



# How to PED

## The +CityxChange Cookbook

Experiences and guidelines on Positive Energy Districts



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Experiences and Guidelines on Positive Energy Districts

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# Welcome to Our Cookbook

## **“A PED is a process, not a product”**

This “How to PED” cookbook contains experiences, lessons learned, and recommendations gained throughout the 5 years of the +CityxChange EU Horizon 2020 project, specifically focused on the variety of activities necessary to develop and build Positive Energy Districts (PEDs) in smart sustainable cities and communities. Over the course of the book we will draw on the experiences of our 2 Lighthouse Cities, 5 Follower Cities, and 26 other partners, to demonstrate what it takes to build a PED.

We show the importance of collaboration and co-creation, involving the right people, designing effective pathways for change, deploying strong partnerships and financing, adapting to existing processes or adapting the processes themselves, developing impactful strategies, building new systems and services, and creating new infrastructure in PED projects.

This cookbook represents the processes and results of +CityxChange, where we all contribute with our own recipes & flavours. Just as in real life, recipes often need adjustment to taste. There is no single way to build a PED, so these recipes from our cities provide guidance through the complexities of the journey and share key information that helps initiate and smoothen the processes.

*From the +CityxChange project, to you.*





# Introducing +CityxChange & PEDs

+CityxChange is a smart city project that brings together two Lighthouse Cities, Trondheim (Norway) and Limerick (Ireland), and 5 Follower Cities, Alba Iulia (Romania), Písek (Czech Republic), Sestao (Spain), Smolyan (Bulgaria), and Võru (Estonia). This collaborative effort aims to pilot integrated, innovative, and replicable solutions for Positive Energy Blocks & Districts, which are developed and tested in Lighthouse Cities, in close collaboration with the Follower Cities. The long-term goal is to create sustainable urban ecosystems with zero emissions and achieve 100% renewable energy city-regions latest by 2050.

The project uses co-creation to develop innovative frameworks and methodologies that help to prototype new and future-proof urban energy systems, structured in our 11 demo projects that you will also find reflected in our recipes. At its heart lies the vision of co-creating a brighter future within a collaborative multi-stakeholder environment. By delving into the unique circumstances of each city, guided by ambitious Bold City Visions formulated during the project, +CityxChange partners have worked together in navigating the path towards energy neutrality. The accomplishments of the project extend to the promotion of policy innovation, market regulation adjustments, and the introduction of business models aimed at nurturing positive energy communities and advancing e-mobility in European cities.

As the project concludes, many established frameworks become common practice, new ventures are launched, and the connections forged during the project endure, ensuring the continued pursuit of sustainable urban development.

## THE FACTS

- Project name:  [+CityxChange – Positive City ExChange](#)
- Funded by: European Union Horizon 2020. Grant agreement No:  [824260](#)
- Funded under: SOCIETAL CHALLENGES – Secure, clean and efficient energy
- Topic: Smart Cities and Communities (Lighthouse Projects)
- Duration: 1 November 2018 – 31 October 2023 (5 years)
- Total EU funding: € 19 999 996
- Lighthouse Cities: Limerick, Trondheim
- Follower Cities: Alba Iulia, Písek, Sestao, Smolyan, Võru
- Coordinator: Norwegian University of Science and Technology (NTNU)



This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 824260. It falls under the topic Smart Cities and Communities (SCC), in which integrated innovative solutions for Positive Energy Blocks/Districts were developed and tested in Lighthouse Cities, with close collaboration with the Follower Cities. As part of the SCC community, we would like to acknowledge the support and opportunities for collaboration we've had from the SCC projects and cities. We encourage you to check out these inspiring projects to learn about what other cities around Europe are doing to build and promote scalable energy solutions! 🌐 [Scalable Cities](#) & 🌐 [SCC1 Lighthouse Projects](#).

### What is a PED/PEB?

A Positive Energy District (PED) is an urban area that consists of several buildings (new and retrofitted) – and the neighbourhood around them. They produce local renewable energy and actively manage their local energy consumption, and their energy flows to the wider grid. Together the PED has an annual positive energy balance: for its results over a year, the PED uses less energy than it produces itself. It can then share this surplus with the city around it. It achieves this through increased energy efficiency, reduced energy demand, and increased local renewables.

PEDs should be embedded in the urban and regional context, requiring interaction and integration between buildings, inhabitants, local and regional energy providers, mobility, and ICT systems. PEDs are both a way to reach energy and emission goals, and to make a city more liveable and future-proof.

*What is the difference between a 'PED' and a 'PEB'? It's about scale: A Positive Energy Block (PEB), is simply a smaller, more compact pilot area. The block should contain at least three buildings of mixed-use and local renewable energy. Having only three buildings is of course not enough, so PEBs and PEDs are supposed to grow and connect to more buildings and areas. Scale this up, and you may get to a PEC – a Positive Energy City!*

A successful PED takes a holistic approach, incorporating technology, spatial, regulatory, financial, legal, social and economic perspectives. Ideally, PEDs are developed in an open innovation framework, driven by cities in cooperation with industry and investors, research and citizen organisations.

A PED combines aspects of built environment, sustainable local renewable production, reduced consumption, mobility, active energy management, balancing and optimisation, optimised flexibility, peak shaving, load shifting, local storage integration, demand response, district-level self-consumption of electricity and thermal energy, smart energy grids, citizen participation, user involvement, and ICT.

Infrastructure development is needed: 1) strong building and district energy efficiency measures or retrofits, 2) building-integrated and district-level local renewable energy production, and 3) integration between them. In this cookbook, we focus mostly on the last aspect, and on how it can support the other two.

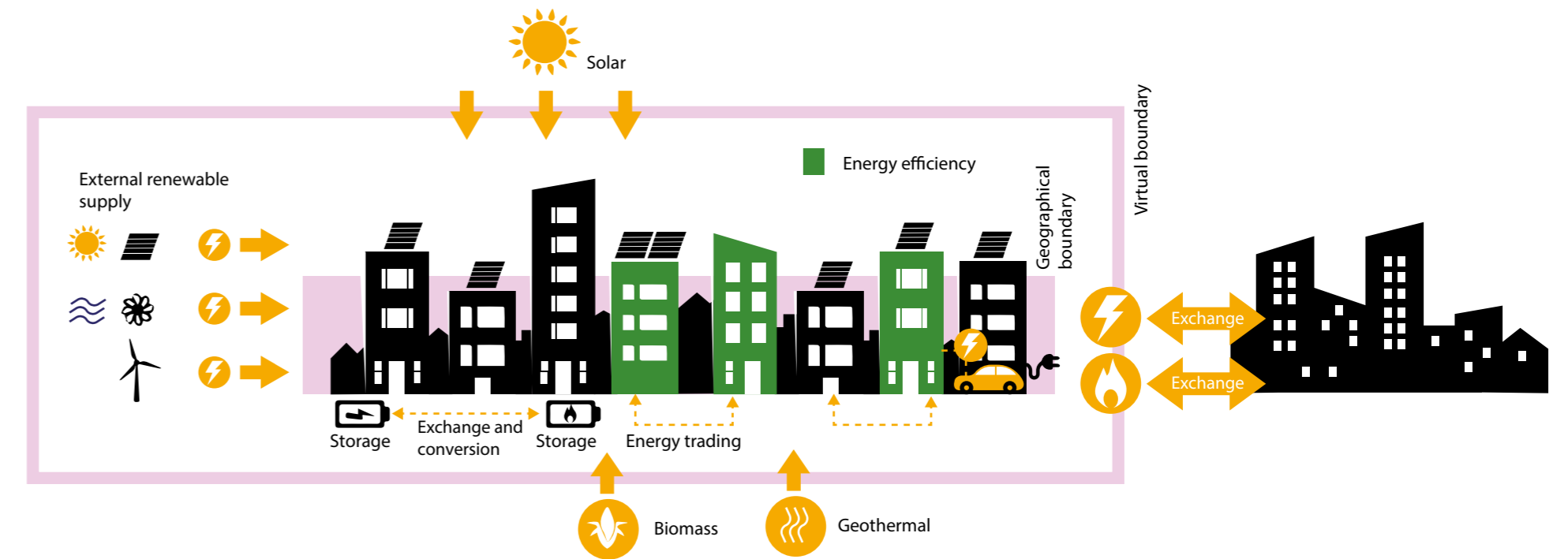
PEDs go beyond energy generation and consumption by prioritising social well-being, encouraging community engagement, and supporting sustainable urban planning and liveable cities.

