and combining different public funding sources. In Munich, Isarwatt and MGS play this role. This is also true **for** Porto, where the various agencies can coordinate the project and bring the required expertise. SPL Lyon Confluence represents another step, using the land property as a lever to negotiate higher standards in terms of performance with developers.
- **Regulation and permitting are essential barriers.** We can see that in Porto, where the Energy Communities are a First-Of-Its-Kind in Portugal, but the permitting process from the national level is lengthy and offers no visibility.
- **Indeed, PCED and its portfolio of interventions look increasingly like a service model,** where an orchestrator organises and combines the different actors of the value chain and the different fundings to provide and guarantee a service.
- **Data is a lever and the raw material of PCED.** We can see very different types of organisations between:
    - Munich, with a powerful IT department providing cutting-edge tools to functional departments;
    - Prague, who, for talent attraction reasons, created an in-house public company that not only develops tools but also advises and uses agile methodologies to build specific applications; and
    - Lyon, with a district platform designed and built at the district scale and embedded in the metropole data platform.
- However, **digital transformation at the municipality level seems to lag** and is not being correctly addressed. Solutions like Digital Twins or serial refurbishment requiring 3D

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models face barriers. As mentioned several times in our discussions, the end-user mindset seems not ready to change to embrace these tools. However, methodologies such as the one deployed by Golemio (scrum methodology with a product owner and an end-user-driven approach) are promising pathways to address the challenge.

- **A certain reluctance is strangely coming from the digital aspect of the PCEDs**. Governance is very well established (Prague, the Golemio platform or the Open by Default approach of Munich). But the role of the platform is to monitor or to allow better urban planning (digital twins), and cities seem very shy to envision the adoption of a more distributed or open-source approach (opening the platform to a community of developers) or to allow for instance credits for citizens to build applications or projects.
- Most of the solutions can be considered as nearly mature, with few First-Of-Its-Kinds (Budapest and Porto can be considered as First-Of-Its-Kind by certain aspects). However, they **lack substantial elements and data to scale**. They are **designed and managed to fulfil pilots** of a specific size but are **not scalable by design**. There is a **lack of basic data to understand and build business models, creating financing schemes that can support and enable growth**. City strategies often pile up grand design and objectives without addressing the conditions (human, competencies, organisation, finances, resources, ecosystem capability) to scale them.

A note on funding mechanisms for PCED implementation

General view on the market

Many previous EU funded projects and initiatives already delivered well-structured screening of available funding mechanisms with the aim to map the potential financial instruments to finance the development of PCED or Solution Packages individually. Some examples are represented by the public resources developed by the projects Making-City (D6.7 Financing Solutions for Cities and Suppliers), NESOI (D1.5: Mapping of Financial Instruments), Sharing Cities Playbooks, Innovative Financing Scheme – Lessons learnt from the Covenant of Mayors Community, Prospect+ Learning Handbooks to quote only a small part of them. Amongst these sources of experiences and information, two searching tools can be highlighted as very relevant for the purpose of ASCEND scope and beyond:

1) the financing opportunities searching tool accessible via the Covenant of Mayors website (https://eu-mayors.ec.europa.eu/en/resources/funding_guide): this tool guides the user in the understanding of different categories of public and private funding options broken down in five macro categories: Shared Management Funds, EU Funding Programmes, Technical Assistance and Advisory Support, Financial Institution Instruments and Alternative Financing Scheme. More recent support services are also listed and explained such as the European Public-Private Partnerships Expertise Centre, Smart Cities Marketplace (SCM), the European City Facility (EUCF), etc.
2) The National Energy Support Scheme dashboard developed by the Investor Dialogue Initiative of the EU Commission (https://dashboard.tech.ec.europa.eu/qs_digit_dashboard_mt/public/sense/app/11845c6b-bcec-4206-ba5c-ead9df5dfb24/sheet/6cc936ff-78e9-4d5e-8354-8e37f81d4f9b/state/analysis): this tool allows the user to navigate amongst a large database of more than 500 financing instruments that can be filtered by country, targeted energy

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segment and financing instrument type (loan, equity, semi-equity, guarantee, blended finance, grant).

The above-mentioned tools are particularly relevant as they are dynamic databases, the information of which is updated periodically by the developers, and they have an extended view on the financing market including a wide range of financing types and technical assistance for financing. All these openly available materials are strongly valuable to upskill the financing expertise of cities and provide examples of case studies to replicate.

Focusing on ASCEND Solution Packages

At this stage of the project, the interviews carried out with LHCs and MCs could not provide comprehensive information about the funding mechanisms explored by the cities to fund and scale up their projects yet. It seems the approaches amongst ASCEND cities are heterogeneous in project maturity and depth in financial analysis expertise. Some of them are at the early stage of development and do not have clear analysis of the financial parameters to be able to quantify the whole need in capital or their financing strategy (i.e., CMS Urban Data Platform in Lyon; Heat exchanger for drinking water application in Budapest); other initiatives seem to strongly rely on the city budget and grants (i.e., Digital Twin and Mobility Points on public ground by City of Munich; Micro Hub in Lyon); a few of them expressed the goal to leverage and attract private investments to scale up their current projects, but they had experience mainly with grants so far (i.e., Golemio Data Platform in Prague; Isarwatt in Munich; Social Housing Complex of Agra do Amial in Porto; installation of electric car chargers in Alba Iulia). Part of the initiatives, mainly focused on energy efficiency renovation of buildings, relies on the capability of private individuals/entities to privately fund the investment which is only partially supported by National grant schemes in a few cases (i.e., social housing renovation project by MGS and Mobility Points on private ground in Munich).

ASCEND implementation (through WP5 activities) aims at supporting cities in reaching a higher projects' maturity with the vision to upscale their current initiatives. This will be possible only if the technical development is supported by enhanced financial and risk assessment expertise and acknowledgement of non-monetary benefits triggered by the implementation of PCED.

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Annexes

Methodology

Questionnaire Template

General information on the solution

- What is the name of the solution?
- Which city is the solution located in?
- What is the solution about?
- Who operates the solution (city, municipal company, private company)?
- How does the solution contribute to a PCED?
    - Reduce energy consumption city (yes/no):
    - Produce renewable energy (yes/no):
    - Make the district cleaner (yes/no):
- What is the impact of this solution on the district´s energy demand? (estimation of the district´s energy % reduction or Non-RES energy replaced by RES production)
- What are the main characteristics of the solution´s place and context (typology of buildings, use, size)?
- What kind of energy production systems are there in the city/closer districts now? (heating+cooling & electricity)
- How is the typology of citizens living in the buildings close to the solution? And the district around?
- To which ASCEND Solution Package is this solution best attributed to?
- Name and email of person filling out this document:

Technological analysis

- Which technology is being used? (Heat Pump, Solar Thermal panels, PV panels, Heat recovery, Biomass, Geothermal, Short-term thermal storage, Regional Thermal grid. Provide a short description)
- What are the technical requirements of this solution? (what kind of infrastructure, components?)
- Do you need data for this solution? What data? How did you tap into the data?
- Does it include monitoring? If yes, what type of monitoring? For how long?

