D1.9 Urban Transformation: New Economic Paradigms and associated Business Models

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Deliverable administration

No & name	**D1.9 Urban Transformation: New Economic Paradigms and associated Business Models**				
Status	Released	**Due**	M60	**Date**	2024-09-18
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Description of the related task and the deliverable. Extract from DoA	**T1.5 New economic paradigms (VTT) M38 – 60** The innovativeness of the task is represented by the settle of a disruptive and customized business model as a horizontal synergic synthesis coming from several sources: the results of other WPs, especially those related to the acceptance, acknowledgement, involvement of the stakeholders; the deployed and tested technological interventions; the benchmark work done at marketplace level in T7.1 among the best practices and instruments. These actions will be systematized and integrated in the D1.9 Urban Transformation: New Economic Paradigms and associated Business Models. New collaborative approaches and deepened clustering dynamics pave the way to the exchange of best practices, pooling of investments, the improved assessment of the 'bankability of projects', and the development of financing strategies (e.g. business cases, use of public procurement, of loans, etc.). The fine-tuned tool will be an improved, structured and active mechanism with a ready-to-use organisational and financial architecture for the decision-making process. Moreover, this task aims to identify the changes shifting cities' economy towards a low-carbon, distributed, digital and end-user-centric one, characterizing the emerging business models to integrating and enhancing the dialogue and redefines the roles among all the relevant stakeholders and economic sectors that play a role in this evolutionary process. The focus will be put on the energy innovation value chain as a whole: transport and mobility, industry, telecoms and new technology, buildings and agriculture, whether they are stimulated by cities and/or end-users, triggered by new players disrupting traditional energy system, emerging from traditional energy players (e.g. power utilities, equipment providers, grid operators, research institutions, etc.) or even the financial and academic communities. Considering this changing arena, under this task the following actions will be developed: (1) Identification and presentation of a changing background scenario;(2) Characterization of the role of business models within the process of urban transformation; (3) Mapping emerging business models; (4) Characterization of relevant sector business models; (5) Clarification of business models constituting elements; (6) Identification of sources of innovation – business models innovation grid; (7) Identification of main barriers; (8) Identification of new stages, partnerships and roles for economic sectors and key stakeholders. **D1.9 Urban Transformation: New Economic Paradigms and Associated Business Models** The D1.9 Urban Transformation: New Economic Paradigms and Associated Business Models is an output from Task 1.5 New economic paradigms. It aims at systemizing and integrating disruptive and customized business models coming from several sources: the results of other WPs, especially those related to the acceptance, acknowledgement, involvement of the stakeholders, the deployed and tested technological interventions, the benchmark work done at marketplace level, among other best practices and instruments.				
Participants	VTT, ESP, LPZ, PIT, KONE, SIE, CEN, LSW				
Comments					

V	Date	Authors	Description
0.1	2024-01-31	VTT	Setting the initiative structure and content of the deliverable.
0.5	2024-07-05	VTT	1st draft version for peer review.
0.7	2024-08-05	VTT, SPI	2nd draft version peer reviewed by VTT and SPI.
0.8	2024-09-16	VTT	Final deliverable ready.
0.9	2024-09-16	WP leader	Deliverable checked by WP leader and released to the Coordinator and the Quality Manager for quality check and subsequent submission to the EC.
1.0	2024-09-18	VTT	Coordinator submits the deliverable to the EC

Dissemination level

PU	Public	X
CO	Confidential, only for members of the consortium (including the Commission Services)	

About SPARCS

Sustainable energy Positive & zero cARbon CommunitieS demonstrates and validates technically and socioeconomically viable and replicable, innovative solutions for rolling out smart, integrated positive energy systems for the transition to a citizen centred zero carbon & resource efficient economy. SPARCS facilitates the participation of buildings to the energy market enabling new services and a virtual power plant concept, creating VirtualPositiveEnergy communities as energy democratic playground (positive energy districts can exchange energy with energy entities located outside the district). Seven cities will demonstrate 100+ actions turning buildings, blocks, and districts into energy prosumers. Impacts span economic growth, improved quality of life, and environmental benefits towards the EC policy framework for climate and energy, the SET plan and UN Sustainable Development goals. SPARCS co-creation brings together citizens, companies, research organizations, city planning and decision making entities, transforming cities to carbon-free inclusive communities. Lighthouse cities Espoo (FI) and Leipzig (DE) implement large demonstrations. Fellow cities Reykjavik (IS), Maia (PT), Lviv (UA), Kifissia (EL) and Kladno (CZ) prepare replication with hands-on feasibility studies. SPARCS identifies bankable actions to accelerate market uptake, pioneers innovative, exploitable governance and business models boosting the transformation processes, joint procurement procedures and citizen engaging mechanisms in an overarching city planning instrument toward the bold City Vision 2050. SPARCS engages 30 partners from 8 EU Member States (FI, DE, PT, CY, EL, BE, CZ, IT) and 2 non-EU countries (UA, IS), representing key stakeholders within the value chain of urban challenges and smart, sustainable cities bringing together three distinct but also overlapping knowledge areas: (i) City Energy Systems, (ii) ICT and Interoperability, (iii) Business Innovation and Market Knowledge.

Partners

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EXECUTIVE SUMMARY

Horizon 2020 project SPARCS aims to create solutions, planning models and processes that will transform cities into sustainable, zero carbon ecosystems with high quality of living. New business models and economic frameworks are essential on the path toward environmentally, socially, and economically sustainable communities that lead the transition.

This deliverable presents an overview of the novel perspectives on economical approaches and business model innovations tested and envisioned in SPARCS during the project lifecycle. It aims at providing a horizontal synthesis of the work done within the project, as well as guidelines for the further use of the results. The transition towards carbon neutrality requires a shift in organizations' mindsets. The practices of city development and business are both going through an inevitable change. Tools for evaluating and managing the factors that drive or hinder the transition are needed in all sectors.

Since the project's start in 2019, many actions have been taken to advance the overall feasibility and novel business ideas related to the energy positive districts across Europe. The activities and collaboration within the project have prepared the partners for understanding and adopting new practical ways of working, while the more theoretical outcomes have provided guidelines for applying novel practices. To simplify the replication and upscaling of the solutions and operation models developed in SPARCS, this deliverable collects the central learnings.

The report is based on a cross-cutting synthesis of SPARCS activities and their relation to the advancements of new economical paradigms necessary for the transition towards the sustainable energy positive and zero-carbon communities. It presents the changing background scenario that pushes public and private organizations to seek new approaches to constitutive elements of business and innovation, shares the insights from business model development within SPARCS and presents a finetuned tool for developing and assessing business models in PED service ecosystem.

The tool, called Ecosystem Business Model Assessment Framework, seeks to provide ways for Lighthouse Cities, Fellow Cities as well as other cities and organizations beyond SPARCS to comprehensively understand PED dynamics and factors that advance commercial viability in PED business ecosystem. It combines the theoretical background of business and service ecosystems and business models with practical examples and learnings from SPARCS. The tool helps to define the ecosystem roles and interdependencies and increases the understanding of main drivers, barriers, and success factors within PEDs.

The tool was tested and further finetuned in Sello demonstration area in Espoo and Baumwollspinnerei demonstration area in Leipzig. These two locations offer different perspectives on development and business models in PED ecosystems and help to illustrate the parallel elements as well as factors that are unique to each PED. The results of the case study compose the empirical part of the deliverable.

1. INTRODUCTION

This deliverable addresses the task 1.5 *New Economic Paradigms* by presenting an overview of the SPARCS actions related to the changes required in our economic environment to advance the transition towards sustainable energy positive & zero carbon communities. It also presents the case study conducted in Espoo and Leipzig and a practical tool, The Ecosystem Business Model Assessment Framework, for PED developers worldwide to use in evaluating PED feasibility and overall commercial potential.

Economic paradigms are narratives through which we study and observe the economic systems in society. The emergence of a new economic paradigm is often related to a shock or crisis, that causes changes in the factors considered focal in defining the system. Recently, the leaders in economic thought and practice have increasingly raised the ideas of sustainable and inclusive growth to answer the problems caused by e.g. climate change and economic crises of the past decades. (Jacobs & Laybourn-Langton, 2018.) According to OECD (2020) report “Beyond Growth – towards a new economic approach”, the new economic narrative needs to involve deeper understanding of the relationship between growth, human wellbeing, a reduction in inequalities and environmental sustainability.

Global megatrends are causing rapid changes in socio-economic system, making it more and more distant from the traditional economic model that defines our current way of conducting business. Accelerating environmental crisis, fast development of new technologies, new patterns of globalization and demographic change together make the need for a new economic approach urgently pressing. (OECD, 2020) This shift has pushed more and more emphasis on actions that support sustainability transitions: major changes in industries, socio-technical systems, and societies toward more sustainable mode of production and consumption (STRN, 2024).

In 2015, the members of United Nations committed to the implementation of the 2030 Agenda for Sustainable Development. It presents the 17 sustainable development goals and 169 targets that aim to shift the world onto a sustainable and resilient path. According to UN, sustained, inclusive, and sustainable economic growth is essential for prosperity, and making fundamental changes are needed in the way that our societies produce and consume goods and services. (United Nations, 2015.)

Energy transition plays a key role in achieving the UN SDGs. Especially targets (7) Affordable and Clean Energy, (11) Sustainable Cities and Communities, and (13) Climate Action are dependent on energy system transformation (Derkenbaeva et al., 2022). Positive Energy District (PED) is a concept that aims to advance energy transition and sustainability on city level. Business Models (BM) can either drive or hinder the change and are therefore important in sustainability transitions (Speich & Ulli-Beer, 2023).

In following chapters of the deliverable, the aim is to synthesise SPARCS activities that are connect to the above-mentioned theoretical concepts.

1.1 Purpose and target group

This deliverable collects the SPARCS project findings related to the economic environment for the transition towards carbon neutrality and presents them as a part of the wider theoretical context. The report provides an overview of the perspectives of the solutions and knowledge developed within the project and proposes the business ecosystem perspective as a basis of viability assessment for future PED developers.

As a result of a desktop study and examination of SPARCS demo examples, the report presents The Ecosystem Business Model Assessment Framework tool for assessing and replicating PED BMs within and beyond the project scope. The focal aim is to create a comprehensive understanding of the factors that make PEDs economically, socially, and environmentally feasible. The conclusions presented are based on the SPARCS project results and deliverables, literature reviews, partner interviews and feedback collected from the participants.

Results can be utilized not only by SPARCS cities and partner organizations, but all the actors that seek to advance PEDs in their own context.

1.2 Relations to other activities

The goal of this report is to concretize what makes PED energy systems commercially successful, and offer a comprehensive tool for businesses, cities and other organizations to assess and drive transformation in their BMs around PED ecosystems.

To reach this goal, it is necessary to observe the results of each SPARCS work package, since they all have a distinctive role in developing the SPARCS demonstrations and operation models around them. This report, however, emphasizes the results of following work packages due to their relevance to the subject:

- **WP1**:
  - WP1 focuses on developing a methodological approach for supporting energy transition in cities. The Smart City Vision 2050 developed in the work package offers the reflection point for the required paradigm changes in economy.
- **WP3** and **WP4**:
  - The Lighthouse city demonstrations form the core of SPARCS and present the practical solutions developed within the project. These are focal in terms of commercial viability of PEDs.
- **WP5**:
  - Replicability and upscaling potential of the solutions is strongly connected to the overall feasibility of PED ecosystems. Also, the SPARCS Business Model Canvas developed in the WP5 opens a view to BM development for individual solutions.
- **WP7**:
  - Work package 7 aims to form a vision of effective, implementable, replicable and scalable business ecosystem and by doing so, provides a disruptive scenario that underpins the 2050 City Vision and validates the baseline for the future exploitation of the results.

The central activities related to this deliverable are defined in Table 1. The activities that provided significant background information for the horizontal synthesis are further elaborated in chapter 2.

Table 1: Relation to other activities in the project

Deliverable	Contributions
D1.1 City Characterization Report	A city diagnosis for a precise understanding of the city conditions and characteristics on both the qualitative and quantitative levels.
D1.2 Roadmap for Urban Transformation	A multi-layered strategy promoting structural transformation directing the partner cities' urban development towards sustainability.
D1.7 Scaling Up and Replication Guideline	A methodology for the smooth and bespoken scale-up and replication of the SPARCS solutions.
D1.11 City Vision 2050 – Draft	Holistic understanding of the 2050 city visions that are guiding the development.
D3.3	Overview of the implemented demonstrations in Espoo.
D4.3	Overview of the implemented demonstrations in Leipzig.
D7.1 Business Models and Financing Mechanisms for Wide Uptake of Smart City solutions	The benchmarks for the SPARCS activities.
D7.2 Demand-driven Holistic Smart City Service Roadmap for Impact Enhancement	The roadmap for additional and complementary smart city services to enhance the impact of the actions.
D7.3 Governance Models for Sustainable Smart City Business Ecosystems	The baseline version of the governance model aiming to create the 2050 Smart City Vision.

1.3 Contributions of partners

The report is compiled by VTT based on the work done in the previous phases of the project as well as the case studies conducted as a part of the task. The following table (Table 2) presents the partners who were involved in the case studies and provided their inputs for the development of Ecosystem Business Model Assessment Framework.

Table 2: Contributions of partners

Partner	Contributions
VTT	Editor of the deliverable. Content planning, literature review, case study and writing.
ESPOO	Providing materials for the desktop study, participating in interviews and validation of materials related to Sello ecosystems.
SIEMENS	Providing materials for the desktop study, participating in interviews and validation of materials related to Sello ecosystems.
KONE	Providing materials for the desktop study, participating in interviews and validation of materials related to Sello ecosystems.
PLUGIT	Providing materials for the desktop study, participating in interviews and validation of materials related to Sello ecosystems.
LEIPZIG	Providing materials for the desktop study, participating in interviews and validation of materials related to Baumwollspinnerei ecosystems.
CENERO	Providing materials for the desktop study, participating in interviews and validation of materials related to Baumwollspinnerei ecosystems.
LSW	Providing materials for the desktop study, participating in interviews and validation of materials related to Baumwollspinnerei ecosystems.

1.4 Methodology

The synthesis of the most relevant SPARCS results is based on the thorough review of the existing SPARCS materials. Each work package has conducted actions and provided deliverables guided by the descriptions in Grant Agreement. To catch all the relevant actions and to broaden the perspective, the examination was not restricted to the work packages, deliverables, and milestones that in their original descriptions are focusing on the business and financial models of PEDs. Instead, the materials and their significance were assessed based on their ability to provide practical guidance that supports sustainability transitions in PEDs for all the related actors.

To connect the SPARCS learnings to the wider theoretical framework and to finetune the process of evaluating the commercial potential in PEDs, VTT conducted a literature review of the ecosystem concepts in energy transitions. Based on the literature review, a first draft for PED Business Model Framework was developed.

The tool was further finetuned through case study in two SPARCS demonstration areas: Sello in Espoo and Baumwollspinnerei in Leipzig. The data for analysis was collected through desktop study and semi-structural interviews.

The desktop study materials were collected from public sources, SPARCS archives and involved partners. After the desktop study, semi-structured online interviews were conducted to elaborate the findings. The final results were validated in joint workshop meetings with the partners.

First part of the case study took place during the end of the year 2023 and focused on Sello demonstration area. The results were validated in January 2024. Second part, which focused on Baumwollspinnerei area, took place in Spring 2024 and results were validated in June 2024.

2. NEW ECONOMIC PARADIGMS IN SPARCS

This chapter presents the central SPARCS activities and their relation to new economic paradigms. In SPARCS, the economic perspective and transition towards sustainable smart cities is addressed in several work packages through different lenses of PED development. According to research, developing the frameworks of economic theory and analysis require a richer basis of understanding as well as evidence of the economic mechanisms (OECD, 2020), for which the case specific observations provide significant perspective.

2.1 Trends and drivers in commercial PED development

PED as a concept has emerged to facilitate the transition as part of the holistic urban strategy that incorporates socio-economic, technological, environmental, political and institutional challenges simultaneously (Derkenbaeva et al., 2022). Trends and drivers that promote holistic urban strategies are also directing the business innovations which emerge from the same challenges and megatrends causing them.