### Want to learn more?

Background: 🌐 [Positive Energy Block \(PEB\) - +CityxChange](#)

Video: 🌐 <https://www.youtube.com/watch?v=cibXP-1-nLw>

Scientific article on the formal PED definition with types for different cities: 🌐 [The Sense and Non-Sense of PEDs, 2023](#)

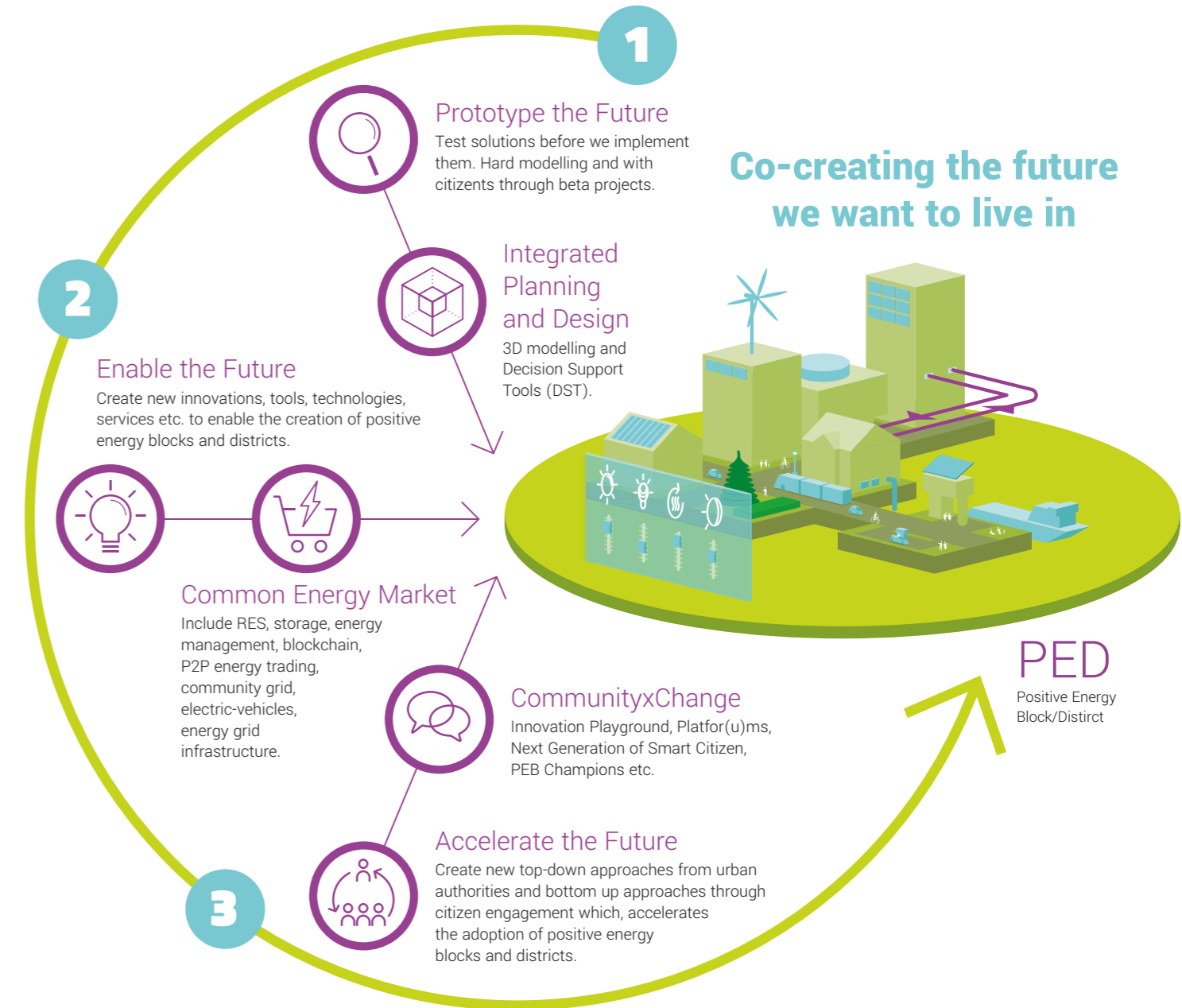




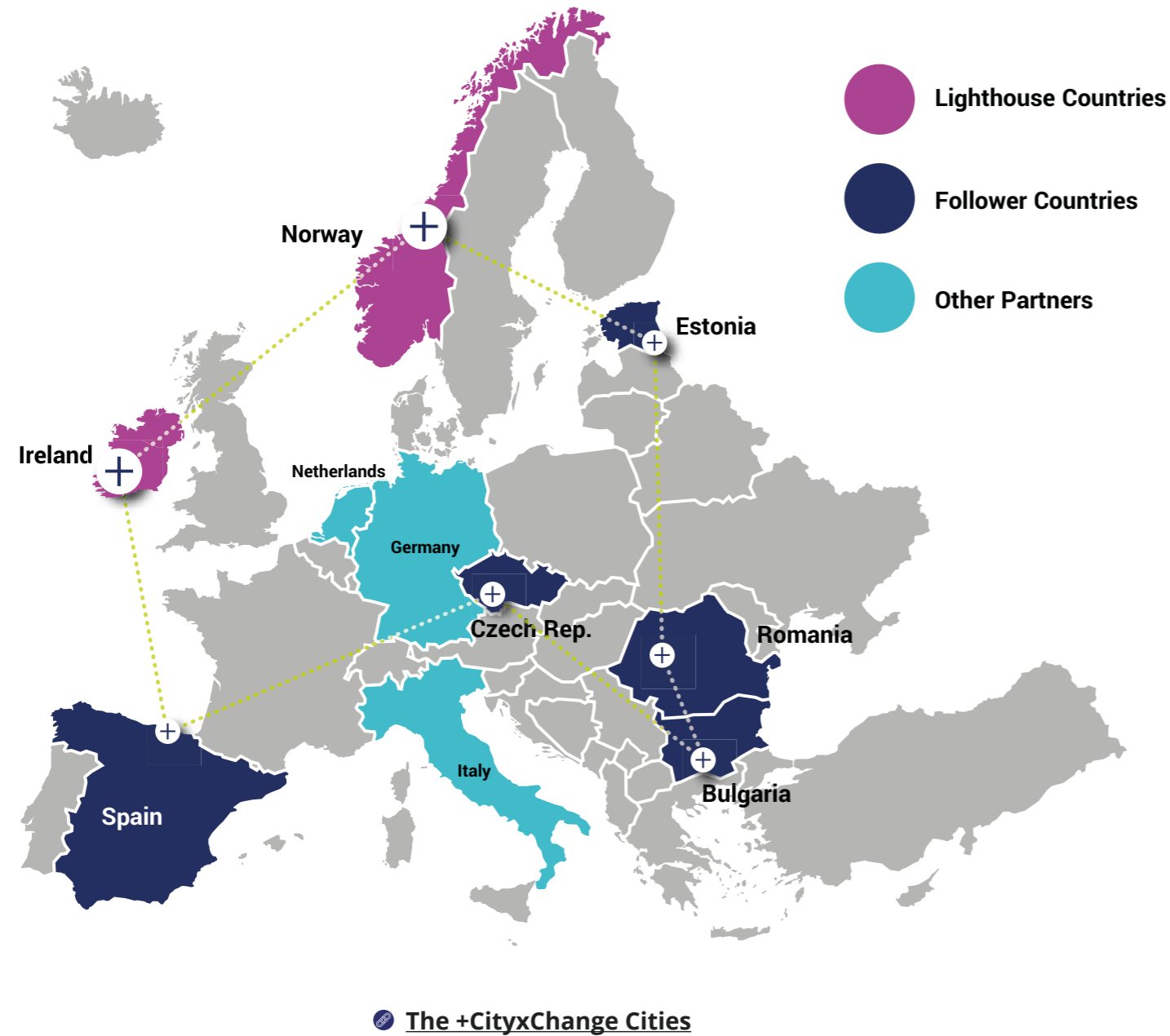
## Making PEDs in +CityxChange

The diagram on the opposite page demonstrates how +CityxChange worked to co-create the future and develop PEDs. In the first phase, you prototype and develop models which are integrated into city planning. The second phase is to bring in tools, technology and innovation and to create a common energy market by incorporating

things like energy management, community grids and electric vehicles. The third phase is to activate citizen engagement through innovation playgrounds and by taking a bottom-up approach to accelerate the adoption of PEDs. These three phases run in parallel.







### Trondheim, Norway

Trondheim is located in central Norway and is the third most populous city in Norway. It is known as the tech capital of Norway and is home to the main campus of NTNU (Norwegian University of Science and Technology), Norway's largest university.

The city has worked towards creating an efficient public transport and cycling infrastructure and constantly innovates to get smarter and greener. It is a hub for technology and innovation, focusing on renewable energy solutions and sustainable urban development. Trondheim's dynamic waterfront, museums, and open spaces create a balanced urban lifestyle, and Trondheim is increasingly renowned as the culinary capital of Norway. Alongside Limerick, Trondheim is one of the lighthouse cities in our project, pioneering many new developments in energy generation and sharing.

### Limerick, Ireland

Limerick, a city nestled on the western edge of Europe, exudes an energy that sets it apart from many others. It stands as a testament to Ireland's commitment to change, sustainability, and innovation. Limerick's transformation from an industrial hub to a vibrant centre for education, technology, and culture is nothing short of remarkable. Startups and tech companies find fertile ground here, while the city actively pursues green initiatives, embracing a more sustainable future. Its commitment to positive change is evident in every corner, from revitalised neighbourhoods to creative arts and cultural endeavours. Developing clean energy sources is also high on the city's priorities. Limerick's blend of history, forward-thinking, and student

vibrancy makes it a city pulsating with an irresistible energy, forever on the cusp of shaping the future of Ireland and Europe as a whole. Alongside Trondheim, Limerick is a lighthouse city in our project.

### Sestao, Spain

Sestao is located in Bizkaia, one of the 3 provinces of the Basque Country, and has a population of ~27,500. Sestao is known for its industrial heritage, having held some of Spain's largest steelworks and shipyards. Now, the heavy industry has significantly scaled back, but the city has evolved through modernization/automatization and still plays a vital role in the overall city fabric. In recent times the city has developed a cultural heritage of its own. It is well connected to the surrounding communities through road, rail, metro, and upcoming new bike lanes along with e-bike sharing programs. A tunnel under the Nervión river is expected to connect Sestao with the opposite riverbank by 2028, a major milestone for the city.

### Alba Iulia, Romania

Alba Iulia is located by the Mureş River in the heart of Transylvania in the central part of Romania and has a population of almost 74,000. Cultural heritage and tourism are of significant importance for Alba Iulia. The historical centre is highlighted as a geometric centre and also as the core of the urban organisation. The Alba Carolina Citadel, the most representative Vauban Citadel in Romania, outlines the city of Alba Iulia.