Business model analysis

- What is the value proposition of the solution? What are the reasons to implement this solution? What important pain points or problems does it solve?
- Who are the target customers of the solution? Who is the user? For whom does it create value? (please note that a solution can have more than one customer / user)
- Which key activities need to be performed for the solution to work and create value?
- Who is involved to deliver these activities (public bodies, utilities, private companies like technology providers, citizens, other key partners)? Please list all the key stakeholders involved in the solution.
- How is the collaboration between the stakeholders organized? What kind of contracts exist between the partners? Do there exist public-private-partnerships?
- What kind of resources are needed for the solution (human capital, technology, financial resources, others)?

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- How does the solution capture environmental, societal and economic value (improved quality of life, generation of revenue, cost reduction, reduced energy consumption, other)?
- What are the revenue streams generated by the solution? (usage fees, subscriptions, government contracts, data monetization, others; just name them, no numerical data required)
- What are the biggest cost factors associated with developing, deploying and operating the solution? (just name them, no numerical data required)

Funding mechanisms analysis

- What is the overall budget needed to develop and implement the solution? Which % of budget is covered by funding from the EU?
- How is covered the remaining % of costs? What are the current available sources of financing for the solution?
- Do you involve building owners / tenants in any payment? How?
- Would you be able to raise/ find further financing to replicate this SP elsewhere in the long-term?
- What specific financial challenges are the cities facing in the urban regeneration project?
- What selection criteria do the cities prefer for the financing schemes?
- Are there any preferences or restrictions related to environmental sustainability and clean energy for the financing schemes?
- Are there any public-private partnerships or collaborations with external entities that may influence the financing schemes?
- Did you consider any innovative financing schemes or new investment models in urban regeneration or clean energy (eg; different from bank loans or City's own budget)?
- Do you have any expectations in terms of payback periods or returns on investment for the proposed financing schemes related to the solution?

Procurement procedures analysis

- Who is or was in charge of retrofitting / construction / installation activities if they are or were necessary for your solution?
- How is or was the company selected? Is any tender process necessary? How is this deployed?
- How is the execution of the works carried out?

Governance models and policies analysis

- How is this solution supported by local, regional and national policies? Is it a priority highlighted by a strategic vision and joint program?
- What are the main levers for policy making?
    - Financing and funding
    - Research and innovation
    - Education
    - Awareness
    - Regulatory aspects
    - Others
- Could you describe the governance scheme for the solution design and deployment? (Is it public led or PPP, how are civil society or citizens engaged, consultation information, co-creation, behavioral changes and nudge, project owners, others)
- What are the main challenges in terms of policy making and governance?

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- How is the ownership/management of the buildings/grid where the solution has been deployed?
- Is there any legal restriction/incentive related to the electric grid or energy efficient measures?

Closing questions

- Why do you think can this solution be considered a State-of-the-Art solution (e.g. results, impact, innovative approach)?
- What are key metrics / data showcasing the success of this solution?
- What are the most crucial success factors for this solution?
- What are key challenges when it comes to this solution and what do you do to overcome them?
- Do you think that this solution is scalable or replicable? Why / why not? (things to consider: how adaptable it is to other PCED conditions? How easy is it to implement? How easy is it to operate, CAPEX needed to implement the solution? What requirements would the cities need to have (e.g. pre-existing Lorawan, sensors…))
- Has this solution been
  - Rolled out in the city (yes/no):
  - Replicated in other cities (yes/no):
- What are the biggest challenges when it comes to widespread adoption of the solution and how are or could they be addressed?
- Is there anything you would like to add that helps us better understand the solution?

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Solutions write-ups

SP1 – Technologies & Digital Tools

Munich: Digital Twin

{intro}: The Munich Digital Twin solution aims to provide a use-case orientated tool to support decision-making in urban planning, compute analysis and simulations, improve efficiency in the city administration, and visualize planning scenarios for optimal citizen information and participation - through the continuous interaction of the real city with its digital representation. This is achieved by supplying a shared infrastructure and data standards for geodata capable of integrating sensor data, as well as analytic and (2D and 3D) visualization tools. The solution can be used city-wide indifferently to building typology, use or size.

{business model + funding}: The Digital Twin primarily targets decision-makers in politics and administration, city planners (decision-support tool), as well as citizens (visualization). It can be used for communication within the project team, towards decision-makers but especially towards the public. It can greatly enhance motivation to actively contribute to PCED by displaying and illustrating the impacts and potential future outcomes, fostering a deeper comprehension of the positive effects resulting from one's actions. At the same time, it is possible to simulate and monitor changes in the district. The solution can contribute to a better quality of life for citizens, e.g., by providing information on urban infrastructure and planning, and fostering citizen participation. It can also support cost reductions and potentially reduce energy consumption by process optimization mostly aimed at the city administration. Availability, harvesting, analytics and distribution of data are the essential key elements for a beneficial use of the Digital Twin as a decision and planning support tool.

{technology}: The solution includes the following digital technologies: Digital Twin, geodata services, sensor technology / IoT, ETL/data integration technologies, platform solutions (frontend/user interface), 3D visualization (e.g., dashboard tool, 3D visualization engine) and simulation. The Digital Twin can be used to support monitoring. The data held and used in the Digital Twin is documented and can be monitored and evaluated.

{governance + procurement}: The Digital Twin is owned and led by the City of Munich. The development of Urban Digital Twins in cities is supported by several national and European funding and projects. It is also part of the city's local digital strategy, and there is currently a cooperation between the City of Munich and the Technical University of Munich.

{replicability and scalability}: Urban Digital Twins are highly replicable and can be deployed in various scenarios and use cases. Its implementation relies on existing IT infrastructures and capacities regarding geodata / geoinformatics and IT management. Utilizing open-source technologies and adhering to industry standards wherever possible further contributes to the replicability of the solution. Numerous cities are working on Digital Twins to be able to meet the ever-increasing challenges of a city.

{innovation}: The concept of Digital Twin is increasingly widespread in European cities, with a lot of investment in the digital representations of cities and their proven benefits. Munich has been working on its Digital Twin project since 2018 and can be considered a pioneer among cities in Europe. Once this knowledge is widely disseminated, with experts from different disciplines contributing with data and expertise, digitalization can be increasingly used to support the development of PCEDs.

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Lyon: CMS Urban Data Platform

{intro}: The CMS (Confluence Monitoring System) is an Urban Data Platform located at the Confluence District in Lyon, focusing on energy and environmental data monitoring. UDP technology is sourced to a specialized software solution provider. SPL Lyon Confluence oversees the platform usage & operations, and Urban Practices is the project coordinator of the UDP platform. The solution contributes to energy consumption reduction through a better understanding and monitoring of energy consumption at building and district level. CMS is embracing all building types (residential, commercial, services, public, new, refurbished, already-existing ones, etc.) located in the Confluence district, therefore potentially impacting Confluence inhabitants and commuters.

{business model + funding}: The CMS is a platform for aggregating, processing and visualizing data of heterogeneous origin and nature. As such, it must have functions that are usually found in different types of solutions: GIS (Geographic Information System) for urban mapping capabilities, IoT platform for ingesting "real-time" data streams, database engine/development platform for creating specific use cases, data visualization to create specific views and dashboards. Land developer SPL Lyon Confluence is the main target user of the CMS. Aggregation of heterogenous data and systems with the support of key stakeholders (data providers) such as building developers, urban service operators (e.g. Enedis Dalkia), public open data operators (e.g., Grand Lyon, CSTB) is key to success.