Understanding these trends and drivers as well as the challenges that affect the shift from centralized, fossil-based energy systems to decentralized and fossil-free systems is crucial for the organizations that seek to establish commercial operations within PEDs. The awareness helps organizations to innovate and implement new business models that benefit from the change and, in the best case, speed it up.

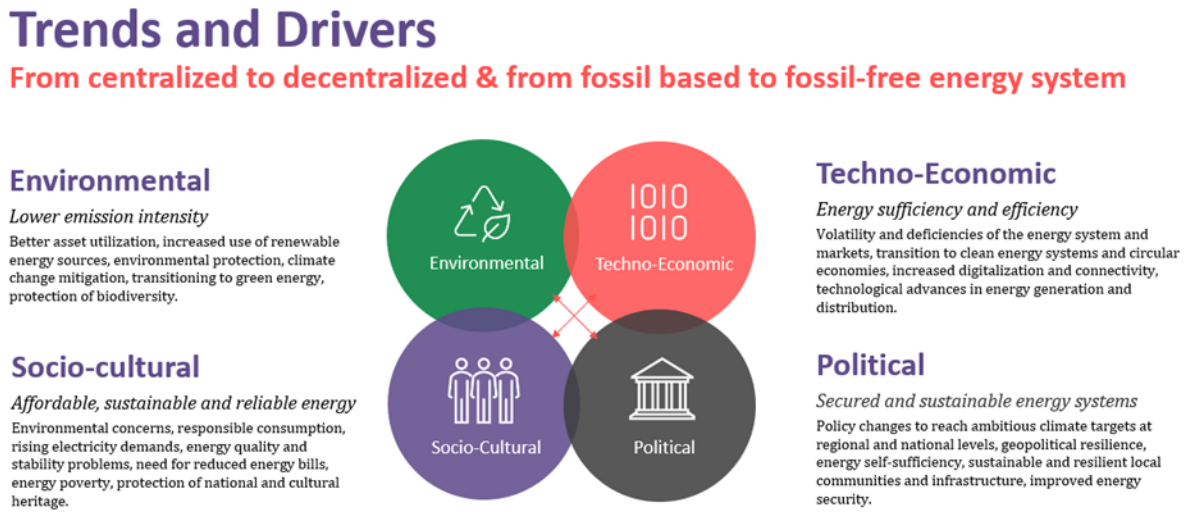

Figure 1. Trends and drivers of commercial PED development

Figure 1 Illustrates the trends and drivers that can be considered focal in terms of sustainability transition in the field of energy: environmental, techno-economic, political and socio-cultural elements are equally important for the energy transition to become reality. In SPARCS these elements have formed the basis for the City Visions, demo actions, as well as replication and up-scaling activities.

Economy can be described as a complex adaptive system, where novel phenomena are emerging as a reflection of the interaction between all the participants in the

system. The system is constantly evolving and is neither in, nor changing toward, a steady state. (OECD 2020.) New approaches require not only a comprehensive understanding of the theoretical framework, but also an expanded set of tools that can reflect the paths and outcomes of the current world.

In SPARCS several different management tools, frameworks and processes have been utilised in order to systemise different aspects of PED development.

In academic theories paradigm change is dependent of two conditions: the turn towards a new paradigm happens, when dominant paradigm continuously fails to explain the available evidence, and alternative theories that offer better explanations gather sufficient support to overcome the hold of the old paradigm. In the field of economics and public policy, the change of paradigm is often affected by politics and groups and individuals of high influence. (Jacobs and Laybourn-Langton, 2018). Cities are in a key role in supporting financial innovation, creating blueprints and business models and advancing real-life piloting. (Ulpiani et al, 2023)

To increase the understanding of the trends and drivers as well as to offer assets for wider reflection of the systems related to PEDs, the following chapters present a synthesis of the work done within the SPARCS project as well as conclusions drawn from the findings and suggested tool to be further elaborated.

2.2 SPARCS activities supporting economic transition

In SPARCS, the cities and technical partners are actively advancing the shift towards more sustainable urban ecosystems. The public-private partnerships with incorporated SDGs are inevitable for the sustainability transition, but also indicate wider economic paradigm change.

PED development as such is closely connected to long term sustainability targets and societal impacts that require changes in micro, meso, and macro levels. In SPARCS these impacts have been acquired e.g. with means of citizen engagement and involvement in micro level, enabling piloting and testing of smart energy solutions in micro and meso levels, and by setting visionary targets expanding to macro level.

Figure 2 demonstrates the long-term and multi-level impacts that PEDs are connected to, and their implementation in SPARCS is further elaborated in the following sub-chapters 2.2.1, 2.2.2 and 2.2.3.

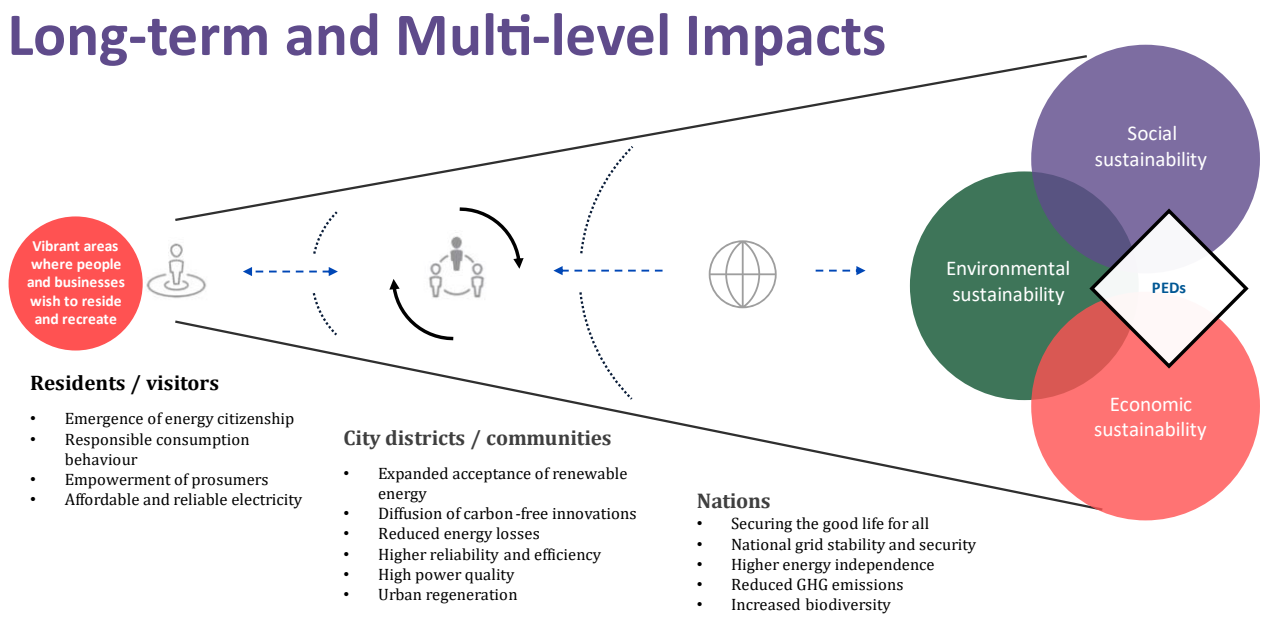

Figure 2. Long-term and multi-level impacts of PEDs

2.2.1 Micro level actions

In micro level, SPARCS actions have focused on citizen engagement, enforcing the energy citizenship and local small-scale piloting and testing. Micro level often refers to small communities or even individuals. The engagement activities in the Lighthouse Cities have been targeted especially toward the residents and customers in the demo areas.

2.2.2 Meso level actions

Meso level activities refer to local actions that first and foremost have impact within the defined area. In SPARCS these activities include e.g. community creation in Lighthouse and Fellow Cities as well as piloting and testing the solutions in the demonstration areas.

Besides the technological solutions, one good example of an outcome that drives the sustainable change at meso level is the Espoo Co-creation model Toolkit for sustainable and Smart Urban Areas. The aim of it is to support cooperation between city, businesses, education and research, and residents in the development of sustainable and smart urban areas in. (SPARCS, 2024)

2.2.3 Macro level actions

Macro level actions aim for wider impact on national or even European / global scale. In SPARCS, the possibilities to effect on national level decision making or policy are limited, but not zero. The general aim of the project comes from the EU level targets, and all smaller scale actions serve to these targets. Bold City Visions and roadmaps guide not only the local actions but feed into national goals as well and based on the Light House and Fellow cities' experience in developing and implementing PED related

solutions, a set of recommendations were put forward, aimed at delivering impact in relevant policies at a local, national, and supranational levels.

During the project lifespan, the participants have also needed to adapt to major economic and social crisis such as Covid-19 outbreak and war in Ukraine. The new growth narratives are useful not only to understand the systemic crises, but to be able to see how to emerge from crisis and build back better (OECD, 2020). From this perspective the learnings of SPARCS are valuable to better cope with unexpected changes in the future.

2.3 SPARCS Frameworks and models

To help the SPARCS partners in their path towards sustainability transitions, several different models, frameworks and tools have been adapted, developed, and used in different phases of the project. The aim of these tools and processes is to create structure for the transition and to concretize the targets and actions required from different actors. Systemized processes are also easier to replicate and implement in other locations beyond SPRACS.

Table 3 presents the focal frameworks and models used in SPARCS in terms of new economic paradigms and associated business models. These frameworks and models especially aim for clarifying the visions, roadmaps and business opportunities in PEDs.

The first three are especially focused on city level advancements and processes that support strategy-based collaboration in cities. The latter ones highlight the governance, collaboration and business potential from wider perspective. More detailed descriptions of the development processes and usage below.

Table 3: Frameworks and models utilized in SPARCS

Model / Framework	Developed by	Deliverable / Task	Purpose
Morgenstadt Model	Developed in 2012 by the Morgenstadt Initiative led by Fraunhofer IAO together with the University of Stuttgart	D1.1 City Characterization Report	A city diagnosis for a precise understanding of the city conditions and characteristics on both the qualitative and quantitative levels.
The Roadmap for Urban Transformation	Methodology and approach developed in SPARCS	D1.2 Roadmap for Urban Transformation	A multi-layered strategy promoting structural transformation directing the partner cities' urban development towards sustainability.
City Vision 2050 process	Methodology and approach developed in SPARCS	D1.11 City Vision 2050 – Draft	Creating a 2050 city vision for the key strategic areas of development in a shared process with all actors involved.
Replication Framework	Methodology and approach developed in SPARCS	D1.7 Scaling Up and Replication Guideline	A methodology for the smooth and bespoken scale-up and replication of the SPARCS solutions.
Participatory governance model	Methodology and approach	D7.3 Governance Models for Sustainable	Step-by-step process for governance model that engages stakeholders

	developed in SPARCS	Smart City Business Ecosystems	
SPARCS Business Model Canvas	Methodology developed by Alexander Osterwalder, undertaken and modified for SPARCS context	Task 5.5 Project Upscaling and replication in LHCs	Easy-to-use canvas that helps the partners to develop BMs for novel solutions and to describe features specific for their BM.

Morgenstadt Model

The model is based on the deep-dive analyses of Freiburg, Berlin, Copenhagen, Singapore, New York City and Tokyo. In order to achieve an in-depth understanding of the sustainability performance of cities both qualitatively and quantitatively, the Morgenstadt Model is structured into three levels of analysis:

1. Key performance indicators (quantitative analysis);
2. Action fields (qualitative analysis);
3. Impact factors (qualitative analysis).

The third level of analysis utilizes impact factors to identify the city-specific drivers and barriers which are determined by unique historic, cultural, economic, climatic, and morphological characteristics. Impact factors thus extend the general model and adjust it to the needs of each city, providing for an objective performance profile while laying out the basis for an individual sustainability profile. Deliverable 1.1 describes the use of this city characterization process in Lighthouse Cities.

The Roadmap for Urban Transformation

The methodology developed for the road mapping process, by SPI, provides the necessary framework enabling the cities to co-create a roadmap together with the most relevant stakeholders in the local ecosystem. Roadmap will guide the cities on their way to City Vision 2050.

The framework builds upon specific features of the participatory process established for the development of the City Vision: the definition of a local task force in each city, the involvement of relevant stakeholders and partners in the context of SPARCS ecosystem, and the development of workshops focused on strategic development areas for the cities. “Guidelines for the road mapping process” - a manual with detailed steps, insights, recommendations, and supporting material for the development of the road mapping activities in each partner city, is elaborated in deliverable 1.2 Roadmap for Urban Transformation.

City Vision 2050 Process

The City Vision 2050 methodology can be described as

- a processual, participatory framework;
- a toolbox and a manual to come up with a City Vision 2050;
- an accompanying set of actions to transfer the methodology and learnings.

It was developed to cover different aspects of the urban realities (e.g., energy, participation, mobility) and to be implemented in the context of planning, implementing and scaling-up of successful smart-city solutions in line with the global UN 2030 SDGs. The Fraunhofer IMW team developed the City Vision 2050 methodology and, together with SPI, supported the cities’ task forces in implementing the process. Further details

of the process are to be found in deliverable 1.11 City Vision 2050 – Draft and its updated version (D1.12).

Replication Framework

It was deemed necessary to create frameworks that help the cities to form the ecosystems for the urban transformation and to tackle the multifaceted challenges that cities are called to solve.

In the deliverable D1.7 Scaling Up and Replication Guideline, seven key challenges were defined, as well a list of solutions that support cities in answering to these challenges. The replication framework helps the cities to do the technical evaluation and characterisation as well as evaluation of the impacts and defining main stakeholders and solution implementation requirements.

The Replication Methodology also allows the main stakeholders to evaluate the status and the potential progress regarding the solutions that contribute to creating positive energy districts. The city, on the other hand, can assess its own potential, choose the solutions, and prioritize them.

Participatory governance model

By working together through a stakeholder engagement approach, public authorities can combine their expertise to benefit the planning process. Local authorities can liaise with local communities and provide local knowledge which can determine the achievability of the plans that are developed. This can achieve multiple benefits.

The participatory governance model proposes three-step methodology to implement stakeholder engagement in local setting. Step 1 aims to identify stakeholders and engage them in the process. On step 2, the stakeholder engagement model is developed, and step 3 is about implementing the developed model. The detailed instructions and the background of the model is presented in deliverable 7.3 Governance Models for Sustainable Smart City Business Ecosystems.

SPARCS Business Model Canvas

The Business Model Canvas, originally developed by Alexander Osterwalder, is a tool for describing, designing, challenging, inventing, and pivoting business models (Strategyzer, 2024). SPARCS Business Model Canvas (see Appendix 1), developed by Bable, is a modified version of Business Model Canvas specifically targeted for SPARCS partners. It differs from the original one in the way it directs the users to pay attention to sustainability and non-financial aspects of the business model. Customers and beneficiaries, surplus, social and environmental costs as well as social and environmental benefits are highlighted.

2.4 Key take-aways

In SPARCS, sustainable and inclusive growth has been advanced through strategies, visions and cross-cutting collaboration. The processes developed and implemented have increased the overall knowledge of PED development and sustainability in cities, as well as business opportunities regarding PEDs.

The actions in SPARCS cover economic levels from micro to macro and aim for long term impact. This has required devotion to citizen engagement, agile piloting and testing of smart city solutions, as well as long-term planning and commitment to an ambitious vision.

Systematic approach to utilising novel tools and methods enables further replicating and upscaling of solutions and processed in other areas and cities.

To elaborate and utilise the results and experiences in SPARCS and to take the business model development to a new level, it is necessary to widen the perspective from single project participant to PED ecosystem level. To answer the question *what makes PEDs commercially viable*, a single actor perspective does not offer comprehensive answers.

PED ecosystem is formed by a combination of actors, that have a role in different aspects of a PED. The following chapters describe, how ecosystem approach can be beneficial in developing business in PEDs.