The city blends tradition with modernity, hosting the 1 Decembrie National University and promoting innovative endeavours. Alba Iulia's strategic location within the Transylvania region makes it a significant development hub. With its proud heritage and forward-looking mindset, the city embodies Romania's journey through time and progress.

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### Smolyan, Bulgaria

The city of Smolyan is a cultural and administrative centre, situated in the heart of the Rhodope Mountains, close to the Greek border. The city is known for its rich cultural history, beautifully preserved nature, hospitable people, and uniquely delicious food. It is the Bulgarian city closest to the stars, home to the biggest Planetarium in the country and the National Astronomical Observatory, which boasts the largest telescope on the Balkan Peninsula. The high achievements in education allow many young people to receive education in prestigious universities in and outside the country.

Due to the favourable geographical and weather conditions, Smolyan is a city with a high number of sunny days and a moderate temperature. This provides great conditions for the implementation of solar technology, which is central to sustainable development in the city.

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### Võru, Estonia

Võru is known as a picturesque green town in the foothills of Estonia. Its old town made of wooden houses lies at its heart and encompasses

the cultural feel of the city. The town is the capital and service centre of the region and ties together two ethnic cultures: võro and seto. Võru's unique languages and customs reflect its close-knit communities. In recent years, the need to bring people and energetic life back to the city centre has led to a significant amount of development in the city. Changes focus on making heritage areas more attractive places to live, bringing more business to the city, and reconstructing buildings to make them more energy efficient. Momentum has also started around developing energy generation and sharing solutions. Through the commitment of those in the city, Võru's challenges are being tackled and the city is becoming a more attractive place for citizens and businesses alike.

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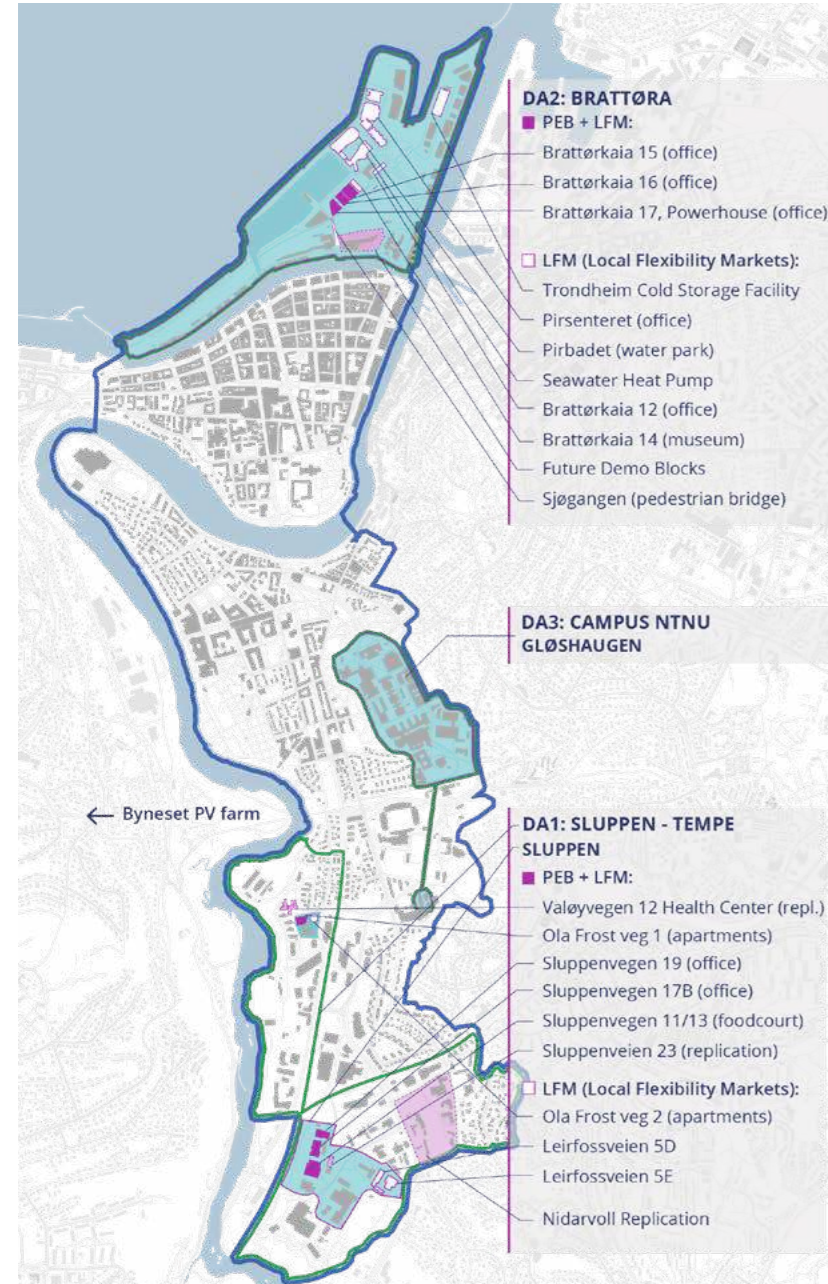
### Písek, Czechia

The Municipality of Písek has a population of approximately 30,000 and is situated in the South-Bohemian Region of the Czech Republic, approximately one-hour from Prague. Its economy has been significantly strengthened by foreign direct investment (FDI) in the industrial zone north of the city, with strong influences from the automotive industry and electrotechnics. The Technology Centre Písek and Centre of Low Energy Buildings are two innovation centres built as 'brownfield site investments' at a total investment cost of €40M. The development of new innovative forms of energy generation, building management and mobility in the city work towards increasing the quality of life for its residents. The city is strongly focused on the future and couples new innovative ideas with a strong cultural heritage.



# City Achievements





# Trondheim

Trondheim has seen many successes in the +CityxChange project, due to the effective collaboration between a series of partners in a range of sectors where new working methodologies have been pioneered to collaborate across fields. The municipality has taken on the role of an active coordinator and facilitator, striving to make real physical changes in the city

## Key outcomes and achievements in Trondheim:

- 🌿 A full launch of 2 operational PEDs – Sluppen and Brattøra. The PEDs, comprising 71,000 m<sup>2</sup> of commercial buildings, include 4 GWh of existing and new local production from rooftop PV and heat pumps: 🌐 Trondheim has established two Positive Energy Blocks - +CityxChange
- 🌿 Development and testing of a new energy trading platform specially designed for PEDs and local energy markets
- 🌿 Development and deployment of a novel solution for local energy and flexibility markets in the two PEDs, in operation for almost 2 years now

- 🌿 Deployment of an eMobility-as-a-Service scheme (eMaaS) in the two PEDs with the EV batteries integrated with the PED ecosystem, enabling these as local “powerbanks” through V2G chargers

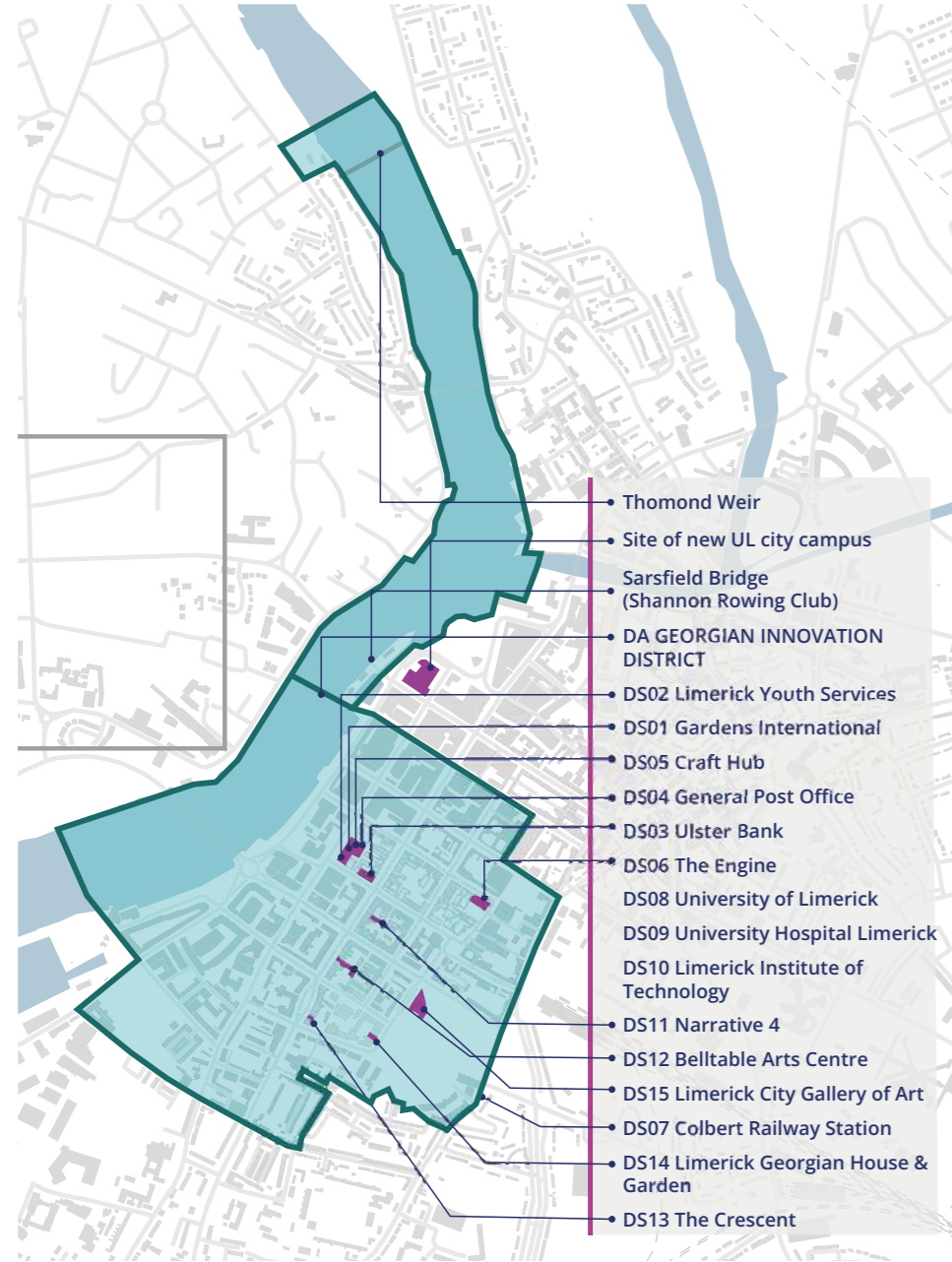
- 🌿 Development and verification of a Finance Risk Sharing Model and a series of investment and business models showing how RES investments can be beneficial in societal and business contexts.