{technology}: CMS is a data platform, having as technical requirement a robust IT infrastructure (e.g., servers, cloud services, UDP system framework, Open API to 3rd tier services, data exchange agreements with project stakeholders, etc.). Data needed include electricity consumption, water consumption, local electricity production, district heating consumption, local weather station, outdoor air quality, indoor comfort (temperature, humidity, CO2 at building level), GIS data for the district map, among others.

{governance + procurement}: Data sharing agreements between Land developer SPL (operator of the CMS platform) and key stakeholders have been written and validated by a lawyer.

{replicability and scalability}: The purpose of this solution is to be replicable, based on this pilot version of CMS which is currently running as part of a previous innovation project (H2020 – Smarter Together).

{innovation}: This is one of the few, if not only, solutions of this type in the French market. CMS is solving a very basic need of a land developer in charge of monitoring its public and environmental policy in the territory it has responsibility for. The key metrics to monitor the success of the solution are number of buildings sharing data with CMS, availability, and completeness of shared data sets managed by CMS.

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Prague: Urban Data Platform Golemio

{intro}: Golemio Urban Data Platform belongs to OICT, a city company owned by the City of Prague, focused on technological and smart city solutions. It works and cooperates closely with the city of Prague, the Smart Prague Department, and other municipal institutions. It is an open-source data platform which provides different municipal departments and citizens with data platform, business intelligence (BI) and customized web applications.

{business model + funding}: OICT was founded in 2014 by the City of Prague as a strategy to gain agility in delivering city services related to Smart City & Innovation, Transport solutions, Digitalization & robotization and IT services. Its purpose is to use the potential of data to support urban decision making, thus making better livable cities by focusing on city data processing and analysis, data-based web creation, and open data community building. Its main target customers are the City of Prague, and citizens. The solution creates environmental, societal, and economic value by capturing the information value about the district impact and performance. Its revenue stream comes from contracts with the municipal government and other municipal institutions, and the main cost factors are human resources and hardware infrastructure. Multiple metrics are in place, e. g. retrofitting potential of monitored building stock including kWh/a or CO2 saving.

{technology}: In addition to the IT infrastructure, complementary technologies are needed, such as smart meters and sensors to enable integration to the data platform.

{governance + procurement}: According to Prague's Climate plan from 2021, the city should reduce CO2 emissions by 45% by 2030 compared to 2010, aiming at carbon neutrality by 2050. Smart solutions such as Golemio will contribute to these goals and have been supported by the municipality. Buildings and infrastructure are owned by the city of Prague. Typically, the smart meter is installed and operated by the distribution company requiring separate agreement on data provision to the building operator. However, this issue is getting gradually solved by cooperation between OICT and Pražská energetika and other utilities.

{replicability and scalability}: The solution was developed with scalability in mind. The source codes are available to be adopted by other potentially interested stakeholders, having as minimum requirements human capacity with IT know-how. Other cities or local governments would need to permanently hire at least a minimum number of IT staff to successfully implement and maintain the running solution.

{innovation}: The innovation of Golemio lies in the institutional set up, being an independent and agile city-owned company, as well as in the service delivery of open source, scalable, cybersafe, citizen engaging, user-friendly solutions suitable for decision makers.

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SP2 – Energy Communities & Prosumers

Munich: Photovoltaics Tenant Electricity Project

{intro}: The Photovoltaics Tenant Electricity Project consists of locally PV-produced electricity that is locally consumed by residents. The solution is offered by Isarwatt, a Munich-based energy cooperative formed by 22 housing companies. Isarwatt has installed 6 tenant electricity systems in Prinz-Eugen-Park (PEP), with a total output of approx. 750 kWp. One kWp produces an average of 1,000 kWh per year. This means a total production of 750,000 kWh per year in PEP. On average, Isarwatt can cover around 40% of the electricity requirements with their tenant electricity systems. The solution is deployed in a new housing project of wood construction apartment buildings of 70 to 100 housing units each.

{business model + funding}: Tenant electricity is beneficial for residents and owners as they can access cheap, clean, locally produced energy. In addition, it strengthens the household community, contributes to the CO2 balance for building owners and to energy transition in the city. Activities include coordination with the building owner, installation of the modules, AC installations, coordination/registration of the system with the network operator, implementation of the measurement concept and customer advertising. Revenue streams include income from electricity sales, feed-in tariff (EEG), tenant electricity surcharge, project planning fee. Isarwatt usually receives a loan from the housing companies to implement the solution, which is repaid with interest.

{technology}: Photovoltaic systems and/or combined heat and power plants are used to generate electricity. The clean electricity produced on site is delivered directly to residents, which results in reduced network fees and other taxes. The partner Naturstrom AG supplies the amounts of electricity that cannot be covered by the solar system on the roof or by the combined heat and power plant in the basement via a hydroelectric power plant. The technologies needed for the implementation of the solution include connection to the public power grid, connection of the PV to the main distribution, installation of a PV production counter and a totalizer, customer billing counters, radio ripple control receiver for the network operator, PV panels, inverter, internet connection for monitoring.

{governance + procurement}: Isarwatt is responsible for the full electricity supply for its customers and relies on the following contracts for a successful operation: building owners, SWM Infrastructure (network operator), additional electricity provider, measuring point operator, billing service provider. The city of Munich supports the installation of PV Panels via the Funding Program FKG

{replicability and scalability}: Isarwatt has already implemented 53 plants in and around Munich, demonstrating a high level of replicability of the solution. Scalability would depend on Isarwatt operating capacity and access to larger sums of loans from its associates, which according to Isarwatt is favorable, as the housing companies increasingly need their services, and due to availability of many suitable rooftops for PV installation.

{innovation}: The solution can be considered a best practice as it represents a pioneer governance model, being a cooperative offering a complementary service to housing companies in need of clean energy solutions. Although there are other companies starting to deliver similar services, Isarwatt is still one of the only cooperatives of this kind.

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Lyon: YDEAL Confluence

{intro}: The Ydeal Confluence project consists of sharing the electricity produced by a roof-top PV system among a group of residents of a 5 buildings complex at La Confluence district. The 5 PV systems are property of the owners' association (Le Soleil d'Ydeal Confluence), set up for this purpose, and the production of the PV system is managed by the DSO, who subtracts the production from the consumption of each user on a monthly basis, shares the result with the electricity supplier, who then bills the actual energy consumed minus the share of the local production given to each user**.** The local electricity consumed is financed by the electricity users on a fixed monthly fee of 3 euros each.

{business model + funding}: This solution meets several energy-related challenges facing local players. Firstly, the cost of locally generated electricity is lower than that of electricity supplied by a traditional supplier, so it is largely immune to crisis-related price rises. Secondly, under a system of state-guaranteed feed-in tariffs, the value generated by photovoltaic systems benefits investors who are often foreign to the region. Further key stakeholders are building owners, as the installation of PV panels increases the worth of their buildings. The solution creates environmental value as it makes renewable energy more widely accessible. Also, it creates economic value by reducing the price paid by users for locally produced renewable electricity compared to conventional electricity. Finally, it creates societal value as the energy produced locally stays within the city, decreasing electricity costs, which is especially beneficial for lower income residents. The financial model is based on lower energy costs for the residents.