3. ECOSYSTEM BUSINESS MODELS IN PEDS

Based on the SPARCS experiences and confirmed by the literature review, effective business in positive energy districts requires seamless cooperation between different private and public actors.

PEDs typically require participation of different commercial actors representing different parts of PED energy system. These actors are again very much dependent on the acceptance of the local citizens and the policies and strategies defined by the local authorities. All actors together form a service ecosystem that enables the PED operations. In these service ecosystems different business models are intertwined in a way that provides additional value to all participants. (Viljakainen et al, 2024.)

To combine the learnings regarding the sustainability transition and commercial viability in SPARCS and to highlight the importance of cooperation, the business models in two Lighthouse City demonstration areas, Sello in Espoo and Baumwollspinnerei in Leipzig, were chosen for closer examination. Both areas were observed from ecosystem perspective to show the similarities as well as the differences, and to create paths for further replication of PEDs in different locations and different type of districts.

The ecosystem-based modelling of the demonstration areas combined theoretical and empirical inputs, aiming to form a precise illustration of the interconnectedness of the actors as well as to form the basis of the PED Business Model Assessment Framework concept. The framework for its part helps to describe a PED ecosystem vision, value propositions, service offerings, and map the ecosystem actors and their interdependencies.

In addition, it guides the user to evaluate the commercial activities, the development actions, and the measures that steer city level efforts. The enablers and challenges are also included to assess transformation potential in PED ecosystems. The following chapters provide more detailed information of the process as well as summaries of the key outcomes of the ecosystem business modelling process in both studied areas.

3.1 Detecting the focal elements of PED ecosystems

Prior to the practical examination of the use cases, it was important to define the focal elements of PED ecosystems from the perspective of profitable business. To address the PED ecosystems from both district service provider perspective and business ecosystem perspective, it was decided to focus on each pillar of the PED energy system as an entity, a sub-ecosystem, that is nested in a wider ecosystem.

In this case study, the focal pillars of a PED are described as follows:

- Pillar 1: positive energy buildings,
- Pillar 2: production, distribution and storage of renewable energy sources,
- Pillar 3: electric mobility solutions and
- Pillar 4: energy management systems.

Forming an ecosystem-based BM for each pillar of PED energy system helps to understand each pillar as a whole, since especially in different stages of development, the emphasis of commercial operations around each pillar of PED energy system might vary.

To make commercially successful PED a reality, there also needs to be defined goals for energy efficiency, flexibility and self-sufficiency as well as environmental, economic and social sustainability. The commercial actions happen on the levels of PED pillars (see Figure 3) and are driven by the enablers.

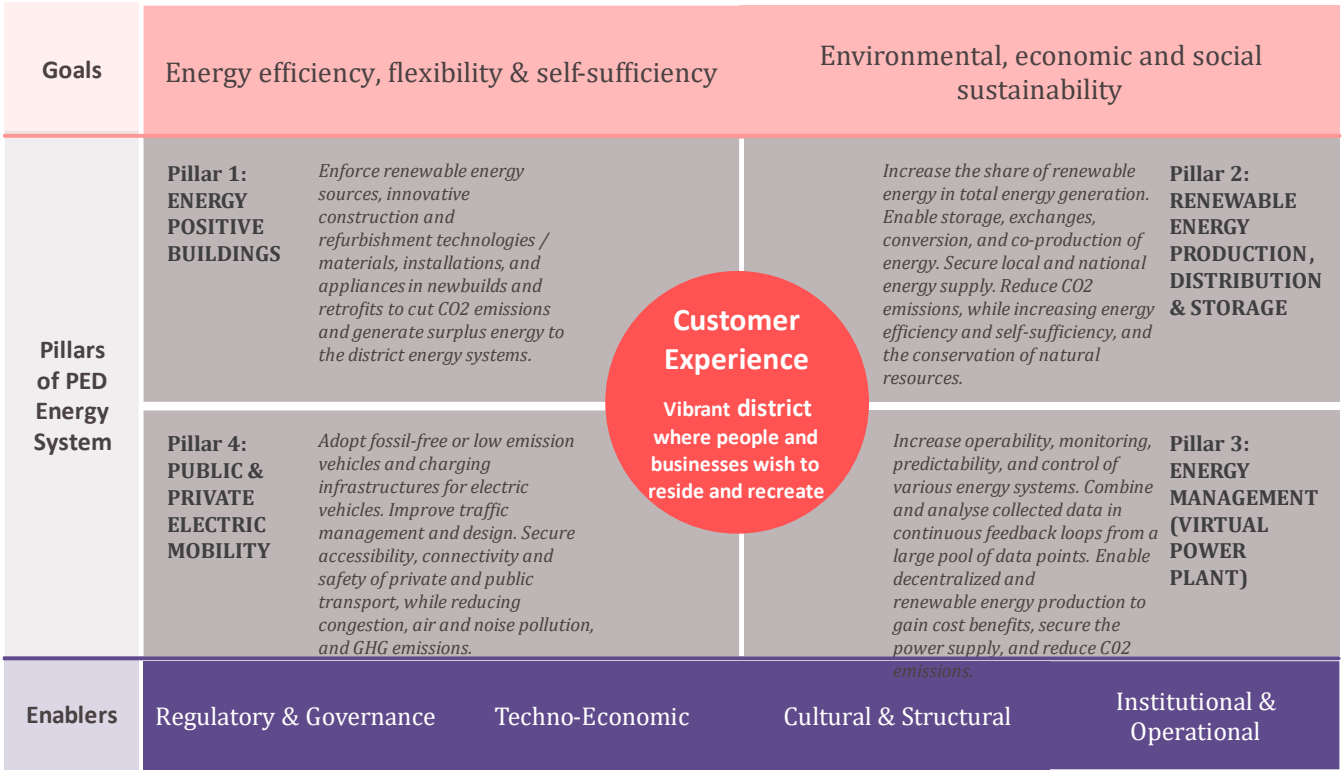

Figure 3. Active parts of PED

Considering SPARCS and PED development in general, the following enablers were found most important.

Regulatory & Governance:

- Strong political commitment and incentive mechanisms to align the priorities and build partnerships within the city ecosystem.
- Concrete long-term vision shared and agreed with investors, citizens and local businesses to build ownership.
- Stable and clear regulatory frameworks, guidelines and objectives for smooth entries, clear roles and responsibilities.

- Municipal strategies and policies codifying the net-zero targets and monitoring their achievements.
- Energy planning, urban planning and municipal services supporting the development of positive energy blocks and zero-carbon mobility towards a common goal.

Techno-economic:

- Financial instruments (e.g., private investments, public subsidies) and mixed sources of investment (e.g., crowd funding) to ensure the economic viability for PEDs.
- PPPs, ESCO's
- Continuous exploration of new business opportunities arising from changes in the private and public sector value chains,
- Adoption of emerging technologies and digitalization to enable cost reductions, data accuracy, security, privacy, and interoperability between physical and digital infrastructures (e.g., Digital Twins, Open data platforms, Blockchain, IoT, Cloud Computing).
- Introducing platform-based business models, (e.g. related to Virtual Power Plants) allowing PED stakeholders to add their standalone products into platform components and jointly monetized offerings.

Cultural & Structural:

- Conducting do-design experiments and pilots with residents to strengthen social acceptance.
- Energy-related education and training to promote the capacities, skills, energy literacy and sustainable behaviours of residents.
- Data democratization and increasing residents' awareness of their rights, obligations and benefits (e.g., providing open data platforms, fostering start-up culture).
- Shared knowledge, experiences and best practices across different locations.
- Systemic thinking and a common language to overcome incompatibilities in organizational cultures and structures across city ecosystems.

Institutional & Operational:

- Durable partnerships, alignment of interests and continuous dialogue to manage the integrated energy networks and systems as a whole.
- Interoperability of standards and systems (e.g. open standards, integrated data systems) to overcome siloes within government sectors and businesses.
- Common evaluation targets to measure the progress against the set targets.
- Cross-domain / multi-sectoral collaboration and strong project management to develop integrated and well-coordinated strategies, plans, and collaborative R&D&I efforts.
- Strong city image to attract residents, businesses and investments.

These enablers amended with the related challenges and the PED pillars formed the structure for the theoretical framework, a tool called PED Business Model Assessment Framework, that was used to systemise the assessment process.

3.2 PED Business Model Assessment Framework

Business model transformation is particularly relevant in ecosystems, where the different organizations use the ecosystem resources to find synergies in achieving sustainable revenue and value co-creation (de Vasconcelos Gomes et al., 2023). As existing business model blueprints are less suited to examine the interdependent nature and transformation of companies operating in ecosystems (Weiller & Neely, 2013), such as PEDs, a literature review was conducted to build a conceptualization grounded in relationships between the key concepts (see Figure 4).

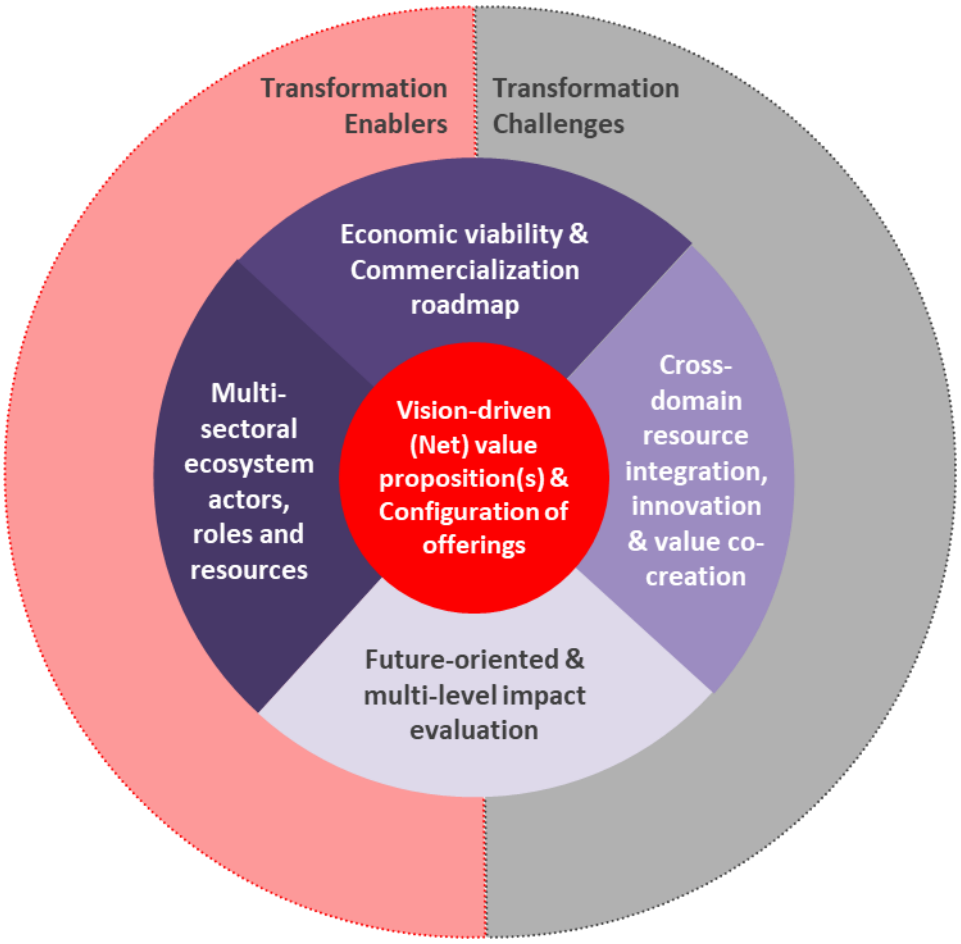

Figure 4. Ecosystem Business Model Assessment concepts.

The PED Business model Assessment Framework (Appendix 2), acts as a model to describe how different actors in PED ecosystems create, deliver, and capture value. It features both the service offerings as well as the interrelatedness of the actors of the PED. The value proposition points the ways in which ecosystem actors contribute to the value creation of the customer, while also generating new resources and value for themselves. The role of the value proposition in service ecosystems is to offer opportunities for co-creation and resource integration between the different social and economic actors, rather than act as the proposal for a service offering per se. (Viljakainen et al. 2024.)

Framework categorizes three main actor groups for PED ecosystems: core partners, key stakeholders, and specialists. Core partners are orchestrators that ensure the overall viability and interoperability of the PED service ecosystem. They also strengthen social acceptance and action.

Key stakeholders are actors that ensure the operability and functioning of the nested ecosystems. For example, energy and district heating distributors, energy infrastructure providers, energy storage operators, energy market providers, distributed energy asset owners, and land/real-estate owners, among others.

The third category is specialists that employ specialist capabilities periodically, for example, for the purpose of research, development, and innovation activity. Actors falling in this category are, for example, consultants, advisors, research institutes, universities, construction, and engineering companies.

The framework was applied into practical use to describe the interwoven business models in Sello PED demo area in Espoo and Baumwollspinnerei demo area in Leipzig. The case specific results of the modelling are described in the following chapters. The results are arranged under the following titles:

- **Operational environment**
- **Value Proposition(s)**
- **Ecosystem Actors and Roles**
- **Role of the City**
- **Sub-ecosystems**
- **Self-sustainability and monetization mechanisms**

These topics were selected as central elements due to their importance in terms of commercial viability, but also to highlight the key factors of the framework and to bring up the differences and similarities between the studied areas.

3.3 Ecosystem Business Modelling in Sello demo area

The theoretical framework was first applied into use in Sello demonstration area. The process included four weeks of comprehensive exploration of academic literature and SPARCS deliverables to fully understand the scope and context. After that, the key stakeholders were interviewed to gain knowledge over services, business ecosystems, economic viability, challenges and enablers specific for the Sello area.

In the last part of the process, the outcomes were validated with interviewees and relevant experts in the field of PEDs. Throughout the process, abductive approach, where empirical and theoretical inputs with emphasis on making interpretations and comparisons to inform both theory and practice, was used. The key outcomes are summarized in the following chapters.

3.3.1 Operational environment

Espoo is the second largest city in Finland with approximately 300,000 residents, and an integral part of the capital metropolitan area. Espoo is a network-type city with five major city centres and diverse areas, ranging from densely built urban areas to forest areas. Espoo aims to be the most sustainable city in Europe and a frontrunner in smart city development.

Espoo's overarching sustainability objective is to reach carbon neutrality by 2030, including fossil-free district heating and sustainable mobility, and to reduce its emissions by 80% by the same date compared to 1990. (Espoo, 2022.)

Leppävaara city district

The Leppävaara district, where Sello demonstration area is located, is the largest and most active of Espoo's five city centres. As an already built area, the centre of Leppävaara, with over 77,000 residents. The area is expected to grow significantly in the near future and the population is estimated to reach 100,000 by 2040. (Espoo, 2022.)

Sello multipurpose area

Sello multipurpose area (see Figure 5) at the centre of Leppävaara district is an existing urban area, where demonstration actions focus on improving the existing urban infrastructure. It has the third-largest traffic hub in the capital region. Sello multipurpose centre has an area of 102,000 m^2 including shops, hotel, library, concert hall, movie theatre and residential block. Sello centre has 2,900 parking spaces including tens of spots with EV charging stations.