- 🌿 Establishment of the Bold City Vision “Trondheim Energy Positive City 2050”, which is also anchored and an integral part of the municipal Societal Master Plan

- 🌿 Six citizen observatories and 11 innovation labs/playgrounds established within the innovation district comprising the demo areas, utilised for testing of 13 specific innovation lab solutions

- 🌿 Establishment of 2 special regulatory districts in PED areas with extensive sandboxing of energy sharing between multiple buildings





# Limerick

Through the +CityxChange project Limerick has worked hard to gain significant knowledge and understanding of the conditions to support the creation of PEDs. Working with many stakeholders to overcome obstacles, PED development is being advanced in the city through various initiatives such as the Pilot Retrofitting Grant Scheme aimed at retrofitting historic buildings.

## Key outcomes and achievements in Limerick:

- 🌿 The opening of the Citizen Innovation Lab, a collaboration, which was a collaboration between Limerick City and County Council and the University of Limerick (UL). The Lab includes a Citizens' Observatory, an Engagement Hub, a digital platform and a programme of events 🌐 [Citizen Innovation Lab](#)
- 🌿 A digital twin model of the city was created which aimed to provide a baseline on energy use and allow the energy transition of the city to be tracked over time. It highlighted the need to identify and source necessary data that would not only provide a clear KPI framework but also show potential value.

🌿 Limerick City and County Council has continued to support the retrofitting of historic buildings in the city centre through the Living City Initiative.

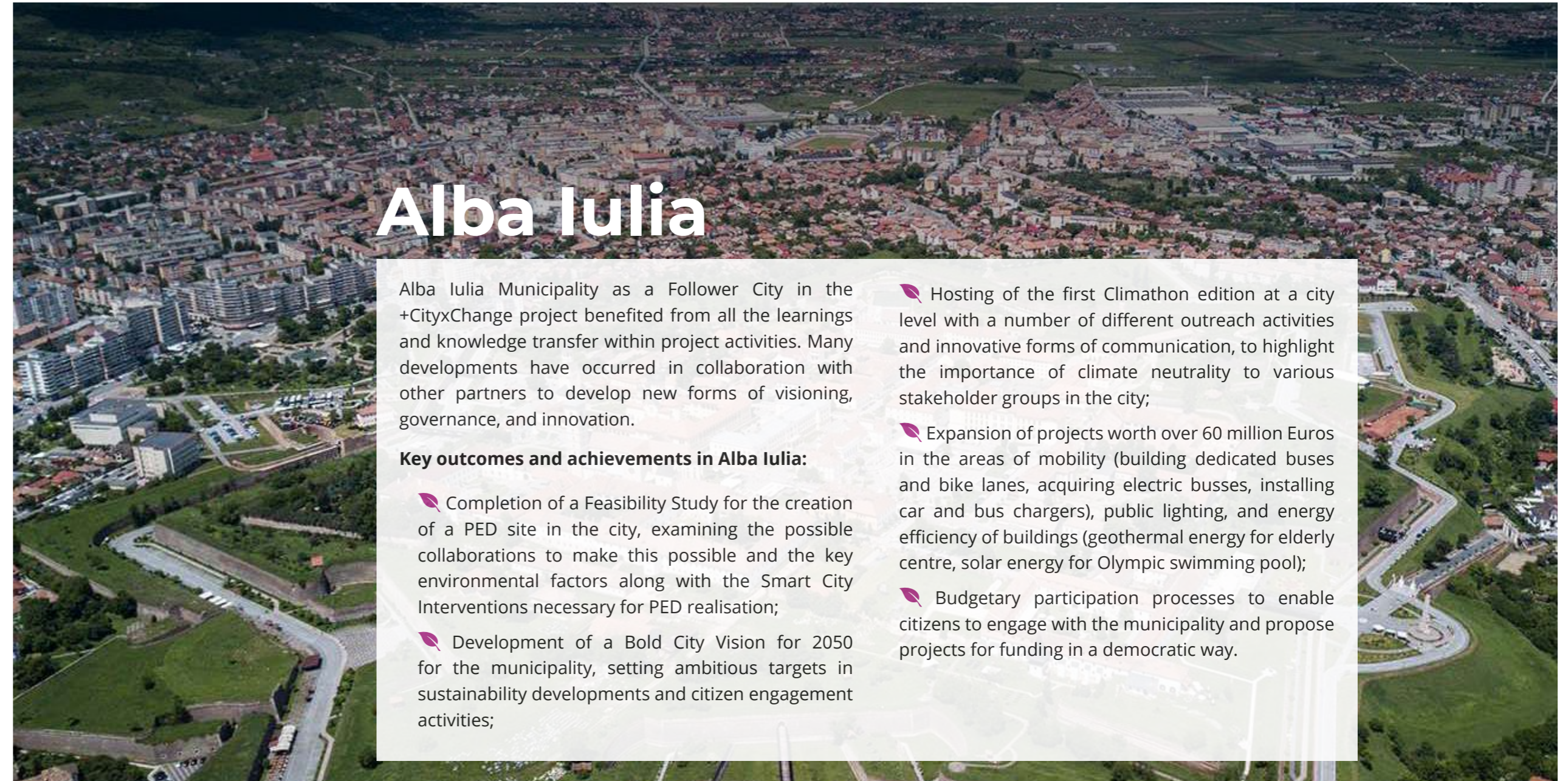
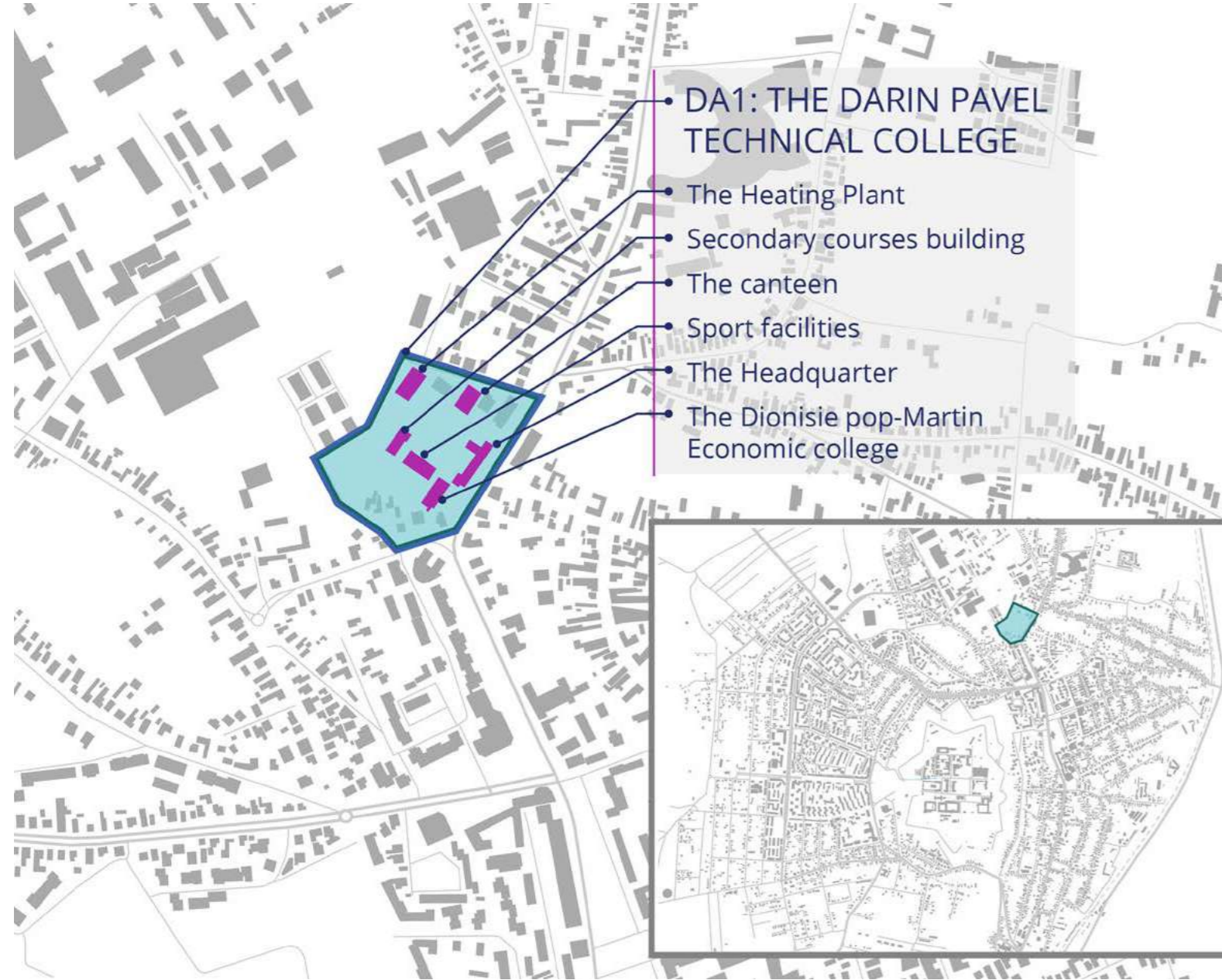
🌿 Extensive citizen engagement activities have been carried out to build trust and transparency with local communities.