{technology}: The technologies needed for the implementation of the solution include PV panels, electric smart meters, battery, in addition to the infrastructure of the DSO to collect and process all production and consumption data at a 30-minute time step. The production and consumption data come from the PV panels, which are monitored through electric smart meters.

{governance + procurement}: This solution is based on the possibility to share locally the production of a PV system that is called Collective Self-Consumption in the French Energy Code (Article L315-2). There is a contract between the DSO and the dedicated not-for-profit organization (in this case Le Soleil d'Ydeal Confluence) to regulate the way the energy produced is split between users. The 5 PV systems are property of the owners' association.

{replicability and scalability}: Within ASCEND, this solution will be replicated in the PCED of Lyon. To be replicable outside France, this requires smart meters to be installed by the Distribution System Operator (DSO). It is rather easy to implement as it has a clear business case for the users and building owners, which makes it attractive for other users / owners as well.

{innovation}: The solution can be considered best practice, as it demonstrates how the electricity produced by a roof-top PV system can be shared between a group of users. Despite operational difficulties to commission the battery of this building block, this project remains a best practice. Key metrics: 5 buildings, 5 PV systems, total power of 174 kWp, 150 users, storage system of 200 kWh.

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Porto: Asprela + Sustentável

{intro}: Asprela + Sustentável aims to transform a vital area of the city of Porto into a pioneering case of sustainability and solar energy management, acting as a driving force for the energy transition and carbon footprint reduction in Porto. It's a multistakeholder project that brings together European, municipal, and private funding, as well as the academia, health institutions and municipal organizations. The Social Housing Complex of Agra do Amial and the local school host the first Portuguese renewable energy community fully promoted by a municipality. The solution is operated by Porto Energy Agency, Águas e Energia do Porto and Associação Porto Digital, as the main representatives of the Municipality. The expected energy production from the combined PV system shall reduce the grid energy demand by about 26%.

{business model + funding}: For the residents, the solution will provide locally produced renewable free electricity for 5 years, as an energy poverty mitigation strategy. For the municipality, it offers a best practice to be replicated. For the companies involved in the consortium, it represents an opportunity to pilot and fine-tune storage, charging and other technical solutions. Potential revenue streams are usage fees, data monetization, and subscriptions. The overall budget for the solution is 1.8 M€, of which 55% is funded by the EEA grant (mainly for human resources), while the assets were financed by private partners and municipal budget. Financial incentives from the Recovery and Resilience Plan can be used to replicate this solution in other city neighbourhoods.

{technology}: Technologies used are PV panels for the Social Housing Complex of Agra do Amial and the local school, storage systems including 2nd life batteries + battery container, and 3 electric chargers for public use. For implementation, the solution required the PV installation, smart metering, licensing from the PV/storage installation and charging points, and wi-fi infrastructure. Consumption, production, and injection data is collected through smart meters. Also, real time monitoring of the whole community will be done through a platform provided by the Portuguese DSO, which will enable monitoring of the whole system during the project lifetime.

{governance + procurement}: The solution is being implemented under "Asprela+Sustentável", an EEA-Grant funded project, through collaboration between various stakeholders. Coopérnico is the official project coordinator, AdEPorto is the technical coordinator, plus 11 additional stakeholders (https://asprelamaissustentavel.pt/parceiros/). The PV installation was contracted through a tender process led by the city. This solution is supported by the main national energy policies, namely the 2030 National Energy and Climate Plan and the 2050 Long-Term Strategy to Carbon Neutrality. Locally, it is fostered by the 2030 Sustainable Energy Action Plan and the Porto Climate Pact.

{replicability and scalability}: Although the solution's main target is Agra do Amial inhabitants, the municipality has an investment plan to replicate it across the 50 social housing districts of Porto as well as all the municipal facilities. Also, it will be the basis of the PCED of Lordelo do Ouro e Massarelos. Part of the solution is replicable to the remaining social housing neighbourhoods in the city. Storage and charging infrastructures can be replicated subject to private investment. Financially, the solution is replicable through the recovery and resilience plan and through ESCO models.

{innovation}: This is a state-of-the-art solution as it tests a set of technical solutions that were not tested together before in Portugal. The innovative approach combines production, storage, and e-mobility, and the potential impact on energy poverty alleviation. Also, the wide range of stakeholders involved renders the project highly collaborative and resilient. Finally, the overall project combines sustainable mobility actions, energy efficiency, renewable energy, circular economy, and citizen involvement, based on innovation and new business models, setting the foundations for a positive energy district.

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SP3 – Energy-efficient Buildings

Munich: Refurbishment with prefabricated elements

{intro}: MGS, a publicly owned subsidiary of GWG (responsible for social housing in Munich), is introducing a social urban renewal solution by using prefabricated elements for the facade and roof of private and public buildings. Their role is to raise awareness and advise owners to refurbish their buildings to a high efficiency standard replacing non-RES for RES. In addition to better efficiency standards, it produces renewable energy due to integrated photovoltaic systems, integrated ventilation and heating systems, thus reducing CO2 emission. The refurbishment can achieve 50 % up to 90 % savings in the heating demand. The solution can be applied to any kind and size of building.

{business model + funding}: Prefabrication enables minimal onsite building time. The elements are built in a safe environment (free from weather impact), with high precision that reduces manufacturing defects, thus leading to reduced installation costs on site. The main target users are owners of buildings needing refurbishment, who can benefit from a much lower construction time and a more precise refurbishment. As a result, tenants profit from lower energy use, better living climate, and lower energy costs. Other key stakeholders of the solution's value chain are building companies, planners, architects, public bodies, and neighbors. This type of refurbishment leads to higher living conditions, lower energy consumption and costs, and lower construction costs for building owners.

{technology}: The main technologies involve photovoltaic panels, prefabricated facade elements with insulation and triple glazed windows that can also include PV panels and ventilation systems. The buildings must be previously scanned and digitalized into a 3D model, so that the prefabricated elements can be manufactured accordingly. The refurbishment effect is monitored in terms of the building's heat usage before and after the intervention, to verify the decrease.

{governance + procurement}: The projects must be specially tendered as prefabricated refurbishment in order to reach specialized construction companies. According to the federal funding programs and the Münchner Förderungprogramm Klimaneutrale Gebäude (FKG), funding can only be requested when reaching specific standards in refurbishment (highly efficient buildings). Also, contracting models can be offered as an alternative to ownership for heating devices.

{replicability and scalability}: The solution is highly replicable and scalable, subject to the availability of specialized planning and construction players. In terms of scalability, construction costs decrease as the demand increases due to the economy of scale of the production of prefabricated elements. The solution has already been carried out in different countries, including Germany, and demand tends to increase in the near future.

{innovation}: Refurbishment with prefabricated elements leads to highly efficient buildings with more precise construction, less onsite time and construction costs. The solution is innovative as it combines facade elements PV and possibly with greenery, a technology still in its early days. The necessary, highly integrated approach among the planners team also represents a certain degree of innovation.