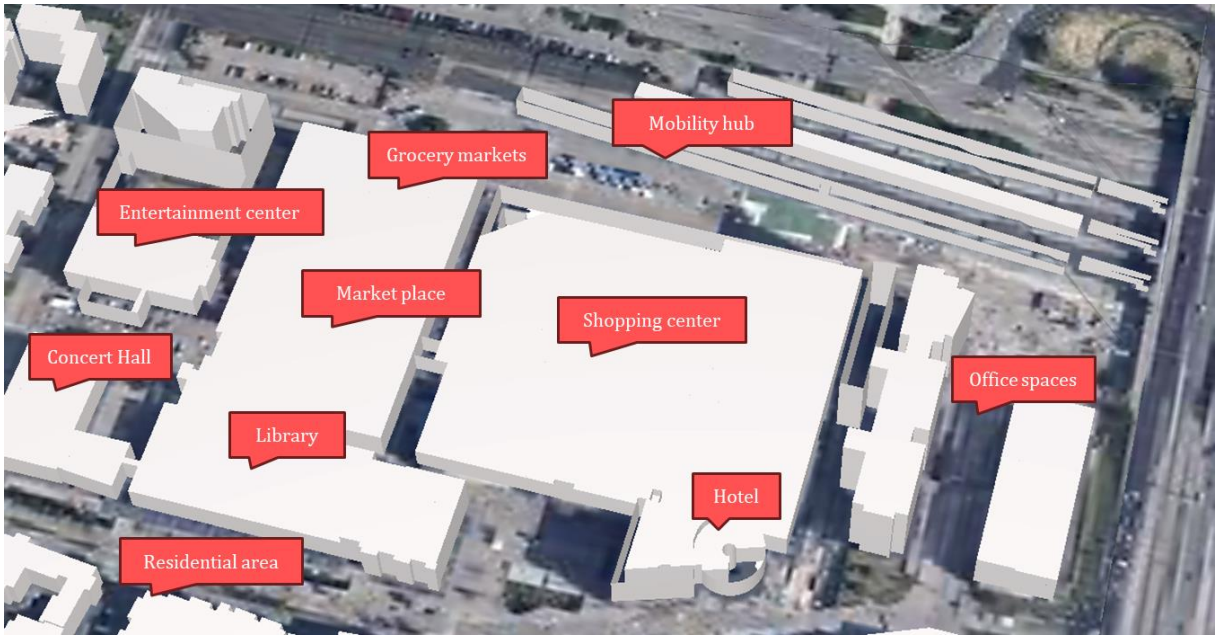

Figure 5. Sello multipurpose area

Sello shopping centre

Sello shopping centre is the second largest of its kind in Finland, with approximately 24 million visitors per year. The Sello shopping centre opened in 2003 and since then it has received several LEED certifications (platinum in 2020 and 2015, and gold in 2011) for its operations. Sello centre strives to achieve energy efficiency and a low carbon footprint and is also active in the electricity market. The virtual power plant developed and maintained by Siemens optimises energy consumption and reduces the load on the main grid. Today, it is one of the most sustainable and smartest buildings in Europe, and recently scored a Smart Readiness Index (SRI) of exceptional 92% in a study by Aalto University. (Siemens, 2024.)

Together the shopping centre, multipurpose area, and Leppävaara district, form the operational environment for local PED solutions. The operational environment is illustrated in Figure 6.

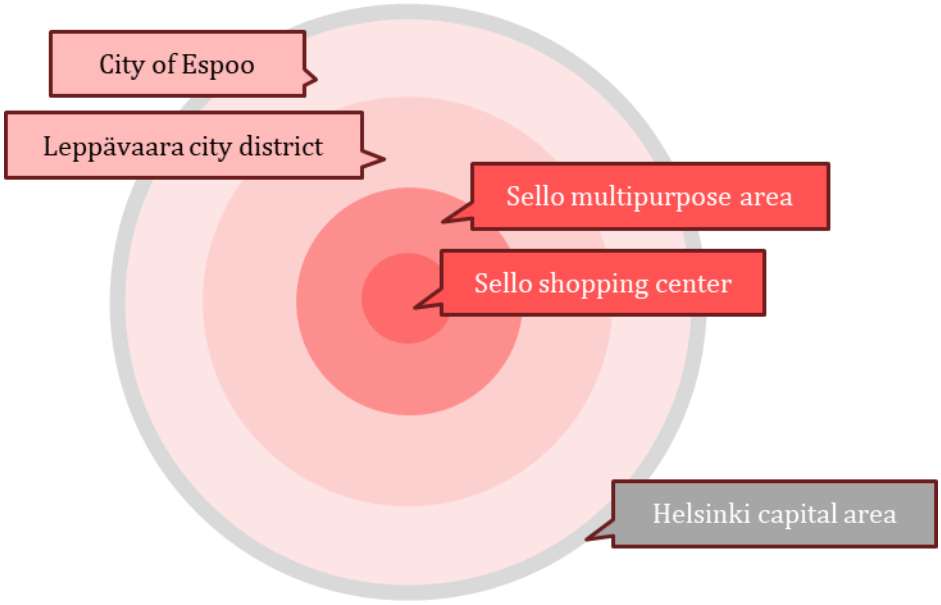

Figure 6. Sello Operational environment

3.3.2 Sello Value Propositions

Shared value proposition in Sello is a compilation of high stakeholder value, continuous innovation, increased competitiveness and benchmark setting atmosphere. Sello aims to be vibrant area for locals to spend their time, and simultaneously energy optimized entity of smart buildings with low operating costs.

Different actors serve different purposes in the area, and the combined value propositions together raise the value of the area to the customer as well as to the engaged organizations. More detailed description of Sello value proposition is illustrated in Figure 7.

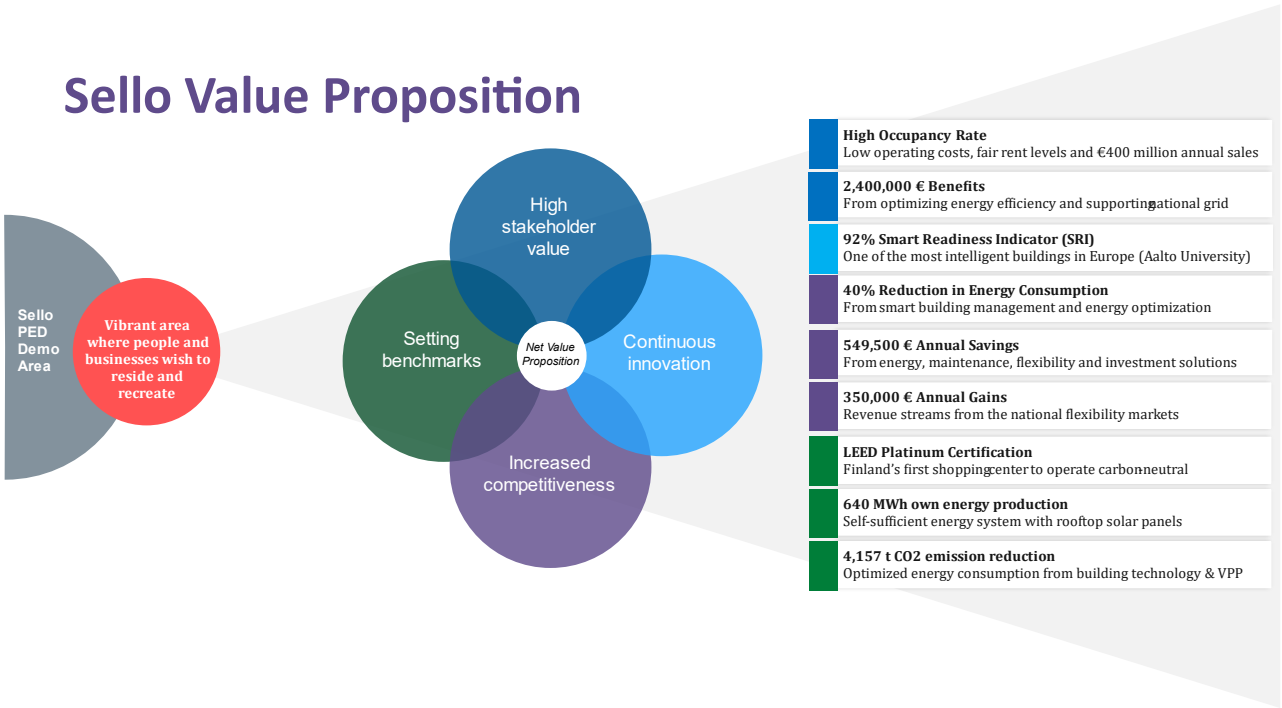

Figure 7. Sello Value Proposition

3.3.3 Sello Ecosystem Actors and Roles

The ecosystem actors and their varying roles in Sello are illustrated in Figure 8. According to the study, the core partners in Sello PED ecosystem are Siemens, Plugit and City of Espoo. They ensure the overall viability and interoperability of the PED ecosystem and strengthen social acceptance and action.

Key stakeholders that ensure the operability and functioning of the different elements of the PED ecosystem, are e.g. Fingrid, Fortum, KONE, Nordpool and Caruna. Specialist, such as VTT, consultants, and Aalto University are employing their abilities to the area when needed.

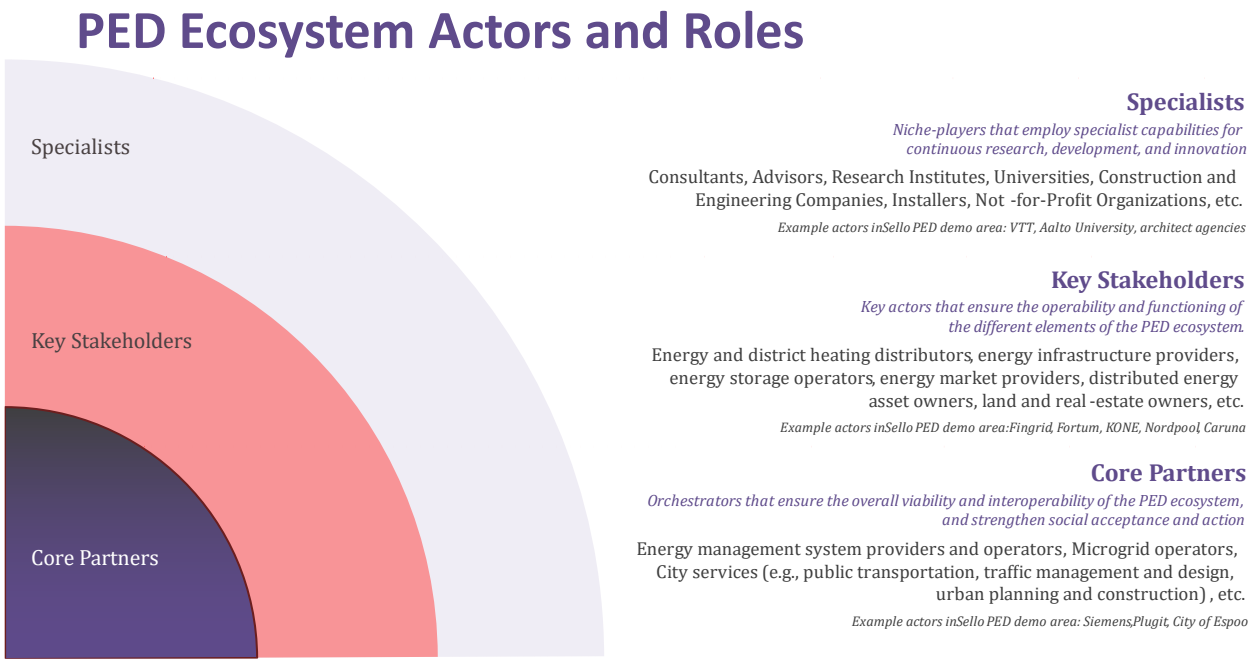

Figure 8. Sello PED ecosystem Actors and Roles.

3.3.4 Role of the city of Espoo

City of Espoo has a strategic and operative role in the area. The Espoo Story (strategy), Sustainable Espoo (cross-sectoral development program), and Sustainable Energy & Climate Action Plan (SECAP) are setting concrete implementation actions within the Espoo community to reach carbon neutrality by 2030. The impacts are evaluated through the goals and performance of the sectoral divisions are periodically evaluated with key performance indicators grounded on the UN's SDGs, which will also be disclosed to the UN in 2025 (Voluntary Local Review, VLR).

City is actively strengthening the community acceptance and sustainable action within the area. Enhanced public-private partnerships and funding across the city ecosystems are ensured by forming coalitions and engaging in R&D&I initiatives. Community engagement is strengthened with co-creation activities and education and training services. City planning functions are integrated with different city departments to enable holistic development efforts.

3.3.5 Sello sub-ecosystem 1: Energy Positive Buildings

First of the observed sub-ecosystems is focused on Energy Positive Buildings. Ecosystem roles, resources and interdependencies are illustrated in Appendix 3. Sello Sub-ecosystem 1.

In Sello, Siemens maintains the energy management system as a service. It is made up of microgrid based on Sello's building technology, solar panel system, intelligent lightning and electricity storage. Thousands of data points enable digital services, and Espoo 3D City model is continuously updated and publicly available for service provides to develop their business based on it.

In SPARCS, the development activities include e.g. demonstration on how elevators, escalators and people flow intelligence solutions could be utilized in smart building energy management and demand response, and evaluation of electricity peak load management.

The shared vision for positive energy buildings in the area:

Using renewable energy sources (solar power, geothermal wells) and appliances (sensors, smart meters) controlling electric loads (e.g., lighting, HVAC and elevators) to cut buildings' CO_2 emissions and generate surplus energy to the district energy systems.

Value Propositions:

In 2010, Sello's annual energy consumption was 34 Gigawatt hours (GWh), and now it is already less than 28 GWh. 40% Reduction in energy consumption comes from smart building management and energy optimization and can be further advanced. Sello's CO_2 emissions have dropped by 20%, and low carbon footprint offers a frontrunner position for involved organizations. Customer and visitor experience is enhanced by retaining Sello tenants and creating the image of a green shopping mall for buyers.

Self-sustainability and monetization mechanisms:

<u>Range of financial instruments</u>

- Private investments (Siemens)

<u>Pricing and revenue models</u>

- Service fees (Sello real estate operator) to building energy management operator (Siemens) based on the service agreement

<u>Main areas of costs</u>

- CAPEX: Data sensors, infrared cameras, other data collecting infra
- OPEX: Building energy management system (Siemens DesigoCC), Advanced analytics platform providers (Siemens Navigator), operational personnel (energy manager), remote support (Siemens Digital Service centre)

<u>Main areas of savings</u>

- In 2017, energy savings of 125,000 euros were achieved in Sello shopping centre compared to 2016 without significant additional investments. In addition, annual cost savings of 200,000 euros in heating energy consumption.
- The financial benefits achieved annually by the Sello shopping centre are greater than the total service fees and investments.

Main areas of surplus

- No surplus as such. As commercial actors, each of the partners related to the Positive Energy Buildings sub-ecosystem invests their profits according to their individual plans.

3.3.6 Sello sub-ecosystem 2: Renewable Energy Production, Distribution and Storage

Second sub-ecosystem is renewable energy. Resources, actors and roles related to business in this field are illustrated in Appendix 4. Sello Sub-ecosystem 2.

In Sello, renewable energy is produced by a 750 kW photovoltaic plant. If more solar energy is produced than used, it's stored in 2MW battery storage. Battery storage is used during peak load, when the market price of electricity goes up, and as a part of Sello's participation to energy flexibility markets. The area is being developed into a micro-grid with Battery Energy Storage Systems and other flexible assets e.g. integrated electrical equipment, HVAC, elevators and EV-chargers. District heating demand is covered by renewable district heating.

Shared vision for renewable energies in the area: Increasing efficiency, flexibility and self-sufficiency through distributed renewable energy production, digital tools and through local thermal energy production.

Value Propositions: From 2023, all the electricity and heat Sello shopping centre consumes, is generated with 100% renewable energy. Electricity consumption, is, and will be, adjustable. Now part of the electricity consumption is adjusted, so that the production could be steadier at the more optimal, and the efficiency level is high.

Self-sustainability and monetization mechanisms:

Range of financial instruments

- Private investments in Sello PV plant and energy storage (As-a-service by Siemens)

Pricing and revenue models

- Sello PV plant and energy storage service fees for energy operator (Siemens) based on the service agreement
- District heating service fees for DH operator (Fortum) based on the service agreement
- Energy distribution service fees for DSO (Caruna) based on the service agreement

Main areas of costs

- CAPEX: Sello PV plant and energy storage. District heating & grid infrastructure and assembly costs
- OPEX: Sello PV plant and energy storage. District heating & grid operating costs

Main areas of savings

- PV plant: 640 MWh own energy production. Repayment period for the investment in renewable energy production was halved, which means hundreds of thousands of euros saved every year.