🌿 Citizen innovations have been enabled through the Innovation open calls and experimentation labs held throughout the project.

🌿 Through the open innovation call 3 process Limerick City and County Council has supported the installation of solar PV on properties as a demonstration project at St Michael's Rowing Club and St John's Band Hall.

🌿 GKinetic has developed Tidal Turbines to be installed in the river Shannon, pending approval of a foreshore licence. The tidal turbines are being demonstrated at a Climate Exhibition in the city which explores the future of renewable energy on the Shannon Estuary. This has catapulted Limerick beyond the regulatory system in Ireland.





# Alba Iulia

Alba Iulia Municipality as a Follower City in the +CityxChange project benefited from all the learnings and knowledge transfer within project activities. Many developments have occurred in collaboration with other partners to develop new forms of visioning, governance, and innovation.

## Key outcomes and achievements in Alba Iulia:

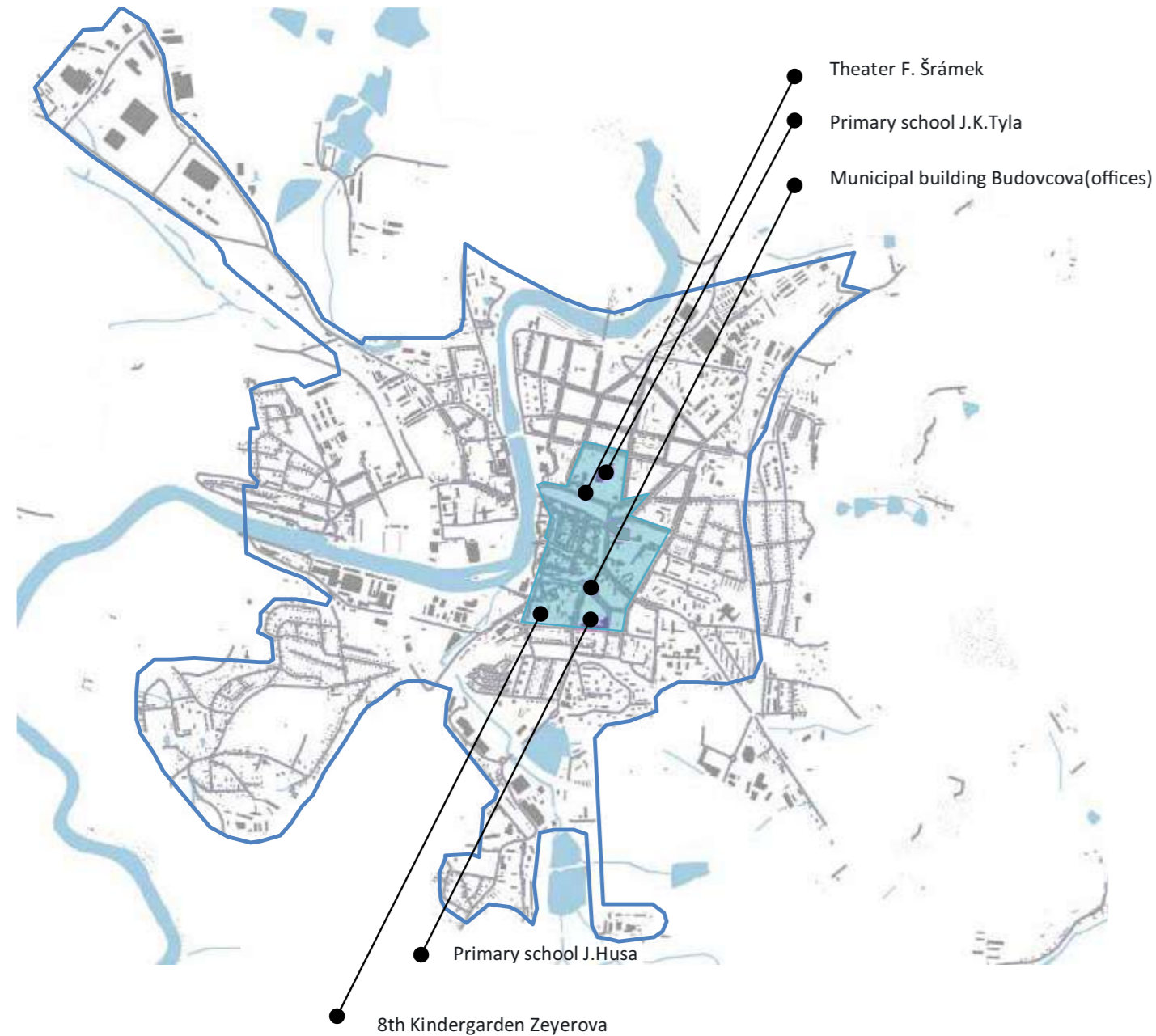
- 🌿 Completion of a Feasibility Study for the creation of a PED site in the city, examining the possible collaborations to make this possible and the key environmental factors along with the Smart City Interventions necessary for PED realisation;
- 🌿 Development of a Bold City Vision for 2050 for the municipality, setting ambitious targets in sustainability developments and citizen engagement activities;

- 🌿 Hosting of the first Climathon edition at a city level with a number of different outreach activities and innovative forms of communication, to highlight the importance of climate neutrality to various stakeholder groups in the city;

- 🌿 Expansion of projects worth over 60 million Euros in the areas of mobility (building dedicated buses and bike lanes, acquiring electric busses, installing car and bus chargers), public lighting, and energy efficiency of buildings (geothermal energy for elderly centre, solar energy for Olympic swimming pool);

- 🌿 Budgetary participation processes to enable citizens to engage with the municipality and propose projects for funding in a democratic way.





# Písek

The city of Písek entered the +CityxChange project without any experience with European innovation projects. The participation in the project itself was therefore a great experience for the whole team of the City of Písek and significantly influenced not only the project team itself, but also the entire municipality. Thanks to the project, data management was improved, horizontal cooperation within the municipality was improved, and effective cooperation with stakeholders was increased.

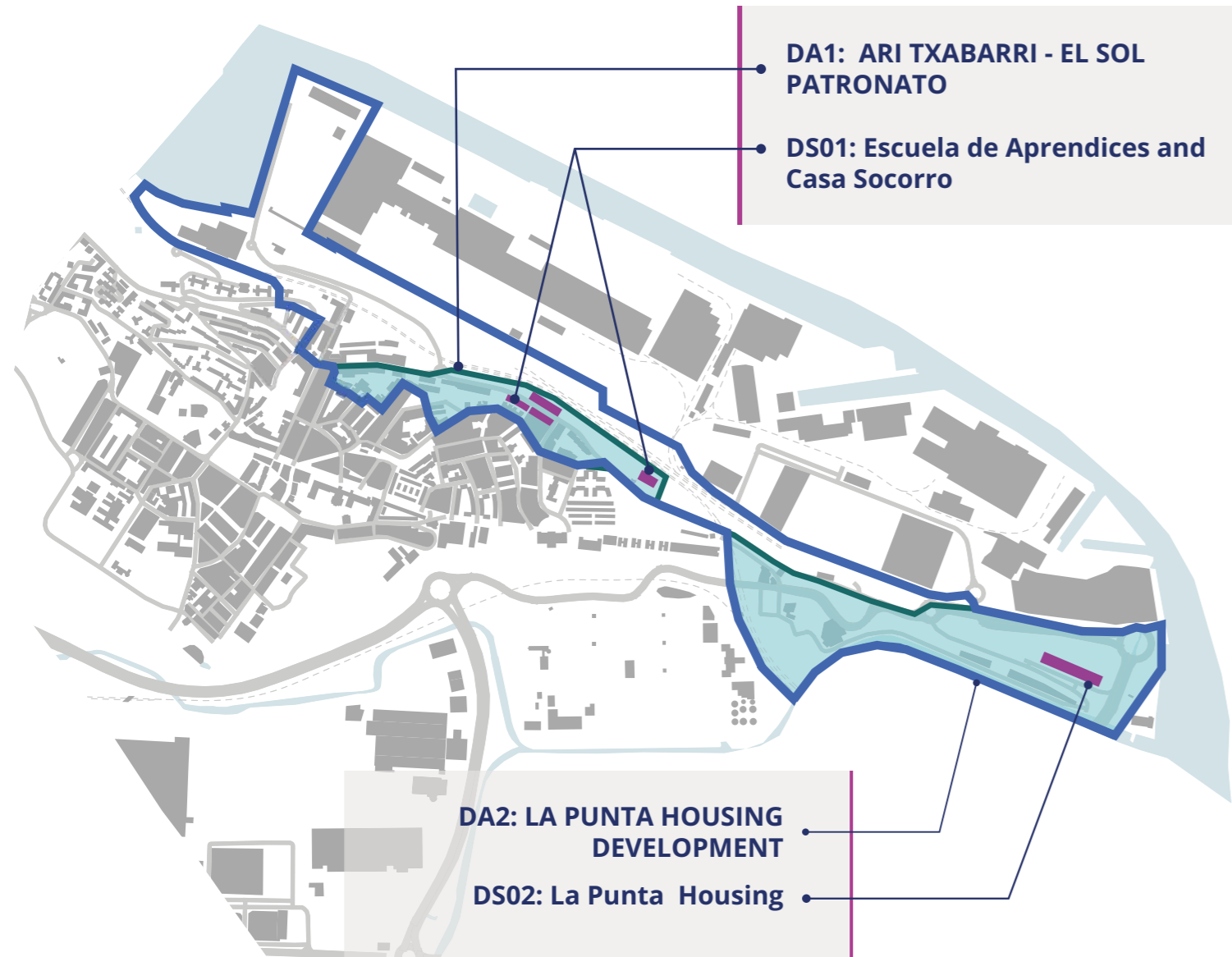
### Key outcomes and achievements in Písek:

- 🌿 Introduction of new tools for communication with citizens and local communities
- 🌿 The first Climathon in Písek, which initiated regular and close cooperation with the community

### “Water and greenery in Písek”

- 🌿 Citizen Engagement Week organised under the title “Hlava v Písku” where the project, sustainable development goals, and Positive Energy Districts are regularly presented
- 🌿 Development of the smart Písek organisational unit with new ideas and innovations to create physical changes in the city
- 🌿 Achievement of the ISO 50001 Energy Management certification
- 🌿 Preparation and improvement of new renewable energy sources (PV, Small Water Power Plant)
- 🌿 Establishment of a municipal company dedicated to the development of municipal energy and the promotion of community energy.





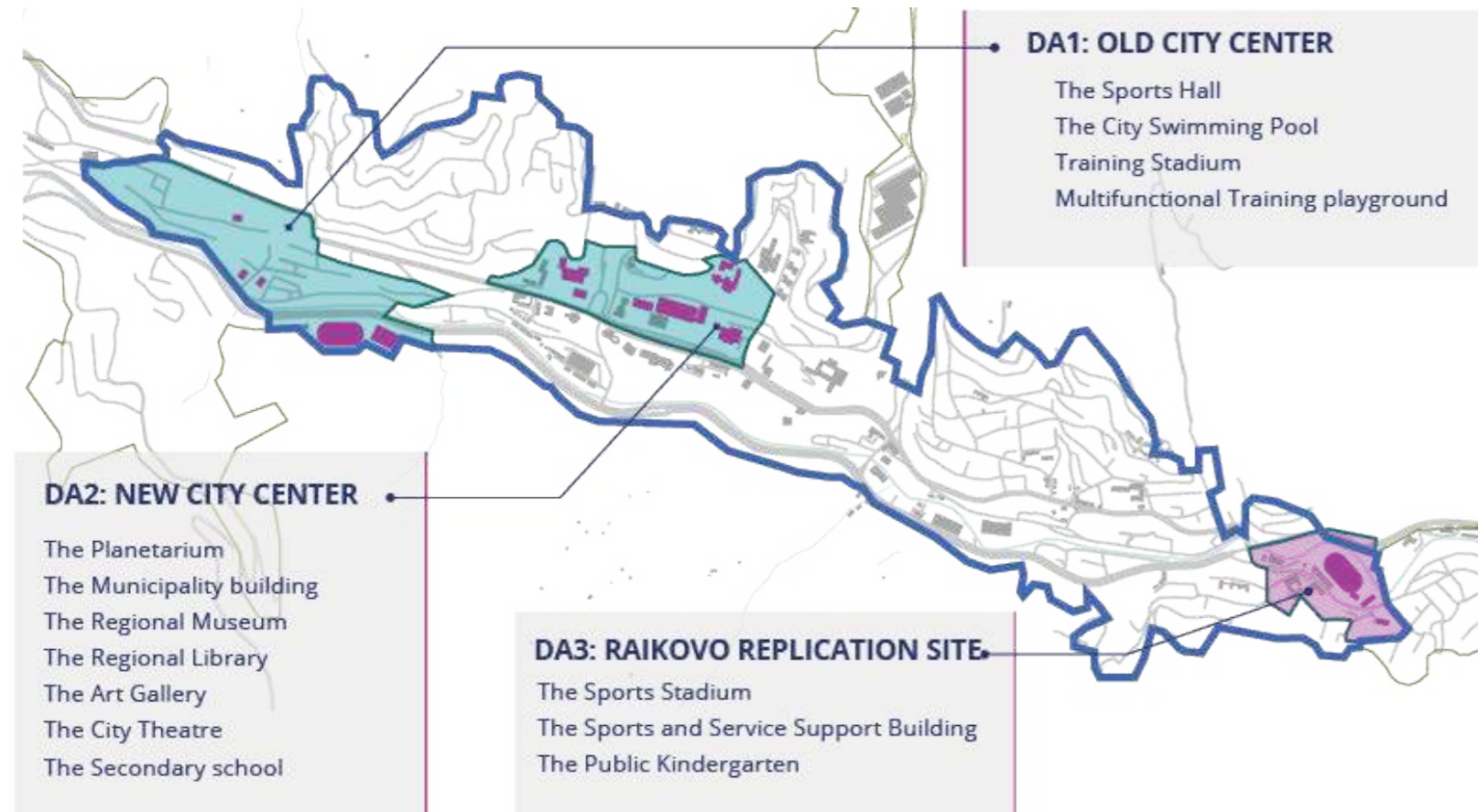
# Sestao

Participating in the +CityxChange project has not only provided the City of Sestao with valuable tools to begin the transition to a more sustainable and energy-efficient city-model, but has also helped to establish long-term objectives, provide motivation to get started, and tackle barriers. The groundwork, built over the course of the project, will help the city continue to advance into the future with greater ambition and chances for success. Lessons learned and partnerships made will play an integral part in this.

**Key outcomes and achievements in Sestao:**

- Securing approval of the Bold City Vision + Urban Agenda for Sestao
- Becoming a Covenant of Mayors signatory
- Entering the European Energy Efficiency Fund's (EEEF) Technical Assistance Facility program, worth 200.000€, which directly led to the creation of the €5 million municipal energy efficiency-focused SeSmart project. Includes:
  - 8 photovoltaic installations (several becoming energy communities to meet the electrical demand of Sestao's PED Demonstration Area 1)
  - modernising old LED street lighting
- procuring 8 municipal e-vehicles + 8 e-chargers
- partially retrofitting 5 public buildings for improved energy efficiency
- deploying a city-wide energy monitoring platform
- Getting a SECAP approved pledging to reduce 55% of municipal emissions (compared to 2009 baseline) by 2030 (to be achieved thanks to the SeSmart project)
- Celebrating Sestao's 1st Climathon event and extending the event to the neighbouring cities of Santurtzi and Portugaleta
- Securing a €3 million grant for retrofitting with high energy efficiency criteria the Escuela de Aprendices building
- Retrofitting the Casa de Socorro with a €400.000 grant and making it Sestao's first Visitors Center to promote tourism in the city
- Securing a €60.000 grant for a Sustainable Wiki project that was a result of the +CityxChange Innovation Playground initiative
- Celebrating a strategic multi-stakeholder event aimed to act as a stepping-stone towards the goal of accelerating Sestao in becoming a carbon-neutral city





# Smolyan

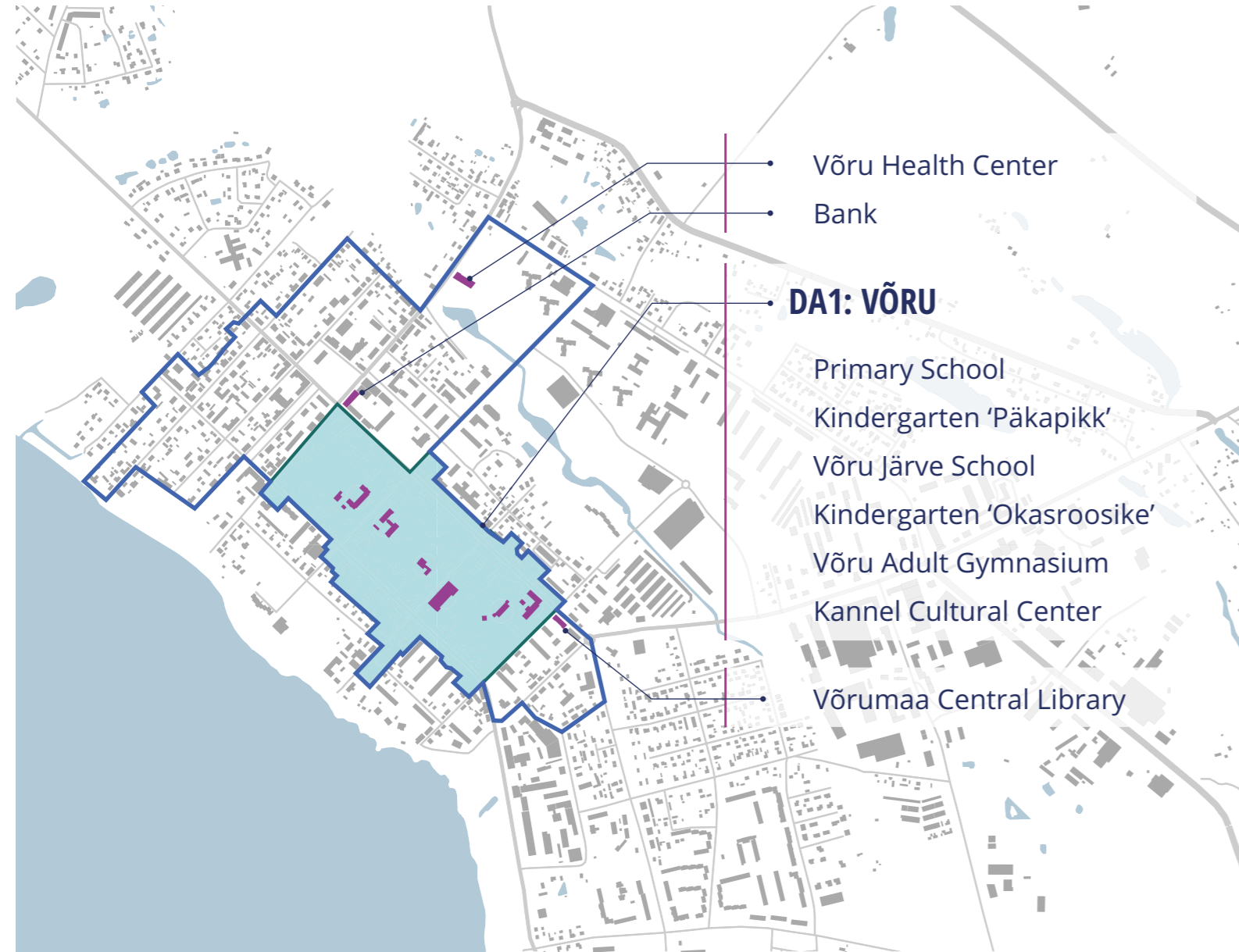
Smolyan has worked on the development of a new bold approach to collaboration, innovation, promotion, and citizen engagement in the city. Smolyan has seen a number of achievements with regards to visioning and the development of new environmental infrastructure.