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Lyon: Super-efficient buildings

{intro}: The aim of this solution is to massify the production of energy-efficient buildings at the Lyon Confluence district, as a strategy to make cities more energy-efficient, and to develop renewable energy production, starting with a group of buildings equipped to reach high energy performance with reduced energy consumption (-26%) and renewable energy production, covering between 20% - 100% of energy needs with renewable energy. La Confluence is an urban project in the center of Lyon with a strong functional mix (offices, housing, public facilities, shops) as well as a social mix.

{business model + funding}: The solution creates mainly environmental value as it reduces energy consumption and makes renewable energy more widely accessible. Lyon Métropole (Greater Lyon Authority) has granted a concession to the developer SPL Lyon Confluence. The SPL Lyon Confluence designs and builds the public spaces and sells the serviced plots to real estate developers, who must comply with specifications concerning construction and energy performance of the buildings. Key stakeholders are the urban developer (SPL Lyon Confluence), real estate developers (and their architects and engineering companies), buildings' owners and residents, and construction companies. Extra costs associated with environmental performance range between 10-15% of the construction cost.

{technology}: The technologies needed to deploy the solution include photovoltaic panels, external insulation, Building Operating System (BOS), and require the availability of power grids. The data to be collected and monitored during the demonstration period comes from the photovoltaic panels and from de BOS, through electric smart meters. The data is collected and processed by the DSO (Distribution System Operator).

{governance + procurement}: SPL Lyon Confluence is responsible for organizing the district development, acting on behalf of the municipal authority as a link between public and private players. The environmental performance of buildings is one of the major local challenges of Lyon's commitment to climate neutrality. The price at which land is sold to developers is fixed at the time of the call for projects, meaning that the competition between developers is solely based on the quality of the project in terms of environmental performance, rather than on financial advantages.

{replicability and scalability}: To reproduce this solution, cities need to meet at least three important criteria: control of land ownership, creation of an SPL capable of managing a long-term project and strong political will to achieve the objective. The massification strategy shall reduce construction costs, which remain a barrier to the massive replication of these solutions.

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Budapest: Heat exchanger with potable water

{intro}: Budapest Waterworks (BW), a publicly owned water utility service provider, has designed an innovative technology aimed at harnessing the excess heat capacity of potable water, by integrating a heat exchanger for drinking water into standard heat pumps, providing heating and cooling for surrounding buildings. The solution is at Budapest's District IV and jointly operated by BW and the heat pump operator. It reduces energy consumption and produces renewable energy locally. The pilot project's target building is a former school, to be converted into a pilot co-housing initiative.

{business model + funding}: Since 2017 the technology has been successfully prototyped and funded by BW. For the target groups (building owners, households, industrial complexes), the new heating technology will provide cost reduction with reduced energy consumption, compared to traditional technologies, decreasing carbon emission, and improving air quality. From a social perspective, the residents will access affordable heating/cooling from a green energy source, and new working places will be created. The project encompasses two main revenue streams, namely a monthly bill paid by users to BW and the electricity provider (unless the building utilizes solar panels). The overall implementation budget is €600,000 – to be funded by external partners.

{technology}: The heat exchanger is connected to the underground drinking water pipe system and utilizes its excess free heat capacity. The heat exchanger is connected to a heat pump through a safety circuit. At the design phase, data from the water supply system is needed to select the correct section of water pipe for the heat exchanger installation and data on the building's energy demand (e.g., building size and consumption estimate). The required minimum water pipe diameter is DN 300 and the minimum flow rate in the pipe is 0,2 [m/s] for the technology. During the operation, an automated smart control technique allows to read all the main parameters and thus adjust the heating/cooling system accordingly. Also, continuous monitoring is needed regarding velocity, pressure, temperature.

{governance + procurement}: The main stakeholders involved in the design and implementation of the solution are BW, Municipality of Budapest, Municipality of the IV District, and subcontractors. The solution is supported by various regional wider strategies, such as SECAP of Budapest, Integrated Urban Development Plan of Budapest, Sustainable New City Parts of Budapest Manual, Smart Budapest (Smart City Framework Strategy), Environmental Protection Program of Budapest, Green Infrastructure Project of Budapest, and the BW sustainability plan.

{replicability and scalability}: This heating technology can be replicated to other locations, subject to local availability of the heat source and the necessary water pipe dimension and minimum flow rate close to the target building. For the upscaling, the manufacturing process could be optimized with standardized sections with various diameters, resulting in lower manufacturing costs and time. Private companies have expressed interest in the technology, and the Climate Department intends to map this solution not only for the BW pipelines, but for the sewage system as well.

{innovation}: The solution is highly innovative as there are no other heat exchangers using the excess heat capacity of drinking water, without posing water quality risk and causing pressure loss in the pipe network. The technology provides sustainable heating technology, which coupled with solar panels, can potentially reach zero emission. The technology is more efficient than conventional heating systems and reduces the operation cost of heating/cooling.

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SP4 – Mobility & Freight

Munich: Mobility Point

{intro}: Led by the City of Munich and co-designed with local stakeholders, the Mobility Point solution aims at reducing fossil fuel consumption and thus contributing to the climate and to a more sustainable city environment, while keeping residents and visitors mobile. By 2026, 200 mobility points will be built citywide on both public and private ground, of which approximately 35 are already in operation. A Mobility Point is a bundled offer of shared mobility vehicles and services concentrated in one place (e.g. carsharing, bike sharing, rental bikes, e-scooters, cargo bike sharing, bicycle repair station), providing attractive sustainable alternatives to private cars as well as a convenient complement to public transport. The City of Munich provides the physical infrastructure (parking spaces, marking, signage), and the vehicles are offered by various private providers.

{business model + funding}: For users, Mobility Points offer alternatives to private vehicles and a complement to the public transport network. For the providers, they offer a wider infrastructure for mobility service delivery. Also, they contribute to a wider local strategy of reaching climate neutrality by 2035, offering citizens a city environment with improved accessibility, reduced CO2 emissions and traffic noise, inclusion, space and economic efficiency, diverse mobility offers, more green areas. The construction of the Mobility Points is funded through a city council resolution until 2026, after which there will be an impact evaluation to support the decision on the continuity strategy.

{technology}: Data-based parameters are used to support the location selection of the Mobility Points, such as a heatmap to track space availability. Also, digital tools such as an App and a website aim to facilitate access and usage of the solution.

{governance + procurement}: Participatory governance measures include channels for citizens to contribute to the selection process of locations and mobility offers (www.unsermuenchen.de), which can generate engagement and adherence to the services. In addition, proposals from district committees and shared mobility providers with further suggestions are reviewed and matched with various data sources. Public-led contracts and procurement tenders will allow sharing providers to park in all Mobility Points for a monthly fee.

{replicability and scalability}: Mobility Point is a positive pull-measure as it offers multiple convenient alternatives to reduce private car ownership, keeping citizens and visitors mobile. It proves to be a highly replicable and scalable solution due to its simplicity, low cost and fast implementation. In addition to the 200 Mobility Points planned for the city of Munich, the model is being replicated in other German cities such as Bremen, Nürnberg, Erlangen, Kempten and Rostock.