- Energy storage: Energy savings for Sello equivalent to the electricity needed to heat 20 detached houses each day during winter.
- Other: Reduced maintenance costs; all 3,000 light bulbs in the shopping centre have been replaced with energy-saving ones.

3.3.7 Sello sub-ecosystem 3: Energy Management

The third sub-ecosystem in Sello revolves around Energy Management and Virtual Power Plant (VPP). The illustration of actors, roles and resources can be found in Appendix 5. Sello Sub-ecosystem 3.

The VPP in Sello stabilises the national grid by offering flexibility. VPP responds to increases in the market price of electricity to reduce energy costs e.g. recharged batteries with cheap spot electricity. In the future, also district heating demand response solution could enable a reduction of peak load and produce savings both in energy expenses and CO_2 emissions.

Shared Vision for Energy Management: The VPP enables Sello shopping centre to automatically optimise not only energy consumption, but also energy purchasing and increase the interoperability, monitoring and control of various energy systems. As a long-term vision, the entire Espoo region could be a part of the VPP (e.g., metro, rail transports, etc.). The point is how the solutions are integrated into the entire region and the city, not just Sello centre. Sello building block is an active node in the energy system.

Value Propositions: Stabilising national grid and receiving 350,000 € annual gains from the national flexibility markets, which results in increased value of building and district. Flexibility also reduces energy costs and emissions.

Self-sustainability and monetization mechanisms:

Range of financial instruments

- Private funding used for new energy assets and flexibility platform (Siemens)

Pricing and revenue models

- Service fees to VPP operator (Siemens) based on the service agreement (including for example trading, providing hardware, operating or all-inclusive service)
- Flexibility market income from Finland's transmission system operator Fingrid

Main areas of costs

- OPEX: Flexibility platform, operational personnel
- Reduced CAPEX needed in the energy transmission & storage infrastructure when flexibility potential of the consumer is sold to the TSO for energy asset optimization

Main areas of savings

- VPP halves the repayment period for the investment in renewable energy production, hundreds of thousands of euros saved every year
- Reduced network fees due to peak load shaving

Main areas of surplus

- Service optimization and flexibility platform evolution e.g. more accurate predictions

3.3.8 Sello sub-ecosystem 4: Electric mobility

The fourth sub-ecosystem, illustrated in Appendix 6. Sello Sub-ecosystem 4, is forming around e-mobility solutions.

Leppävaara has the biggest public bus charging system in Finland and works as a real-world demo for future solutions. The private e-car charging system (80 EV stations) is being integrated in the virtual power plant and is used in the overall energy optimization for the block. New e-mobility hub connects the local and long-distance trains and a new fast tramline. Car sharing service GreenMobility offers 100% electric shared cars in the area**.**

Shared Vision for the Electric Mobility: The Sello block and area will be developed into a new E-mobility hub that aims to develop large-scale EV charging systems. The goal is to implement a charging system which could be used by multiple EV types.

Value Propositions: More cost-efficient solutions are offered to the customer. Aiming to create services that suit everyone with any type of vehicle. Overall solutions are helping to achieve national / EU CO_2 reductions and e-mobility targets. Offering reliable, properly maintained charging equipment, that is convenient for the user. Working as a testbed for future solutions.

Self-sustainability and monetization mechanisms:

Range of financial instruments

- Electric bus charging system: Bank/financial institutions (95%), non-municipal public funding from multiple sources (5%)

Pricing and revenue models

- Service fees: Customers pay for charging point operator for charged energy
- Electric bus charging system: Plugit provides the infrastructure, local public transportation operator HSL buys as-a-service (monthly fee)

Main areas of costs

- Capital expenses: Electrical infrastructure, chargers, cabling, installation cost
- Operational expenses: Land rent, charger and infrastructure maintenance, marketing, payment traffic, remote management, customer service
- Electricity expenses: Charging point operator pays to the grid company and electricity seller

Main areas of savings

- Lower costs for transport: Electric buses have 1/5 of the energy costs of a diesel bus
- Shared infrastructure: Reduced infrastructure cost to customers
- Managing the peak charging level: Significant monetary savings

Main areas of surplus

- No surplus

3.4 Ecosystem Business Modelling in Baumwollspinnerei demo area

The ecosystem-based business modelling for Baumwollspinnerei started after the results in Sello had been validated and summarized. Besides forming a better picture of the ecosystems in Baumwollspinnerei, the aim was to finetune the processes that were first tested in Sello, and to see, if the differences between studied areas have direct effects to the modelling practices.

The first step of the modelling included a presentation of Sello results, which helped to simplify the data collection: partners were able to deliver suitable information over their solutions and development actions within and beyond SPARCS based on the Sello examples. After the introductory meeting, the involved partners filled in data-collection templates and shared relevant other documents with the researchers, who were then able to continue with a desktop study. Based on the desktop study, a draft version of modelling was prepared and shared with the partners. Partners got familiar with the findings, after which the material was amended through online interviews. The final results were validated in a joint online meeting with all involved parties.

3.4.1 Operational environment

Leipzig

Leipzig is one of the fastest-growing cities in Germany. A phase of strong growth began in 2012, with the population increasing by 10 000 residents annually. This growth is response to the high quality of life in Leipzig and the above-average employment rates.

The city of Leipzig is committed to the goals set at the Paris Agreement in 2016, which are adopted at the municipal level. Germany's target for GHG reduction is 65% by 2030, 88% by 2040, and climate neutrality by 2050. Leipzig will act as a role model and is set to decarbonize by 2040. As an interim goal towards climate neutrality, the city has set itself a goal of reducing GHG emissions to 1.9 tons of CO_2 per resident by 2030, and 0.25t by 2040.

In 2019, the City Council declared climate emergency, recognizing that existing measures were not sufficient to achieve GHG reduction targets. In 2017, fossil fuels, electricity and gas were the main energy sources, representing almost 77% of total energy consumption and 83% of GHG emissions. A new Sustainable Development and Climate Protection Department was established to coordinate cross-departmental collaborations and steer the implementation of Leipzig's Energy and Climate Protection Program 2030.

Plagwitz

Plagwitz, an old industrial area, has transformed into one of Leipzig's vibrant hotspots in recent years. Start-ups work alongside established companies, creative enterprises, manufacturers, and service providers. The lively atmosphere is palpable daily. Families, singles, artists, and locals come together in the green, leafy streets, surrounded by nineteenth-century houses, lofts, and industrial buildings.

Baumwollspinnerei

The protected premises of Baumwollspinnerei (former cotton mill from 1884) with approx. 30,000 m² consist of partly renovated buildings mainly built of brick. The demo area is a best-practice example for the revitalization of a former industrial site used for cultural activities.

It sets a new standard for former industrial sites by creating a greener, more resilient, and economically prosperous future for all stakeholders, while setting a precedent for sustainable industrial or commercial developments all the while preserving heritage charm. The Baumwollspinnerei demo district is representative of the urban transformation in the German real-estate industry. Originally, during the late 19th century, it was used as a large-scale industrial processing site for cotton.

The actual spinning mill factory site really looks like a small factory town. It is a closed neighbourhood development covering around 6 hectares and consists of 20 individual buildings inside. In addition to the four former large spinning mills, now Halls 7, 14, 18 and 20, there are another 16 former functional buildings. Of the original 24 buildings, these are still preserved. Almost all buildings were built as very massive brick buildings. The gross floor area of the area is around 100,000 square meters.

From the 1990s onwards, the site was increasingly made available for other users, and soon became a hub for artists. Thus, a large site that previously served a fixed purpose gradually became a place of different tenants with different requirements and demands. This change brought about unique challenges for the historically developed energy infrastructure.

To be able to reach a sustainable energy system for the Baumwollspinnerei in harmony with the preservation of the historical monument and the needs of the tenants, implementing digitalisation of the energy resources on the site is a must. Due to the preservation, e.g. the energy efficiency actions must focus on smart energy systems use instead of replacing the original structures with more energy efficient solutions.

3.4.2 Baumwollspinnerei Value Propositions

The shared value proposition is to create value by pioneering innovative solutions that decarbonise the energy supply, reduce demand, and promote sustainable practices in area protected by the Monument Protection Act.

Efforts not only benefit the environment but also enhance economic viability, regulatory compliance, conservation of cultural heritage and tenant satisfaction. Decarbonized energy supply, optimized energy usage and increased renewable self-sufficiency are going hand-in-hand with enhanced socio-cultural sustainability.

Value proposition and central targets related to it are further detailed in Figure 9, Baumwollspinnerei Value Proposition.

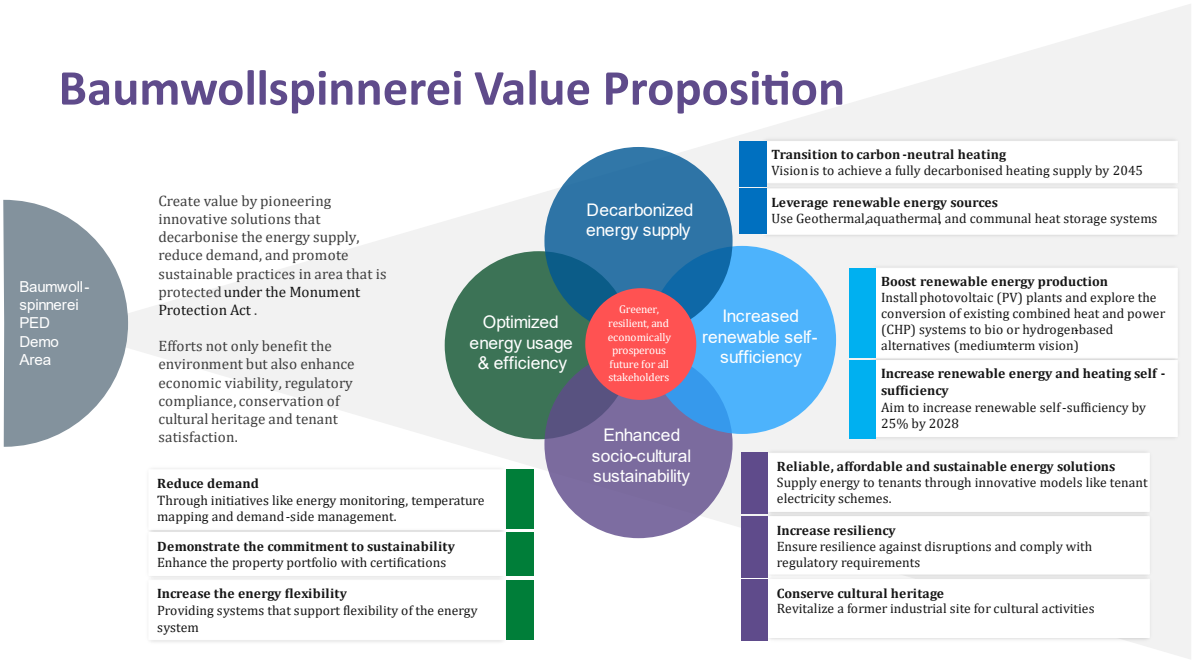

Figure 9. Baumwollspinnerei Value Proposition

3.4.3 Baumwollspinnerei ecosystem actors and roles

The most important actor in Baumwollspinnerei is Cenero. City of Leipzing has also important role in advancing the PED development and creating opportunities for business and can be counted as a core partner.

Key stakeholders include, for example, building owner Leipziger Baumwollspinnerei Verwaltungs GmbH and The Leipziger Stadtwerke as well as Netz Leipzig. There are several other active partners in the area, such as Spinlab and University of Leipzig, but in general they have a smaller role in the ecosystem and can be labelled as Specialists. Focal actors and some examples of each category are presented in Figure 10.

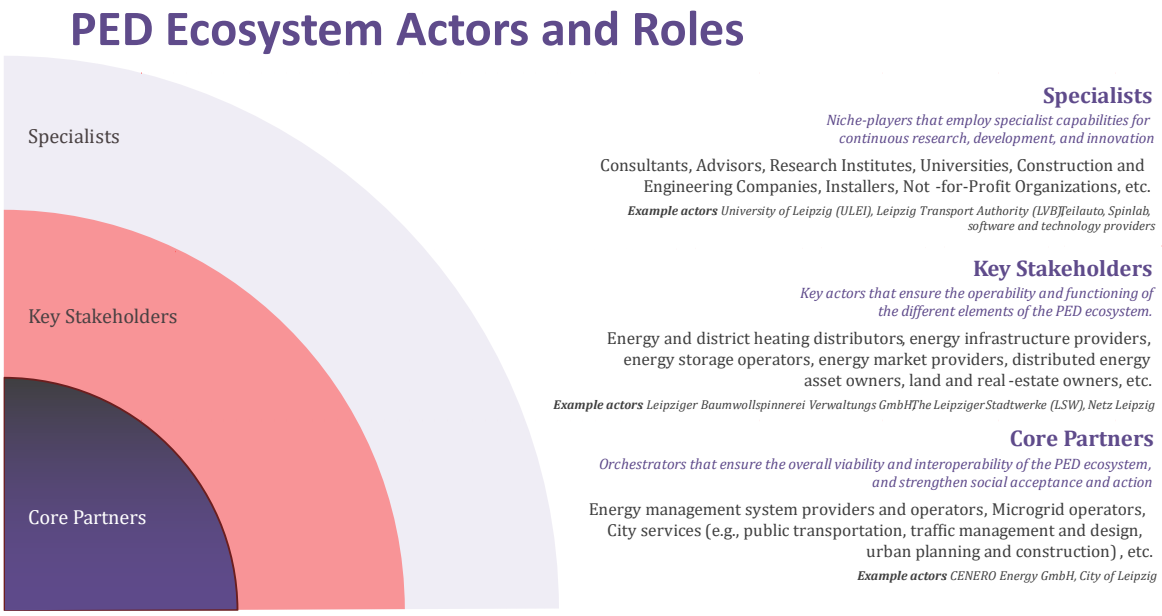

Figure 10. Baumwollspinnerei ecosystem actors and roles.

3.4.4 Role of the City of Leipzig

The Strategic Vision for Leipzig 2030 sets guidelines for urban development highlighting the core tasks and challenges in development initiatives ("Leipzig is growing sustainably!"). It is the city of Leipzig's Integrated Urban Development Concept (INSEK), established to steer multidisciplinary and cross-sectoral urban developments. The Strategic Vision sets Strategic Goals, Priority Fields of Action, and principles for joint action involving all municipal actors. By networking public and private organizations, the city aims to solve problems collaboratively and remove development hindrances as they occur. The Energy and Climate Action Programme (EKSP+ implementation programmes) establishes action fields and measures for climate protection. The City of Leipzig is participating in the Europe-wide certification system "European Energy Award" (EEA). The digital agenda (Digitale Agenda der Stadt Leipzig) sets principles for common goods led digitalisation and smart city technology installations.

Urban development is grounded on the Leipzig Charter for a Sustainable European City and the UN's SDGs. Four goals steer sustainable growth: (1) quality of life (comfort, prosperity, natural environments for residents); (2) competitiveness (solid economic base, new business opportunities, sustainable jobs); (3) internationalization; and (4) social stability (inclusive urbanization, equality); based in the UN development goals, all led by the idea of Leipzig growing sustainably. For each goal, six areas of concrete interdisciplinary action with specific targets have been introduced. Leipzig monitors its climate impacts with the BISKO standard.

Four core principles for desirable urban development are identified: a stable economy, a solid financial base, natural resources, and a vibrant democracy. These principles steer the co-creation of intelligent and forward-looking concepts for sustainability increases. Four key stakeholder groups are identified: (1) Civil society (civic engagement, public participation, communication); (2) Region (cooperation within the metropolitan area); (3) Service companies (co-creation of high quality and reasonably priced communal services); and (4) Leipzig City Council & Administration (flexible, strategy-led learning-organization). The city acts as an initiator and a focal connector between actors that are required in PED development.

3.4.5 Sub-ecosystem 1: Energy Positive Buildings

The first sub-ecosystem of Baumwollspinnerei pictures service providers for energy positive buildings. Detailed illustration in Appendix 7. Baumwollspinnerei Sub-ecosystem 1.