## Key outcomes and achievements in Smolyan:

- Complete Feasibility study to create a comprehensive and extensive local database for public buildings data and energy needs of the municipality. Used as a base for developing strategies and other grant applications
- Development of short- and long-term strategies that incorporate the vision and concrete goals towards a greener and more sustainable city. Including: SECAP 2030, Bold City Vision, Plan for integrated development of the municipality, Sustainable Urban Mobility Plan
- Partnership with NTNU for an EEA grant “Partnership for Adaptation to Climate Changes” to secure investment for RES installation and monitoring system for some buildings in DA1
- Rehabilitation and Modernisation of the System for External Artificial Lighting

- Successful bid for an EUCF grant to develop an investment concept for the implementation of Energy Efficiency measures in public and private buildings
- Feasibility study for the development of a PED including the possibility for energy exchange and transition to green public city mobility.
- Refurbishment and Energy Efficiency measures in 12 multi-family buildings and in the Planetarium of Smolyan, applications submitted for 65 residential buildings
- Hosting of over 28 citizen engagement events with innovative engagement methods, bringing young people into conversations to give them a voice in their future
- Change in the mindset of the experts in the municipality in terms of considering the long-term development of the city and the region
- Introduction of the PED concept to citizens, focused on increasing general knowledge on topics such as climate change, SDGs, RES, PEDs, energy communities and Energy Efficiency measures in both children and adults
- Expanding the concept of Innovation Playgrounds and bringing it to local communities and significant places





# Võru

Through their involvement in the project, Võru has made significant strides towards PED creation and energy neutrality in the city. Collaborating with different stakeholders, including private citizens and businesses, many new ideas and plans have been created to make physical changes in the city.

## Key outcomes and achievements in Võru:

- Completion of feasibility studies and a priority list of investments for key developments in the city
- Reconstruction of actual buildings and increasing of organisational capacity (people, software, and processes) to improve building stock
- Foresight up to 2050 through the development of a Bold City Vision that makes attainable projections for how to move forward

- Development of knowledge and motivation to tackle complex issues and build new partnerships (e.g. Taltech, BUILDEST)
- Formation of local partnerships and international exchange through partnerships focused on innovation and development in the city
- Development of a Sustainable Energy and Climate Action Plan (SECAP)
- Tackling of regulatory issues for energy measures
- Mapping with the local Distribution System Operator (DSO) of available grid capacities for solar PV
- Regulatory change with the Ministry of Economic Affairs and Communications to establish fees for holders of unused grid capacity, enabling efficient grid supply and supporting PED development





# Recipes to make PEDs

*This cookbook combines a number of recipes that combine to serve up a PED, when followed together with a committed range of stakeholders.*

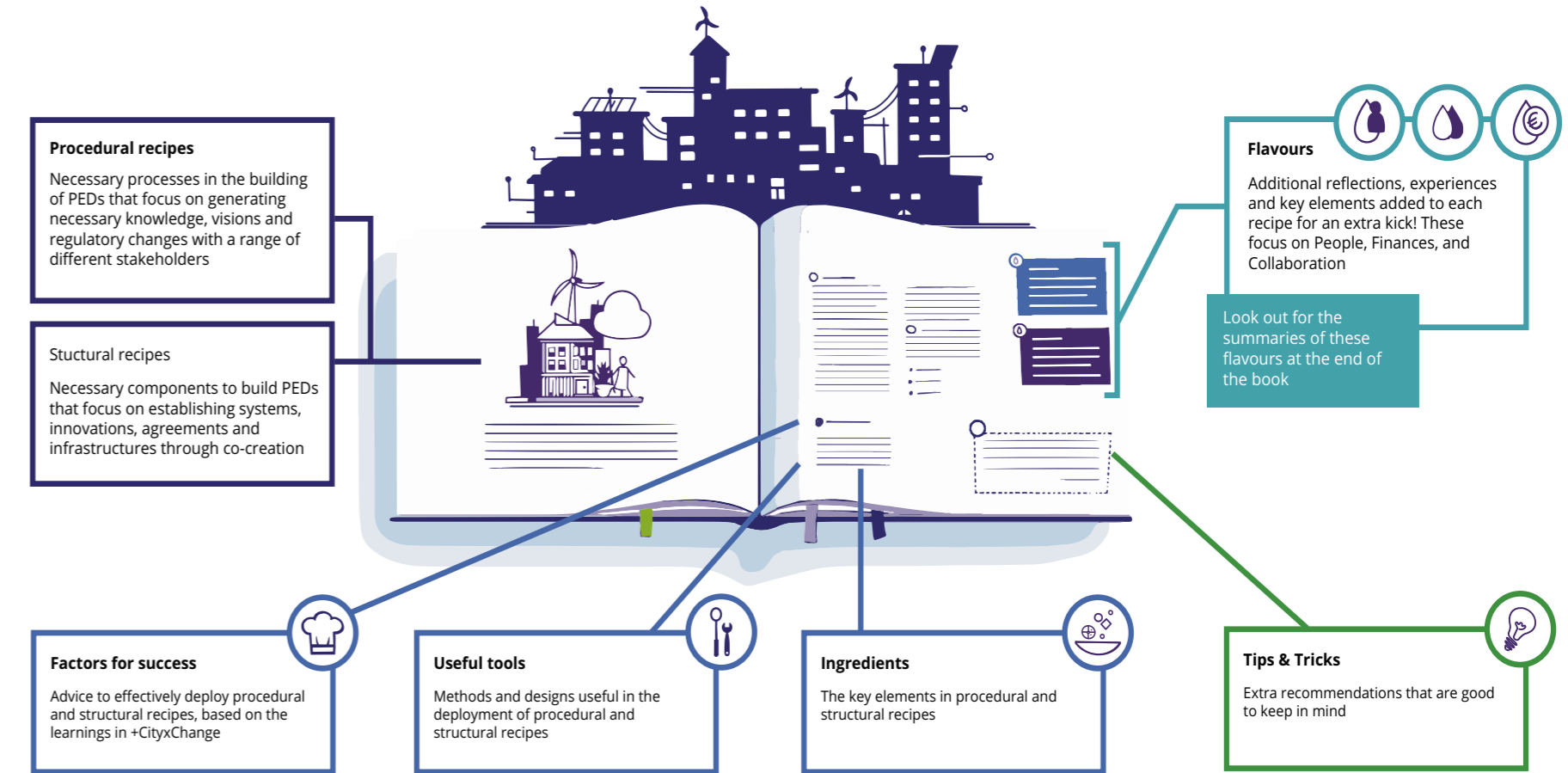
The recipes each focus on a different aspect of PED development. Collectively, they provide essential components for building PEDs, drawing on our experience from our demonstration projects and insights gained throughout the project. These recipes are organised into two categories: **procedural**, which outline the critical processes towards PED development, and **structural**, which detail the elements supporting the implementation and deployment of PEDs.

For each recipe, we offer a set of tips and tricks, factors for success, useful tools, and of course, a list of ingredients. We also reflect on the

different “flavours” – or key considerations – that are at the heart of successful recipes. These include **people**, **finance**, and **coordination**. Follow the **light blue**, **blue** and **green** lines for supplementary information that culminates at the end of the book!

As you read the cookbook, you’ll find that many of the recipes are interdependent or complementary to each other. Their contributions to building PEDs are context dependent and should be tweaked as necessary to achieve your desired outcome. This means that the recipes are not presented in a specific order here, but should be followed according to your specific situation.

To present the different recipes to build PEDs, we use a number of structural elements to help you to navigate the cookbook. Check out the graphic opposite for an overview of these elements!