{innovation}: Mobility Points offer a reliable and simple mobility alternative citywide rather than restricted to specific districts. The solution has been already tested and considered as an efficient measure to reduce car driving and car owning. The multistakeholder approach is an additional innovation factor, as it strengthens the local mobility ecosystem while engaging and empowering citizens from the beginning.

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Lyon: Micro Hub

{intro}: The Lyon Micro Hub is an innovative logistics solution implemented in Lyon as part of the LEAD H2020 project. This initiative repurposes the existing “Parc Marché Gare” underground car park to host a variety of logistics services. Its primary aim is to help users comply with urban pollution regulations while maintaining their delivery and business activities. Specifically, it provides a low-carbon storage area for delivery vehicles and a load break zone, enabling goods and parcels to be transferred from heavy, polluting vehicles to lighter, low-carbon means of transport. The services are provided by different private companies.

{business model + funding}: The Micro Hub offers a low-carbon storage area and a transfer zone for goods and parcels. Facilitating the shift from heavy, polluting vehicles to lighter, low-carbon transport means significantly reducing the carbon footprint of urban logistics. This approach not only simplifies deliveries in densely populated areas but also decreases greenhouse gas (GHG) emissions and noise pollution. The hub is predominantly used by delivery companies, including major players like UPS, but could also extend its services to other businesses requiring city-center logistics, such as professional waste collection companies (e.g., SUEZ). Moreover, companies supplying site equipment for tradespeople, etc. could also benefit from the Micro Hub solution. To avoid their customers (tradesmen, building and public works companies) having to travel outside the city to large warehouses, the supplier can use the logistics hub as a temporary storage area where customers with sites in the city center can come to stock up and collect the equipment ordered the day before. The primary resource for this solution is space, a scarce commodity in dense urban areas.

The economic impact of the solution for the companies using the hub has not been fully assessed, with the financial model primarily revolving around the rental of logistics space. Since the hub utilizes an already existing infrastructure, major costs were averted. The only significant expenses were for minor installations like securing the space, installing safety signs, and setting up electric recharging points. The LEAD H2020 project provided substantial funding, with additional support from the internal budgets of LPA and SPL, the project's primary stakeholders. Reduction of costs and impacts on delivery time and quality could not be monitored nor estimated.

{technology}: The hub's technology needs are relatively straightforward, focusing mainly on the provision of electricity sockets and recharging points. While there was an initial goal to include a monitoring system to track logistics data (number of parcels delivered, volume...), this was not realized due to insufficient data from delivery operators.

{governance + procurement}: The governance structure of the logistics hub involves a special-purpose vehicle (SPV) co-owned by the Metropolis of Lyon and private shareholders. SPL Lyon Confluence is the urban developer of the Confluence district and is looking for solutions to reduce the environmental impact of mobility in the area. With this in mind, SPL - then owner of a large underground parking lot - joined forces with LPA - the parking lot manager - in the LEAD project, to develop this logistics hub. SPL Lyon Confluence and LPA both played significant roles in selecting logistics companies and establishing contracts.

{replicability and scalability}: The Micro Hub model has proven successful and replicable in other settings, such as the Cordeliers car park in Lyon and in Madrid. The main reason behind that is the business model that can be realized in existing infrastructure. Therefore, the time needed to realize this solution is limited, with the most time-consuming phase being the launch and the negotiation and signing of contracts. Moreover, no major investment is required. The primary challenge in replicating this model is finding suitable space in city centers. The project's scalability is evidenced by its replication in various locations, although its return on investment in new constructions remains uncertain.

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{innovation}: The Lyon Micro Hub is set to pave the way for the construction of a customized logistics hub by 2026. Feedback from participating logistics companies has been mixed, but the continued use of the hub by these companies indicates a market demand. This solution stands as a testament to the city's commitment to reducing the environmental impact of urban logistics. In conclusion, the Lyon Micro Hub represents a forward-thinking approach to addressing the challenges of urban logistics. By optimizing existing infrastructure and promoting low-carbon transportation methods, it offers a sustainable and efficient solution for city-center deliveries, setting a precedent for similar initiatives globally.

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Alba Iulia: Car charging infrastructure

{intro}: The Romanian municipality of Alba Iulia is leading the installation of a network of electric car chargers for private and public electric vehicles, in addition to private initiatives, given the increasing numbers of hybrid and fully electric cars, which imposed a rapid development of local electric transport infrastructure. The municipality will install 15 additional e-car charging stations in the city through a National Resilience and Recovery program-funded project. The charging stations target the general public and the municipal fleet of public transport. The solution contributes to reducing CO2 levels and reaching the municipality's sustainable goals by improving air quality at city level.

{business model + funding}: This solution is convenient for all electric car owners who want a fast and reliable energy source to charge their cars. A major advantage is the dual mode (AC/DC) charging, allowing fast and slow charge. There are currently 215 fully electric cars and more than double the number of hybrid cars in Alba Iulia (2% of all cars), which represents an estimated reduction of 9000 kWh/month and 110 kg CO2. The solution does not provide any revenue to the municipality since the electricity is sold at no cost other than the energy itself by accredited production and commercial companies. For Alba Iulia, the investment's total value is about 600.000 Euros, for an 18-month execution. Main sources of funding include Environment Fund Agency, Regional Operational Plan, Recovery and Resilience Plan. The commercial and maintenance activities will be implemented by an authorized company, selected through an acquisition process.

{technology}: The electric car charging stations rely mainly on electricity from the grid, and the needed infrastructure requires a proper space inside parking areas ensuring a medium power (over 100 kW) connection to the electricity network. When possible (considering available space and funding), optimal infrastructure that adds a PV system and electricity storage will be considered, in order to minimize energy required from the grid. Management and reporting are usually based on mobile networks and are provided by third party dedicated applications to the entire city area. Information of availability of charging stations is usually integrated into dedicated platforms, including a mobile app {www.evconnect.ro/retea/aplicatia-mobila}.

{governance + procurement}: There are currently 3 charging stations operated by the city and 12 operated by private companies. Based on a public acquisition process, the municipality subcontracts a company for the technical project and for installing the changing stations, and a company responsible for the related service on behalf of the municipality (e.g., issues billing for customers, repairs units etc). Also, there is a contract between the municipality and the electricity provider for supplying the electricity.

{replicability and scalability}: The solution is 100% scalable and replicable since there are a lot of electric cars coming into the cities and there is the need for this type of infrastructure at the local level. A close relationship with electricity grid companies, a competent private operator to install and maintain the equipment, easiness of use, availability and promotion are crucial success factors.

{innovation}: In technical terms, the solution is similar to other solutions installed in other European cities. Related solutions, like flexible applications for users, flexible invoicing of electricity allowing integration of local prosumers and local energy production can be areas of innovative development. Also, this project is related to an important project of reducing the number of old norm polluting cars, by offering a scrapping premium for them, through government funds (National Environment

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Agency) and the local budget, which completes the subsidy offered at the government level for the purchase of electric and hybrid cars.