The buildings in Baumwollspinnerei enable decentralized energy production as well as other on-site generation. Extensive digitalisation and data analysis are setting foundation for identifying optimisation potential and insufficiencies. Retrofitting an existing building can result in 50-75% less carbon than constructing the same building from scratch, and in Baumwollspinnerei it is important to make use of and optimise what there already is to create energy positive buildings.

Shared vision for the area: Pave the way in sustainability through comprehensive monitoring, encompassing consumption, generation, and building parameters. Ensure optimal resource utilisation by identifying inefficiencies and minimising energy losses. Enhance, renovate, and preserve the integrity of existing structures and infrastructure via data-driven decision-making. Create a future-proof green district and merging historical elements with innovative solutions through cutting-edge technologies.

Value Propositions: Offer tenants decentralized, efficient, affordable and clean energy in a holistic, transparent, and informative manner, following regulations and compliance to ensure safety for all.

Self-sustainability and monetization mechanisms:

Range of financial instruments

- Private investment

Pricing and revenue models

- Direct sales: Sale of energy
- Service fees: SaaS monitoring and management
- Rental fees: Meters, sensors and charging columns
- Energy trading: Sale of excess energy to the public grid

Main areas of costs

- CAPEX: Hardware (e.g., CHP plants)
- OPEX: Personnel costs, cost of electricity (from public grid)

Main areas of savings

- Contracting: Increased profitability through energy savings

Main areas of surplus

- Test bed on how to implement PED systems and attract future clients
- Reinvest surplus in PEDs to install new PV / CHP plants

3.4.6 Sub-ecosystem 2: Renewable Energy Production, Distribution and Storage

The second sub-ecosystem of Baumwollspinnerei, energy production, distribution & storage, is further illustrated in Appendix 8. Baumwollspinnerei sub-ecosystem 2.

In Baumwollspinnerei, there is a 70.47 kW (63.50 kWh/a) solar power system on the roof of Hall 10, and the electricity bought from grid is 100% green. For storage purposes there is a 50 kW / 48 kWh battery and flexible e-mobility charging stations that can be up or down regulated by the load management according to load on the grid.

Shared vision for the area: Decarbonise heating supply by 2045. Increase the degree of self-sufficiency by renewables from current 5% to 35% by 2028. Join Leipzig's efforts to become climate neutral by 2040, or if possible, by 2030. Use the demonstration activities to embark a range of solutions supporting transition towards low carbon areas and testing of possibilities for positive energy blocks in Leipzig.

Value Propositions: Make the central district heating system more efficient and lower CO_2 emissions while increasing the share of renewable energies. Create a greener, more resilient, and economically prosperous future for all stakeholders – considering both generation and consumption – while setting a precedent for sustainable developments, preserving the heritage charm, and making use of as much of the existing infrastructure as possible.

Self-sustainability and monetization mechanisms:

Range of financial instruments

- Private investment
- Public investments: City of Leipzig initially brought financial resources for the external facilitation of RES (discontinued)

Pricing and revenue models

- Direct sales: Sale of energy
- Service fees: SaaS monitoring and management
- Expert service fees: Consulting / Operational

Main areas of costs

- CAPEX: Hardware (e.g., Photovoltaic plants)
- OPEX: Personnel costs, cost of electricity (from public grid)

Main areas of savings

- Long-term savings due to generation of renewable energy for own use

Main areas of surplus

- Calculations from VPP are used for product development (microgrid trade) and market assessment (LSW)
- Reinvest surplus in PEDs to install new capacity
- Possibility to sell energy to the main grid

3.4.7 Sub-ecosystem 3: Energy Management

Third illustrated sub-ecosystem in Baumwollspinnerei is energy management. Ecosystem roles and resources from the energy management perspective are pictured in Appendix 9. Baumwollspinnerei Sub-ecosystem 3.

In Baumwollspinnerei, there is more than 2,000 digital meters that enable high level energy management. All main meters are integrated into cenero.one energy monitoring platform, most are digital. Intelligent thermostats are distributed in selected rental spaces. Complex communication between the thermostats and an automated valve via cenero.one allows the automated closing of a valve in response to the heating demand. Load management is implemented on the site to monitor the generation capacity and load on the grid.

Shared vision for the area: Digitising the entire Baumwollspinnerei site and have a comprehensive holistic overview of all energy resources and parameters driving the efficiency and of the site. The energy management system visualizes and displays consumption to make tenants aware of their heat usage. The system is intended to reduce heat-related emissions from the corresponding rental spaces through this combination of information and control.

Value Propositions: Gain near to real-time insights and precise control over energy generation and consumption at the Baumwollspinnerei. Proactively optimise performance, reduce costs, and drive sustainability with scalable, flexible, and reliable tools. Make data-driven decisions and unlock the full potential of energy resources for operational excellence and a greener future. Use the data to set a foundation for conceptualising future installations.

Self-sustainability and monetization mechanisms:

Range of financial instruments

- Private investment

Pricing and revenue models

- Service fees: SaaS monitoring and management
- Rental fees: Meters, sensors and charging columns
- Energy trading: Sale of excess energy to the public grid. From energy providers and energy trader perspective all the businesses are a source of flexibility that can be used both ways.
- Consulting revenues: Planning and ramp-up of new energy systems together with a large stakeholder network
- Additional revenues: Billing, reporting, etc.

Main areas of costs

- CAPEX: Hardware (e.g. sensors, metering systems)
- OPEX: Personnel costs, cost of electricity (from public grid)

Main areas of savings

- Contracting models linked to energy savings

3.4.8 Sub-ecosystem 4: Electric mobility

Fourth sub-ecosystem of Baumwollspinnerei is Electric mobility ecosystem, which is presented in detail in Appendix 10. Baumwollspinnerei sub-ecosystem 4.

In the area, there is existing public transportation, including increasing number of e-buses. For private e-mobility there are charging columns leased by tenants. The charging capacity responds to the load on the grid and in accordance with the hierarchy set in the load management to achieve peak shaving goals. Originally, there were aims to test bidirectional charging in the area, but unfortunately due to technical problems which neither the vehicle manufacturer nor the charging column manufacturer could identify and resolve, bidirectional charging could not be tested.

Shared vision for the area: To improve Leipzig's charging infrastructure by developing a comprehensive and intelligent network of EV charging infrastructure for private and public use, for both EVs and e-bikes. Lead with efficiency and value, prioritising a greener, cleaner, and more connected urban ecosystem for all using cutting-edge technologies. Enhance the existing network of public charging stations with intelligent capabilities to meet the increasing demand for e-mobility.

Value Propositions: Offer tenants, visitors, and others an accessible, safe and comprehensive EV charging infrastructure at an affordable price. Optimize energy management with access to highly reliable EV-fleet data for potential cost-savings. Source green energy and decentralised renewable energy to power the charging stations to create a greener, cleaner, and more connected urban ecosystem, enhancing value and convenience for all.

Self-sustainability and monetization mechanisms:

Range of financial instruments

- Private investments

- Public investments: City of Leipzig brought funding (SPARCS project) to support and development of e-mobility options available, and strengthen the renewable energy system

Pricing and revenue models

- Direct sales: Supplying electricity for charging
- Rent income: Rental of charging columns to tenants

Main areas of costs

- CAPEX: Hardware (e.g., new chargers)
- OPEX: Personnel costs, cost of electricity (from public grid)

Main areas of savings

- Electricity savings (Peak shaving)
- Monitoring the effects of intelligent e-mobility on the grid and peak shaving potential

4. CONCLUSIONS

When it comes to the new economic paradigms and applications that drive the change, PEDs have a lot to offer. Simultaneously focusing on financial, economic, and environmental sustainability, PED development is speeding up the energy and sustainability transition and answering the needs of changing societies and economy.

SPARCS activities have helped the organizations to adjust to the change, and to develop plans and solutions that support the socio-economic as well as technical transition in cities. Systematic approach and use of practical and well-directed tools has enabled effortless replication of the processes, as well as comparability of the results.

The conducted case study illustrates the earlier achievements of the project through comprehensive ecosystem-based business model assessment in real-life SPARCS demonstration areas. The examination of the interconnectedness within PED offers a view not only to business models and collaboration within the area, but to cross-cutting cooperation and results achieved in the earlier phases of the project.

The case study shows that successful business in PEDs is characterised by strong intersectoral collaboration relying on public-private partnerships across the city ecosystem. There are differences in between areas as well as different type of PEDs, but the core elements are similar. PEDs in general form around four elements: energy positive buildings, renewable energy, energy management systems and e-mobility. Understanding the focal elements of PEDs and the interconnectedness of the actors is important for driving sustainable business in PEDs.

In the studied demo areas, the differences were shown, for example in the basic characteristics of the area and buildings: Sello area is relatively new, and in many ways more prepared for smart energy solutions and energy efficiency, as Baumwollspinnerei is an old area and object of protection due to the cultural heritage. In both areas, the PED development included actions and strategies for all four PED elements. The positive energy balance was pursued through solutions that focus on building level solutions, renewable energy, energy management and VPPs, and e-mobility. The scale, however, depended on the area specific characteristics.

In both Sello and Baumwollspinnerei each PED element draws interest of suitable partners and forms a sub-ecosystem around the topic. At some topics, the sub-ecosystems are overlapping, and in most of the times interdependent. Both Sello and Baumwollspinnerei have their crucial core actors, that drive the collaboration and have either a strong focus on commercial development in the area, or city development goals with high level of ambition. Cities hold a key role to strengthen the institutional and social acceptance as well as driving the action with clear regulatory frameworks, incentive mechanisms, long-term political commitment and vision.

4.1 Impacts

Creating tools and processes may offer great benefit to organisations working on the EU targets of establishing 100 PEDs by 2025 (JPI Urban Europe, 2024) as well as other aims to advance energy transition across the globe. The Ecosystem Business Assessment Model Framework helps public and private organizations to evaluate how to get involved in PED business ecosystems, or alternatively, expand their operations within PEDs. In addition, the framework can be used as a tool to scale solutions on a city level or to other positive energy districts.

Increased understanding over the interconnectedness of the business models and commercialization of novel energy solutions can accelerate the breakthroughs in energy transition and promote new projects that have a long-term macro-level impacts on societies.

4.2 Other conclusions and lessons learnt

Based on the case study, many of the technological solutions developed in the SPARCS project have reached maturity and the studied PED areas are already operating in competitive market and gaining advantage of the PED service ecosystem. The future business and RDI activities in the studied areas are mostly market based: the solutions are being developed by own cost mainly, and forms of public funding are additional.

From PED perspective, the main hindrances are related to the regulatory and political challenges: incentives for PED development are not clear, and regulatory mechanisms are struggling to keep up with the rapid pace of technological advancements. The legal aspects are also creating clear distinctions between the studied areas. In Europe in general it is typical that the local regulation varies from country to country, which makes it difficult to replicate frontrunning business models that require new approaches to the regulatory frameworks.

The issue with managerial tools is that only wide enough diffusion will create optimal end results. For the level of understanding to increase, the tool needs to be actively used and developed further if needed. To tackle this problem, the Ecosystem Business Model Assessment Framework will be offered for public to use as free online tool.

The online tool acts as an interview guide as well as workshop template for the institutional users but can be also used by an individual organisation willing to evaluate their role in existing or potential PED. The process will also be further developed in other locations – the current understanding over country and area specific factors and their effect on the tool is still rather limited.

5. ACRONYMS AND TERMS

Economic paradigm

A narrative through which we study and observe the economic systems in the society.

Sustainability Transition

Major change in industries, socio-technical systems, and societies toward more sustainable mode of production and consumption.

Business Models (BM)

A description of the way an organisation is conducting business.

Positive Energy District (PED)

Energy-efficient and energy-flexible urban areas or groups of connected buildings, which produce net zero greenhouse gas emissions and actively manage an annual local or regional surplus production of renewable energy.

Business Ecosystem

Self-containing and self-adjusting group of resource-integrating organisations connected by shared goals and mutual value creation.

OECD

Organisation for Economic Co-operation and Development (OECD) is an international organisation that works to build better policies for better lives.

UN

The United Nations is an international organization founded in 1945. The United Nations can take action on a wide variety of issues due to its unique international character and the powers vested in its Charter, which is considered an international treaty.

SDG

Sustainable Development Goals defined by UN.

PPP

Public-Private Partnership: a mechanism for government to procure and implement public infrastructure and/or services using the resources and expertise of the private sector.

ESCO

ESCOs are energy service companies that offer energy services to help their clients to achieve energy and environmental goals.

CAPEX

Capital Expenditures: funds that company uses to acquire, upgrade, and maintain physical assets such as property, plants, buildings, technology, or equipment.

OPEX

Operating Expenses: shorter-term expenses that are required to meet the ongoing operational costs of running a business.

VPP

Virtual Power Plant: a system that integrates multiple power sources, that individually are too small to be of interest, and sells the output (typically) to an electric utility.