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SP5 – Citizen-centric Solutions

Munich: Climate Council

{intro}: Since November 2021, the City of Munich has a Climate Council ("Klimarat") whose task is to support city politics and administration in implementing its climate goals. The Climate Council is a 16-member body of experts consisting of members (and deputies) of the city administration (2), the honorary city council (5) and representatives of civil society organised (NGO) for climate protection (3), business (3) and science (3) representatives. The Climate Council comments on the city's fundamental decisions on climate protection and is intended to support the city as a critical and constructive companion in achieving its climate protection goals. The meetings of the Climate Council are open to the public.

{business model + funding}: The Climate Council's main value proposition is to increase collaboration, pool know-how of the energy transition measures (energy neutrality by 2035) by the civil society, as it has an advisory function to support the city of Munich in achieving its climate targets. Thus, it creates value for both the city and the citizens, who will benefit from a cleaner and healthier city environment. The concertation around Munich's climate goals requires human capital and engagement, meaning that the voluntary time of the participants is the main resource involved in the solution. In terms of economic value, better decision and resolutions of the city council of the city of Munich can potentially generate savings in different areas such as energy, health, mobility.

{technology}: communication channels to make the process as transparent and participatory as possible (e.g. website or direct e-mail).

{governance + procurement}: The Climate Council governance is ruled by its statute and rules of procedure. Around eight meetings of the Climate Council are scheduled per year. There is a rough annual plan, and the Climate Council members should ideally receive the agenda and meeting documents two weeks in advance, so they can prepare their statements. Even if the meetings protocols are generally not yet public, the Climate Council meetings themselves are open to the public. This means that any interested person can register to attend the meetings as a guest listener (without the right to speak) by sending an email to the Climate Council's office under klimarat.gs@muenchen.de. The Climate Council representatives are appointed by the City Council.

{replicability and scalability}: The solution is highly replicable and easy to test in other cities and countries, subject to openness to dialogue and access to strategic partners and legitimate stakeholders. It should also be mentioned that the Climate Council has decided (on request) to participate in a Germany-wide study on climate and citizens' councils.

{innovation}: The innovation of the Climate Council lies in its simplicity, as it is a low-cost solution, but which heavily relies on social and political capital, as the representatives are appointed on a voluntary basis. One key success factor is the good partnership between the city, the experts, the civil society (NGOs) for climate protection, business, and science representatives. The main challenge is to balance the concertation and agility of the decision-making process, as the city must take some decisions quickly. The new election of the municipality could also change the direction, which is a point of attention.

For more information:
https://stadt.muenchen.de/infos/klimarat-muenchen.html

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Lyon: Building Operating System (BOS)

{intro}: The Building Operating System (BOS) for virtuous behaviour, implemented in Lyon, represents a progressive approach to optimizing energy efficiency in office buildings. By integrating technological solutions with behavioural awareness, it aims to enhance energy performance and promote environmentally responsible practices among employees.

{business model + funding}: The BOS is operated by SPL Lyon Confluence in their headquarters. It offers a unique value proposition by combining natural cooling, smart lighting control, and a dedicated application for staff to monitor and control office conditions. The solution primarily creates value for office staff and building managers by improving comfort and reducing energy costs. Financially, the project is supported with 70% EU funding and the remainder by SPL. It faces challenges in achieving a significant return on investment but remains attractive due to rising energy costs.

{technology}: Technologically, the BOS includes sensors for temperature, CO2, and lighting, along with smart meters, servers, and automatic window systems. These components enable real-time monitoring and control, contributing to a smart, energy-efficient building. The BOS is also connected to the district heating system and contributes to the Confluence energy community.

{governance + procurement}: Governance involves SPL Lyon Confluence as the solution owner, overseeing work carried out by subcontracted private companies. This procurement process selected companies based on their expertise in BOS deployment and development of related applications. The legal requirement for new office buildings to have a Building Energy Management System (BEMS) also supports this governance model.

{replicability and scalability}: The BOS is scalable and has already been replicated in other buildings within Lyon, such as the Cordeliers car park. However, scalability is challenged by financial constraints and the need for specialized companies for implementation. Despite these challenges, the solution is increasingly attractive for new buildings.

{innovation}: The BOS for virtuous behaviour is considered state-of-the-art due to its effective integration of technology and user engagement to enhance building energy performance. It stands out for its practical application and potential for wider adoption in urban environments. The key to its success lies in selecting the right companies for deployment and securing adequate financing.

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Stockholm: Scaling Smart City Solutions

{the challenge} Do successful pilot projects mean successful smart city solutions? Many cities are confronted with the challenge of being able to pilot city solutions successfully but not being able to scale them up. Motivated by this challenge, the City of Stockholm, Goteborg and Malmö, together with KTH, the Royal Institute of Technology in Stockholm and IVL, a research center, Uppsala University and SKR (regional association for all municipalities in Sweden) decided to investigate this phenomenon and come up with possible solutions. The main question was "How do we go from innovative, sustainable solutions that have been developed in pilots to mainstream solutions, leading to cost effectiveness and impact of pilot projects?"

{the tool}: Based on the findings of the investigation on the reasons why many successful pilot projects do not scale up, the City of Stockholm, together with the above-mentioned partners, developed an upscaling guide and tool to support the design of pilot solutions at the early stage and upscaling by the end of the pilot project. The guide's aim is to help pilot initiators anticipate upscaling strategies in the design phase, bridging the gap between the pilot experimental logic and the mainstream logic of public administration. The tool consists of a set of questions to be answered so that developed solutions from the pilot can be up scaled in a systemic way and implemented in the core business of the municipality.

{citizen participation} The upscaling guide and tool are built under the assumption that to upscale, municipalities need the appropriate institutional capacity, as well as the knowledge and the relationship channels with a broader range of stakeholders, going beyond their local boundaries. As such, a closer relationship with citizens is seen as crucial, especially when the pilot solutions involve lifestyle and mindset changes (deep upscaling). In this sense, one of the tool's sections focuses on citizen consultation and participation from the early stages of the pilot initiatives, which brings inputs and legitimacy for later upscaling. By including this section, the tool ensures that decision makers consider the crucial role of citizen participation for scaling already from the beginning. The upscaling guide has been used for the sustainability program for a district in Stockholm: Focus Skärholmen, where now two other areas have started to do an analysis to prioritise targets.

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SP6 – Urban Developer/Orchestrator

Munich: Integrated Neighbourhood Approach

{intro}: In December 2019, the Munich City Council set the goal of climate neutrality for Munich by 2035, which means reducing energy-related greenhouse gas emissions to 0.3 tons of CO2 equivalent per capita per year by 2035. The German Advisory Council on the Environment[1] assigns the neighbourhood level (Quartier) a central role in climate and environmental protection. As an informal level, the neighbourhood is the link between higher-level planning and building-related measures. In contrast to a purely city-wide approach, measures tailored to the respective neighbourhoods can be implemented. Projects that would be virtually impossible to implement on a city-wide scale can be tailored to the parameters of an individual neighbourhood. This neighbourhood can then serve as a role model for other neighbourhoods and deliver valuable inspiration on a city-wide level. Actions taken in a neighbourhood are always carried out together with local stakeholders: climate-neutral building stock, use of renewable energy for heat and power, waste and water management, adaptation to climate change, make them more livable, (greening and unsealing according to the "sponge city" principle), emission-free mobility, circular economy, healthy diets, consumer needs, sustainable education, and social considerations. In a first phase spanning several years, the city council will single out certain neighbourhoods and develop suitable approaches for each area, since no two neighbourhoods in Munich are the same. Based on the city-wide analysis of the municipal heat planning by the Department for Climate and Environmental Protection, the strategy of the integrated neighbourhood approach is being implemented in existing neighbourhoods.