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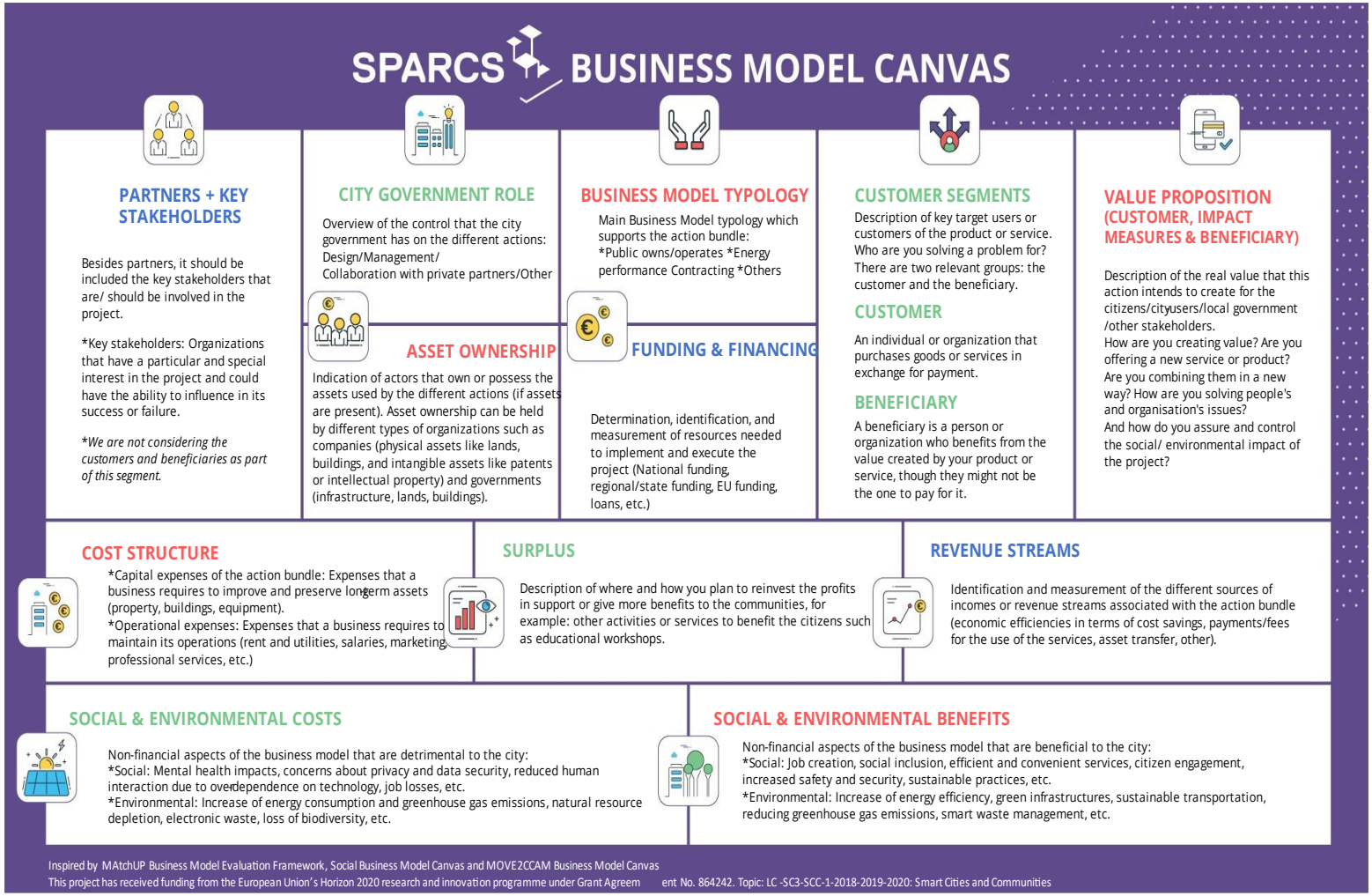
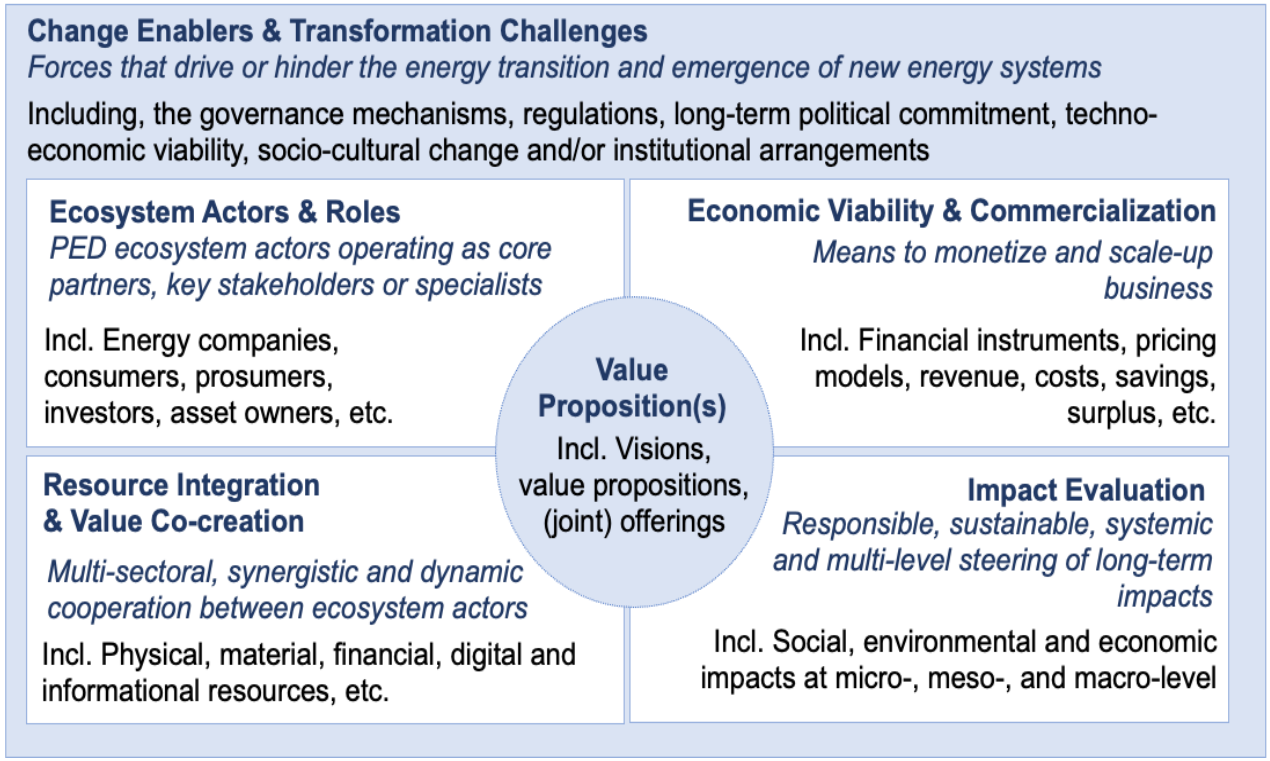
7. APPENDICES

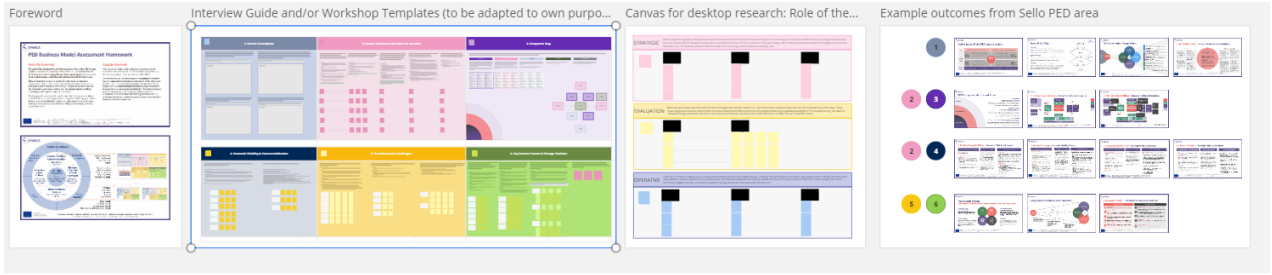
APPENDIX 1 SPARCS BUSINESS MODEL CANVAS



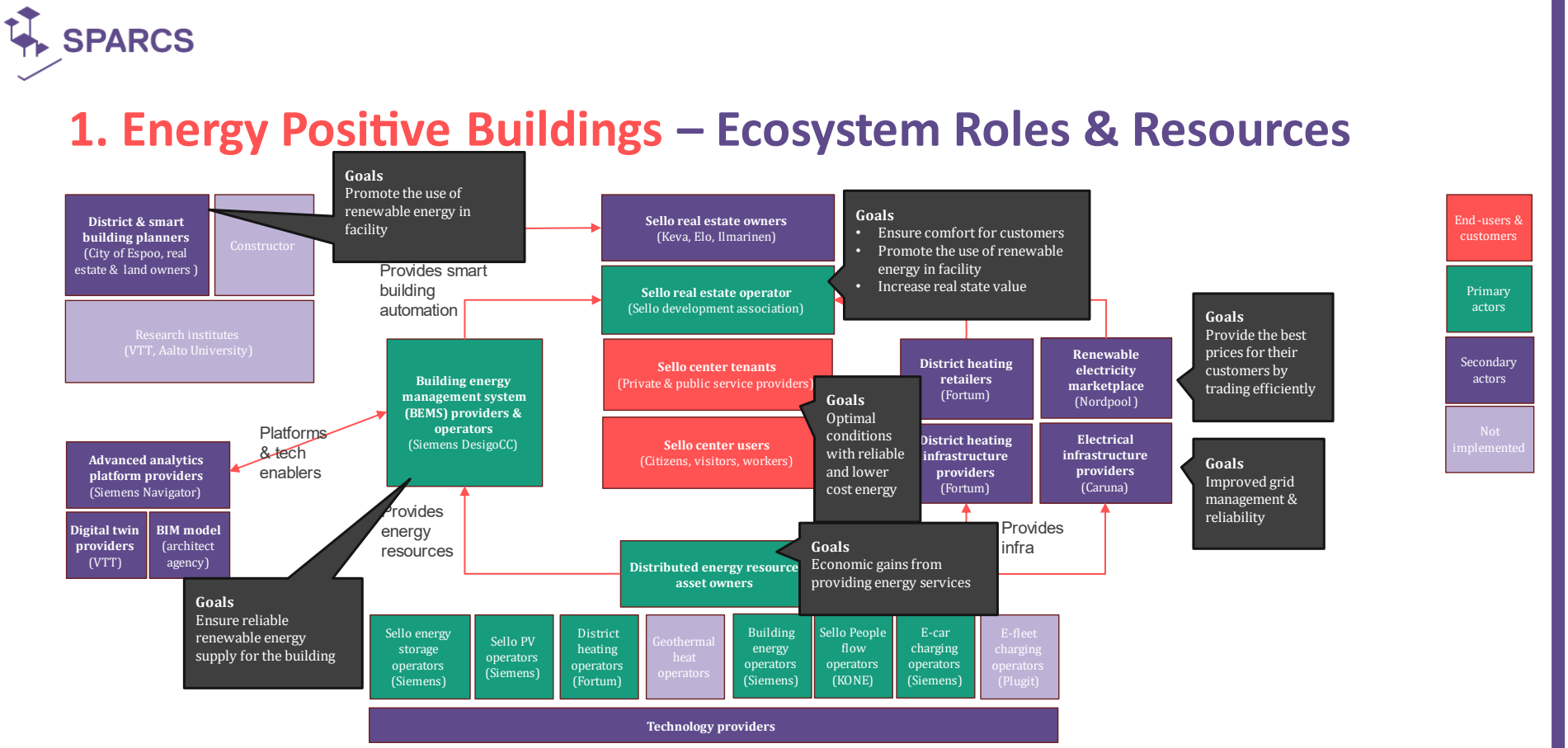
APPENDIX 2 SPARCS ECOSYSTEM BUSINESS MODEL ASSESSMENT FRAMEWORK



Link to the tool with full description of the Ecosystem Business Model Assessment, including the interview guide and/or workshop templates:https://miro.com/app/board/uXjVNF5E53I=/



APPENDIX 3 SELLO SUB-ECOSYSTEM 1.



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Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities
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Figure: Stakeholder Map for BEMS Systems (E-LAND Project Output, 2019; BABLE, 2021)

APPENDIX 4 SELLO SUB-ECOSYSTEM 2.

SPARCS

2. Sello Renewable Energy – Ecosystem Actors, Roles & Resources

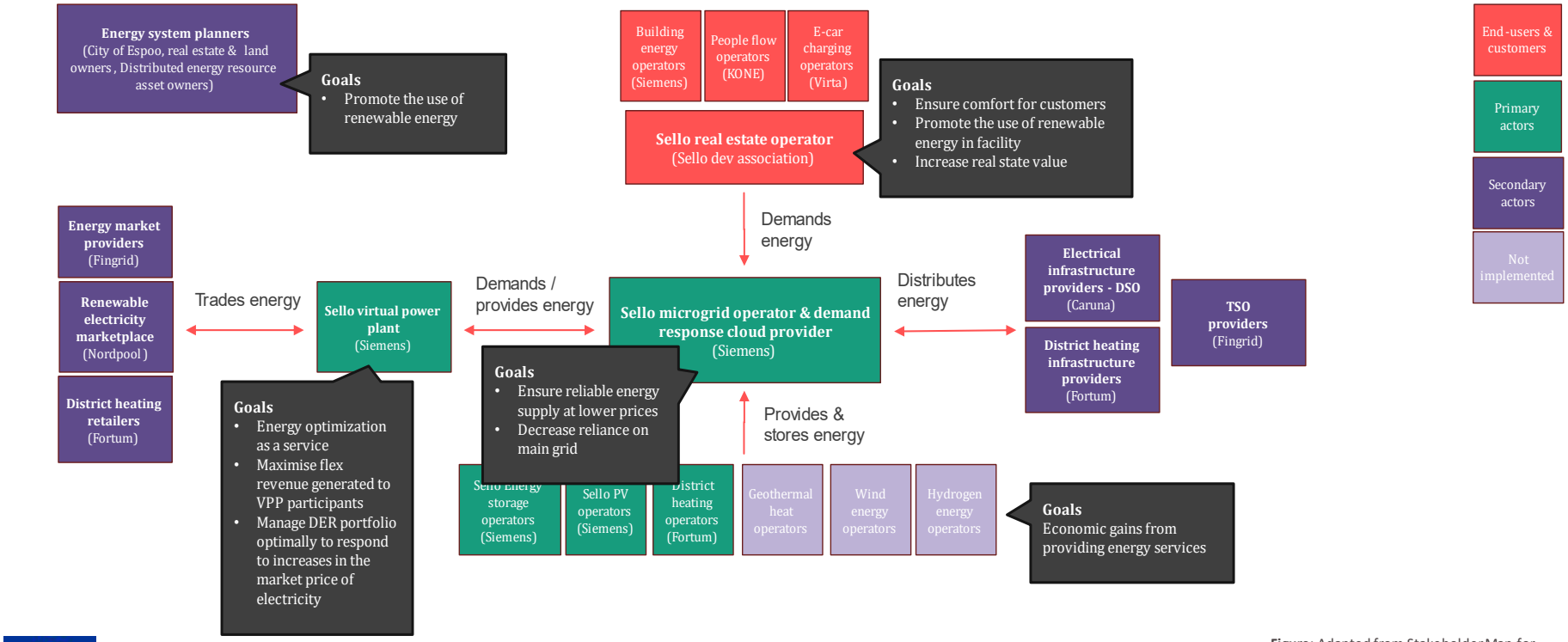

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Figure: Adapted from Stakeholder Map for a Smart Grid System (BABLE, 2021)

APPENDIX 5 SELLO SUB-ECOSYSTEM 3.

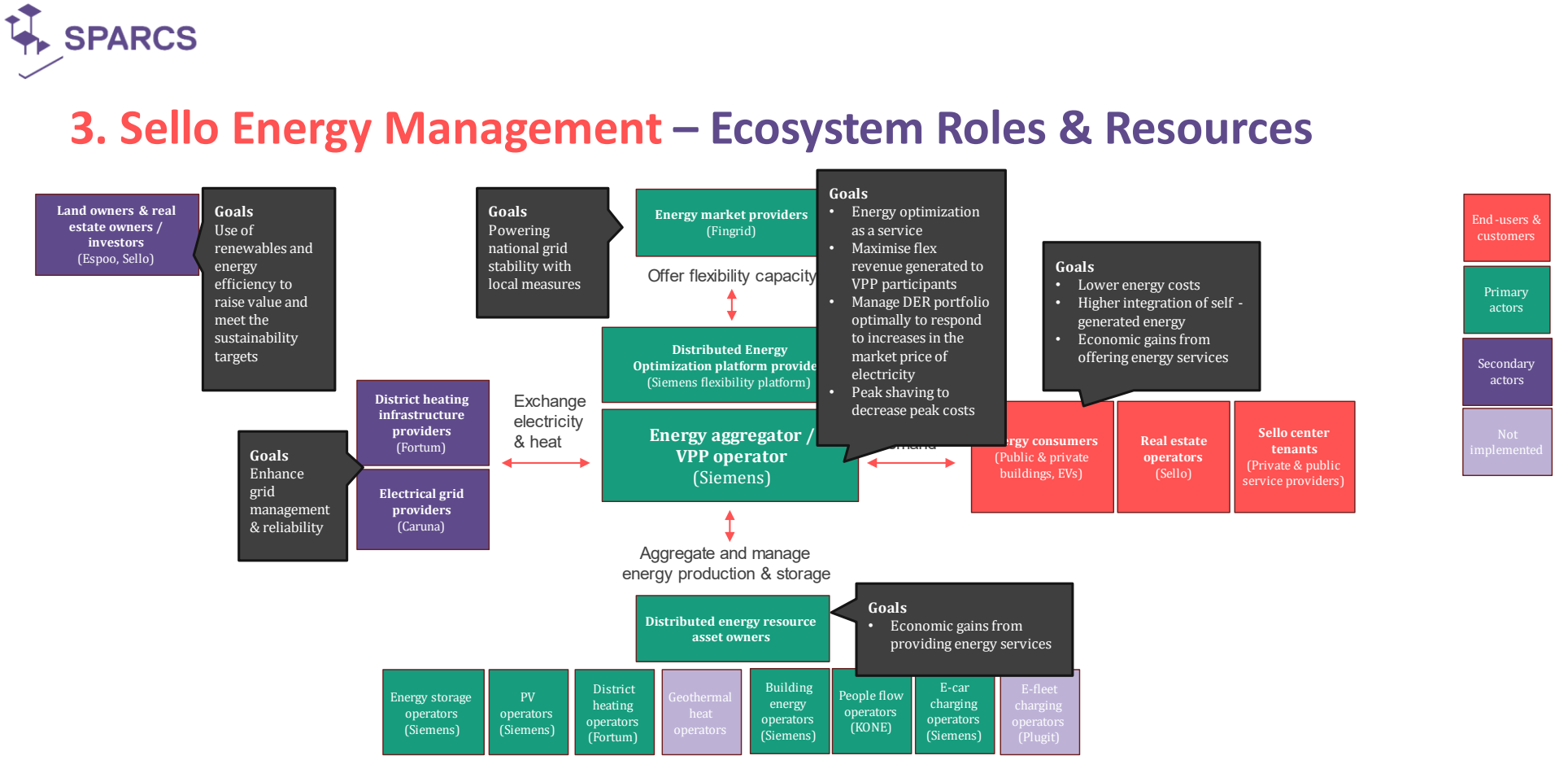

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Figure: Adapted from Stakeholder Map (BABLE, 2021)

APPENDIX 6 SELLO SUB-ECOSYSTEM 4.

SPARCS

4. Sello Electric mobility – Ecosystem Roles & Resources

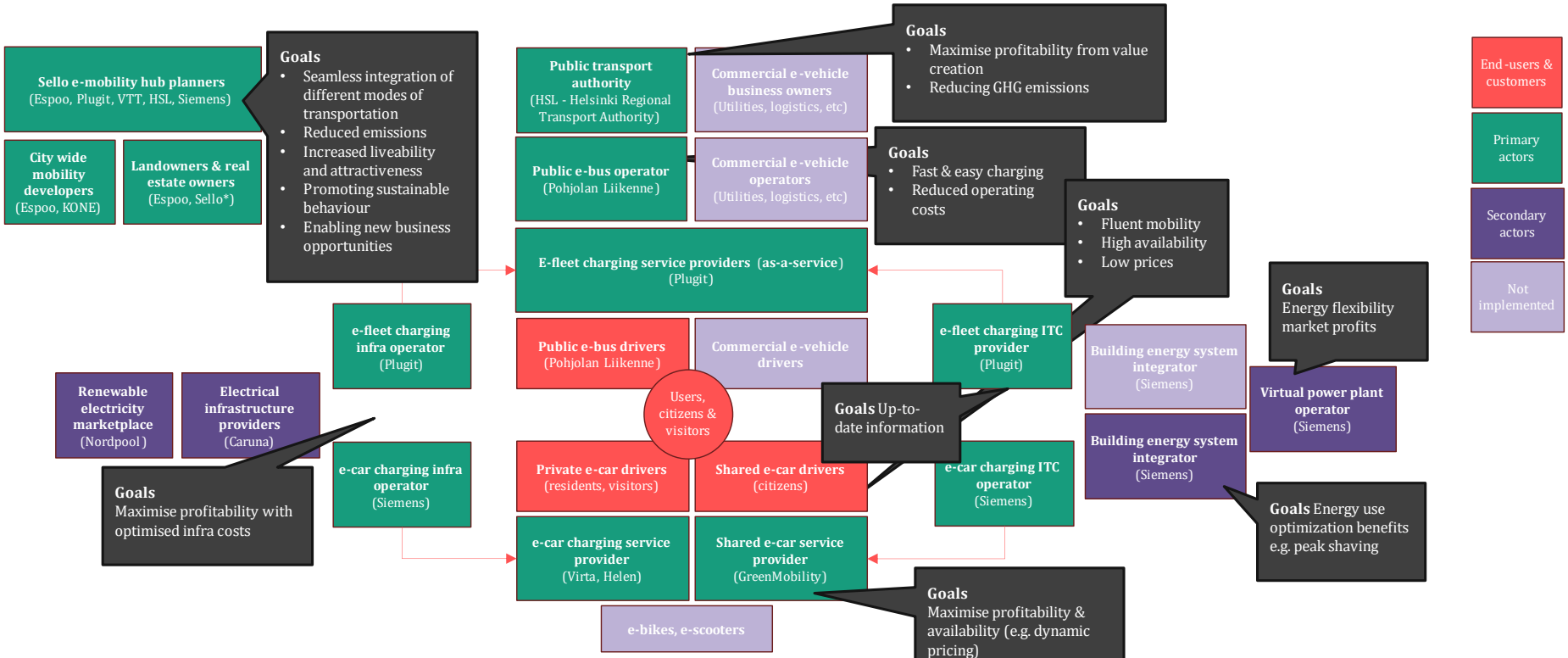

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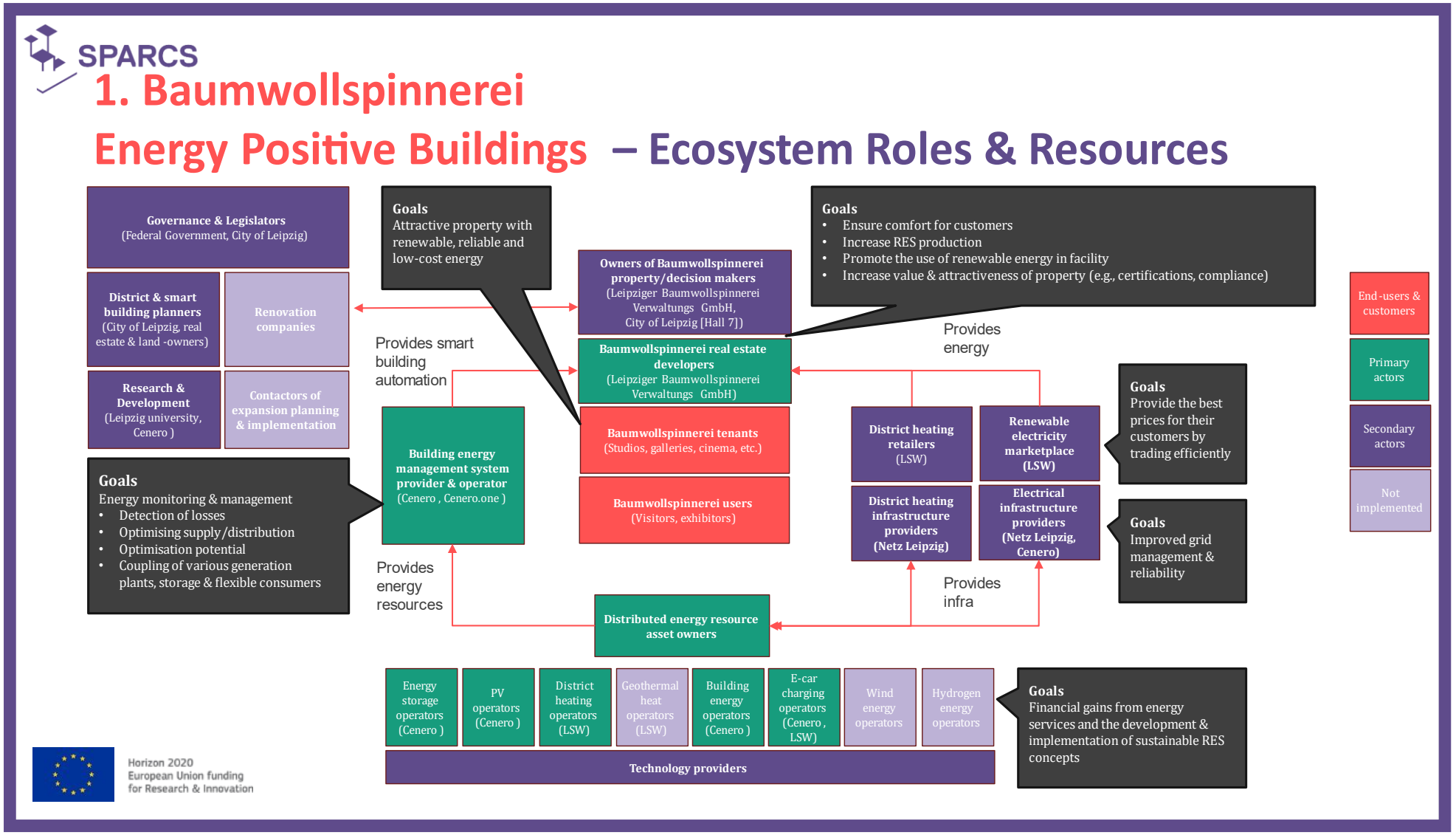
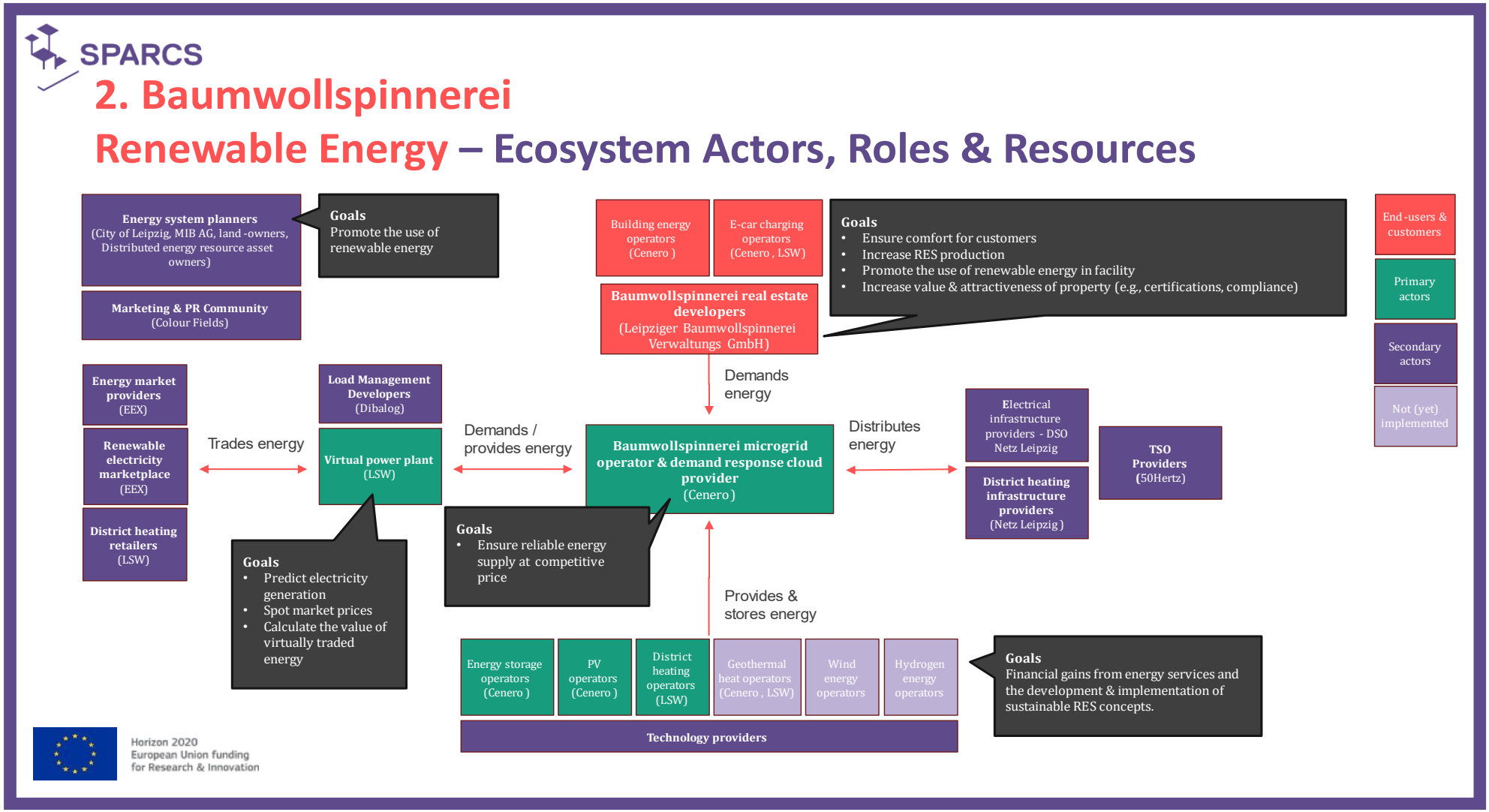
Figure: Adapted from Stakeholder Map of Mobility Hubs (Gavilán Orozco, 2020; BABLE 2021)

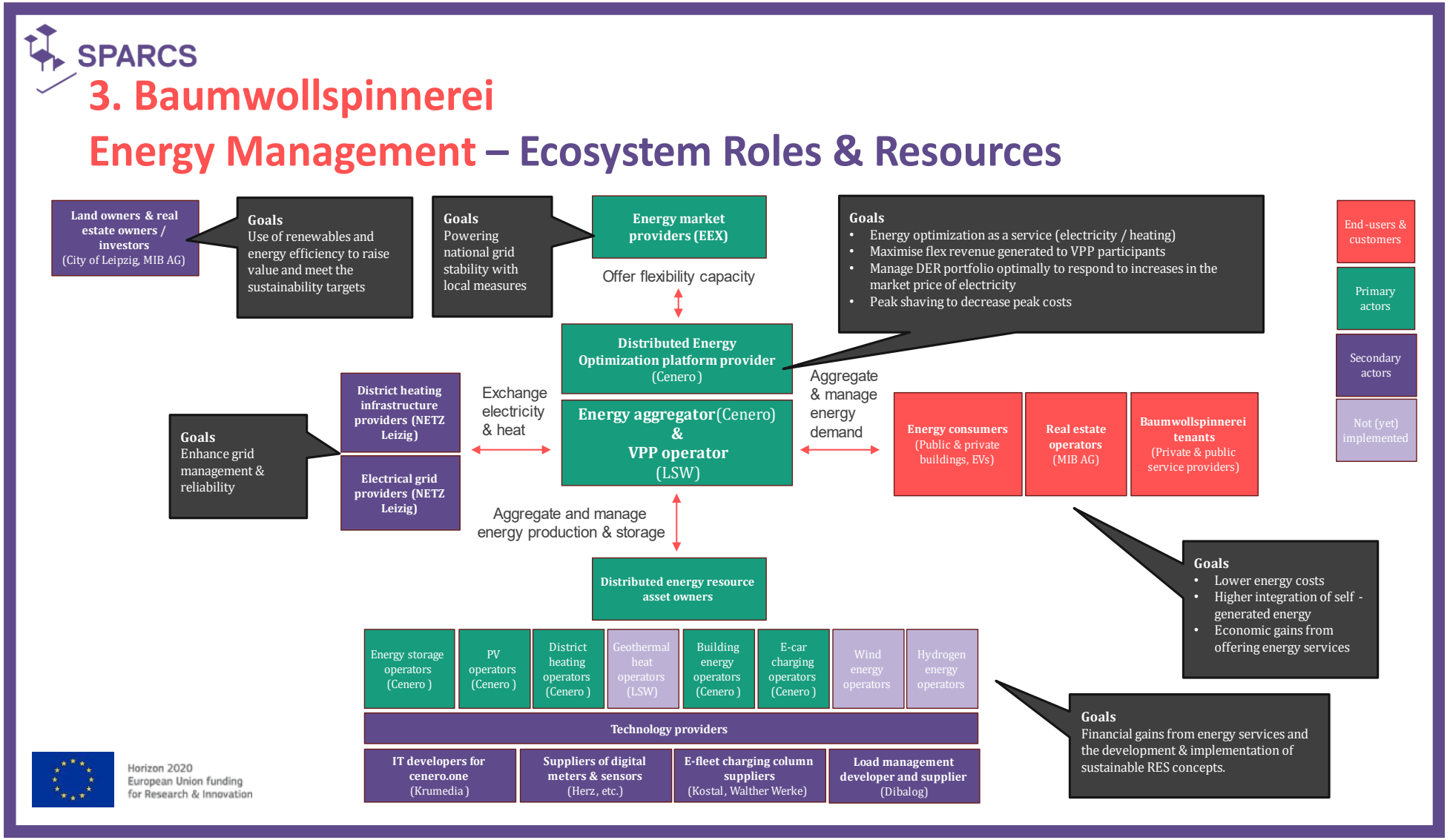
APPENDIX 7. BAUMWOLLSPINNEREI SUB-ECOSYSTEM 1.



APPENDIX 8. BAUMWOLLSPINNEREI SUB-ECOSYSTEM 2.



APPENDIX 9. BAUMWOLLSPINNEREI SUB-ECOSYSTEM 3.



APPENDIX 10. BAUMWOLLSPINNEREI SUB-ECOSYSTEM 4.