{business model}: The implementation of a neighbourhood concept is carried out by a neighbourhood manager. The key to successful neighbourhood development is the willingness of the main stakeholders to participate. The objectives are defined on a neighbourhood-specific basis, considering urban planning, building culture, climate and nature conservation, housing, demographic and social aspects. Funding can provide support as early as the conceptualisation phase. An analysis of the current situation and potential and an action plan are developed, relevant stakeholders are involved - citizens, the housing industry, private owners, tenants, and energy suppliers. After the conceptualisation phase, implementation is supported by a redevelopment management team.

{technology}: In the future, a development tool for the integrated neighbourhood approach in the digital twin will use the necessary data intelligently to make the preparation and creation of integrated neighbourhood concepts efficient and transparent and to facilitate the implementation phase. This project is currently developed in a nationally funded project Connected Urban Twins. https://www.connectedurbantwins.de/in-der-praxis/muenchen-klimaneutral-2035-loesungen-zur-entwicklung-integrierter-quartierskonzepte/

{governance + procurement}: Several departments in the City of Munich have responsibilities: Climate and Environmental Protection Urban Planning and Building Regulations, and Mobility.
The district councils will be actively involved by the administration. These districts councils are an important partner in the implementation, for instance for communication into the neighbourhood.

{replicability and scalability}: The solution is highly replicable and easy to test in other cities and countries, subject to funding sources.

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{innovation}: The innovation of the Quartiersansatz lies in its approach to split the city into small entities that are more agile and mirror the diversity of the city's structure, especially in terms of the size of the City of Munich.

For more information:
https://stadt.muenchen.de/infos/nachhaltige-stadtentwicklung-muenchen.html
https://rethink-muenchen.de/
https://rethink-muenchen.de/wp-content/uploads/LHM-0090_Quartiersflyer_Rethink_2023_WWW_EN_RZ.pdf (English version)

[1] The German Advisory Council on the Environment (SRU) is an expert advisory body whose mission is to describe and assess environmental conditions, problems, and political trends and to point out solutions and preventive measures. https://www.umweltrat.de/EN/council/council_node.html

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Lyon: SPL Lyon Confluence

{intro}: Société Publique Locale Lyon Confluence (SPL Lyon Confluence) represents a pioneering model for urban development, concentrating its effort on the La Confluence district in Lyon, France. Operating under public interest with a public interest mandate, SPL Lyon Confluence exemplifies a blend of agility to market needs and commitment to political objectives, aiming to represent a new approach to urban development and energy efficiency.

{business model + funding}: SPL Lyon Confluence operates as a special purpose vehicle (SPV) with the dual objective of urban development and advancing a Positive Energy and Climate District (PCED). Its structure, comprising 25 employees, enables rapid decision-making and implementation of climate neutrality initiatives. The company stands out for its financial equilibrium, ensured by the sale of land to developers and the financial participation of local authorities in the construction of public spaces. It benefits from EU funding for specific projects. This approach facilitates the realization of environmental, societal and economic value, by improving quality of life and guaranteeing high energy efficiency in building construction. SPL Lyon Confluence's financial model therefore aims to balance private profitability with public Interest objectives.

{technology}: SPL Lyon Confluence, as an SPV, does not rely on specific technologies but oversees the integration of various energy-efficient solutions within the district. This includes high-performance buildings and the deployment of local renewable energy systems. The company's role as an urban orchestrator enables it to influence and integrate diverse technological solutions in line with its vision for the district.

{governance + procurement}: The governance model of SPL Lyon Confluence involves collaboration with a diverse range of stakeholders, including public local authorities, citizens, and the private sector. Contracts and negotiations with construction companies and real estate developers are key to ensure adherence to environmental and societal guidelines. This collaborative approach, combined with the strategic sale of land, empowers SPL Lyon Confluence to drive the development of the La Confluence district effectively.

{replicability and scalability}: SPL Lyon Confluence's approach to urban development is a replicable model, as evidenced by the existence of numerous similar Société Publique Locale entities in France. These SPVs are tasked with specific missions like urban development or car park management, suggesting the model's adaptability to various urban contexts. This flexibility and focus on local needs make the approach suitable for replication in other cities aiming for rapid PCED deployment.

{innovation}: SPL Lyon Confluence represents an innovative approach to city transformation. Its structure as a SPV allows it to operate with the agility of a private entity while being deeply aligned with public interests and political objectives. This dual nature enables SPL to navigate complex urban challenges effectively compared to traditional public sector models. By strategically selling land to developers under stringent environmental and societal guidelines, SPL ensures that every aspect of urban development contributes to the overarching goal of creating a sustainable, high-quality living space. Through this approach, SPL Lyon Confluence stands out as an innovative solution in urban planning and development.

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Charleroi: Igretec

{intro}: The IGRETEC initiative, "Les Rives de Charleroi," situated in Charleroi, Belgium, exemplifies an innovative urban planning approach. This project, spearheaded by IGRETEC, an intercommunal association, aims to revitalize the urban landscape by utilizing a comprehensive skillset from architects, engineers, and lawyers. Its core objectives encompass promoting digital and technological education, particularly targeting NEETs (Not in Education, Employment, or Training), enhancing innovation in energy transition, and supporting the operational transformation of business processes to align with Industry 4.0 standards.

{business model + funding}: IGRETEC's business model revolves around providing tailored solutions to address the unique challenges of the Charleroi region. These include digital and technological training, fostering innovation in energy transition and Industry 4.0, and enhancing business incubation and entrepreneurship. As an intercommunal company, IGRETEC serves its member communes and employees, focusing on public interest and municipal autonomy. The project is financed through European subsidies and revenues from client-commissioned studies. The partnership with the City of Charleroi, formalized through a convention signed in 2023, outlines IGRETEC's missions and governance model, demonstrating a commitment to public sector-driven development.

{technology}: The solution itself does not rely on a specific technology for service provision. Instead, it fosters digital and technological training opportunities to leverage digital and technological advancements in the context of urban planning and development processes.

{governance + procurement}: Governance of the IGRETEC project is public led, with a strategic focus on environmental sustainability, as evidenced by the adherence to DNSH (Do No Significant Harm) criteria.

{replicability and scalability}: The IGRETEC model's scalability and replicability are notable, with potential for application in other cities. Its approach, focusing on digital and technological education and fostering innovation, could be adapted to various urban settings, promoting sustainable urban development.

{innovation}: IGRETEC's innovative approach in urban planning is evident through its strategic focus on digitalization, technological innovation, and environmental sustainability. The project's success is underscored by its operational masterplan for areas around Charleroi Centrale train station, demonstrating a commitment to revitalizing urban spaces while meeting the needs of current occupants and stakeholders.

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