## A Joint Effort

The information within this cookbook is sourced from conversations, discussions, joint work, consortium meetings, and deliverables in the project and written by many contributors. We intentionally keep the text concise. If you want to learn more, we provide links to

relevant project deliverables and other sources of knowledge. You can find a comprehensive list of these resources at the end of the book, much of which you will also find in our online knowledge base: [Knowledge Base Archive - +CityxChange](#)



# Procedural Recipes





To make the positive future vision come to life, +CityxChange cities have developed specific Bold City Visions (BCVs) for sustainable urban transitions and long-term strategic alignment. BCVs support policymakers and practitioners to work towards climate neutrality by encouraging joint energy efforts and Positive Energy Districts. The BCVs integrate with the city's overarching vision, ambition, and strategies and link them to local actions. The BCV framework is a toolkit that supports this strategy development for any city towards sustainable urban transitions.

## Ingredients

*"It's not just a document, it's a mindset"*  
Siim Meeliste, Võru Municipality

*"Trondheim – Energy Positive City 2050 is fully anchored in and integrated with the municipal Societal Master Plan"*

Bjørn Ove Berthelsen, Trondheim Municipality

### **Bold City Vision Framework:**

The Bold City Vision framework supports cities in translating their vision and goals into steps that can be implemented with the cooperation of stakeholders. The framework is flexible in that it outlines the overall steps to be followed by any city, all the while allowing for local variations

at the operational level. It allows working across different strategy levels, finding anchor points within existing strategy documents, aligning the UN Sustainable Development Goals (SDGs) to local city action, breaking up silos, facilitating cross-domain collaboration, and much more. The Bold City Vision Framework matrix outlines six processes with five phases each. The structure and steps are designed to support cities in identifying their ability to work together, share high level solutions, and repeat the process to scale and replicate. The process covers the urban, technical, financial and social aspects of a citywide transition, and is prepared together with academia, industry, and the public through an open process of engagement and public consultation with citizens, urban authorities, and across municipal units. These activities can be aligned with a digital roadmap that identifies the targets and milestones for co-creating, implementing, and iterating a Bold City Vision, along with the resources and investments required for its delivery.



### **Project flavours: People**

Inhabitants of the city should be at the heart of the city development strategies. Consistent stakeholder engagement throughout the BCV process is encouraged to secure wide buy-in.



### **Project flavours: Finance**

The BCV can be supported with suitable diversified financial instruments or investment portfolios, and it can also structure incentives towards specific goals, which then together the city can use to support developments



### **Project flavours: Collaboration**

Aligning the BCV with the larger political contexts, societal trends, and the varied existing strategies within a city makes this a very difficult undertaking in a complex landscape, but it can help anchor and formalise larger energy, climate, and city development ambitions in a collaborative way within a municipality and with external stakeholders.

### Co-creation Strategy for a Bold City Vision:

- Planning for participation:** Figuring out who will participate and how they will be affected or can contribute.
- Fitting into city plans and strategies:** Making sure the BCV fits within the city's bigger picture and determining how they can mutually improve.
- Making it happen:** Deciding who will do what, and then testing and changing things as needed.

### Factors for Success

The BCV framework contains many components across sectors and goals as a guideline for action. The overall framework is intended for adaptation to the local context of the city. Below in the links you will find the framework definitions and the process and results of the local adaptation that has already happened for our cities.

It is a continuous interactive, iterative, and collaborative process for long-term transformation, both on the strategic side and in everyday activities.

It is important to start early, as legislative processes do take time. Seek out knowledge and networks to support innovation and co-creation. You will encounter challenges in finding a balance between different interests: for example, energy efficiency and heritage protection. In our experience, achieving this balance can be supported through the co-creation and engagement approach towards larger BCV goals.

The BCV process is intended to also support larger systemic changes in governance and introduce new ways of working that are needed to deal with the current challenges.

### Useful tools

*Other city strategies* with which to align or to influence, for example, *Climate Action Plans*, *City Climate Contracts*, *Mobility Plans*, *Urban Development Plans*, *Municipal Masterplans*, *Sustainable Energy Action Plans (SEAPs)*, *Sustainable Energy Action Plans (SEAPs)*, *Sustainable Urban Mobility Plans (SUMP)*s, *UN SDG local implementation*, and others.







*Mapping of stakeholders:* Think of everyone who is impacted by a BCV – such as residents, businesses, community groups, and other stakeholders. Mapping who they are, the role they play, and how they can help allows for an understanding of the role they play in the vision and what each can bring to the table or how each should be considered.

*Multi-domain approach:* BCVs aim to integrate spatial, social, political, economic, regulatory, legal, governance, cultural, heritage, ICT, and technological dimensions.

*Data-driven approaches:* The BCV process can be supported and linked with a range of tools, such as detailed data-driven scenarios, prediction models, digital twins, or digital and physical collaboration tools and citizen participation platforms.

### Want to learn more?

- [D3.1 Framework for Bold City Vision, Guidelines and Incentive Schemes](#)
- [D6.2: Bold City Vision 2050 for each FC](#)
- [D4.7: Limerick 2050 Vision](#)
- [D5.7: Trondheim 2050 Bold City Vision and Guidelines – Vision for Sustainable Urban Transition](#)
- [Smart Cities Marketplace: Systemic Changes in Governance](#)

	Engage	Design	Activate	Accelerate	Support
 Standardisation	Evaluation	Visualisation	Simulation	Funding	Sharing
 Policy development	Review	Revision	Planning	Budgeting	Analysis
 Innovation partnerships	Appointment	Linking	Collaborating	Prioritising	Portfolio management
 Organisational development	Identification	Leadership	Intrapreneurship	Self organisation	Twinning
 Citizen engagement	Acknowledgement	Deliberation	Localisation	Connection	Amplification
 Project development	Pitching	Prototyping	Delivering	Capitalising	Storytelling

**BOLD CITY VISION FRAMEWORK FOR 2050**



# Limerick's vision

## Case Study

**In Limerick, developing a strong vision for the future has helped to set targets and work together with a diverse array of stakeholders. The BCV framework was applied to the development of the Limerick Development Plan 2022-2028. This plan provides an overarching strategic framework for a sustainable Limerick. The process drew on experiences of being involved in the development of the framework earlier with Trondheim Kommune and engaged many different actors to develop a strong and realistic vision.**

By hosting Bold City Vision workshops, the city of Limerick was able to engage different stakeholders such as businesses, locals, energy providers, and the municipal authorities to work together towards testing and prototyping new and innovative ideas.

A critical step in Limerick's BCV process was to create a digital twin model of the city that enabled creating city-level energy models and scenarios that highlighted potential future energy environments with consideration of locations and renewable energy sources. These were extremely useful for use as a political tool to demonstrate the value of

investing in local renewable energy generation, storage and flexibility. Developing the digital twin highlighted the need to identify and source necessary data that would provide a clear KPI framework and show the potential value of developments and reference the social, infrastructural and environmental benefits of different scenarios. This helped to develop scenarios that were politically attractive as well as technically sound. The scenarios also served to define priority areas for intervention.

The BCV framework is currently being applied to support the development of Limerick's first Climate Action Plan which will outline a path to a 50% reduction in carbon emissions by 2030 and carbon neutrality by 2050 at the latest. A central theme within this strategy is the designation of a Decarbonisation Zone which will act as an innovative playground for the trialling and testing of new means of engaging society. The process was a strong exercise in collaborative working and helped to realise a strong vision that will support developments for many years to come!

[D4.7: Limerick 2050 Vision, Integrated Action Plan and Digital Guide](#)





# Alba Iulia's vision

## Case Study

**From the beginning of the project, the Alba Iulia team dived into the visioning process to develop a BCV that covered a large range of environmental themes while setting actionable goals. The range and specificity of Alba Iulia's BCV not only excelled as a strategy to orient and guide the city's PED development, it also became an essential tool for dealing with legislators, exploring collaborations, and securing new projects and grants. The BCV helps navigate urban climate neutrality, aligning aims, strategies, and technologies to offer a roadmap for sustainable planning.**

Alba Iulia's main BCV process occurred over the course of two years and was spearheaded by the municipality. Starting with a solid data analysis, the team first sought to develop a baseline assessment of the state of energy transitions in the city. This provided a robust starting point to develop targeted and committed new strategies.

Every detail in Alba Iulia's BCV, from the integration of Sustainable Development Goals (SDGs) and the city's Sustainable Energy and Climate Action Plan (SECAP) to commitments to become carbon net zero by 2050, underwent a process of political and legal ratification. The municipality developed its vision through continuous consultations with local political leaders, key stakeholders, and the local community. This makes Alba Iulia's BCV more than just a vision and also includes clear implementation plans. It represents a number of real commitments and pathways for change, and will play a key role in continued environmental development, already having played an important role in securing funding for further projects. Collaboration is key.

### Sources:

[D6.2: Bold City Vision 2050 for each FC \(BCVs for Alba Iulia, Smolyan, Vöru, Písek, and Sestao\)](#)





# Modelling



Modelling plays a crucial role in PED development, as it enables testing and improvement of various aspects before starting actual construction. By modelling smart city scenarios, cities can use these alternatives to support their visions and provide data-based evidence to share with stakeholders for decisions to proceed to PED development.

## Ingredients

**Decision support tool (DTS):** An online tool which helps cities make smarter planning decisions. Once people are trained on using the tool, they can analyse scenarios and identify areas where intervention is needed or most promising, such as looking at places where energy efficiency upgrades could have the largest impact. The DTS does this by assessing energy consumption and supply at building, block/district, and city levels. It gives building owners a detailed understanding of their current energy demand, how it could be reduced, which renewable energy systems are most suitable, and potential constraints on the electricity network. The tool also recognises impacts on societal factors, such as potential job growth.

**Training for cities:** By training people on how to use the DTS, they can use what they learn


to support the *why* for making changes and developing PEDs in their city. Note that this can take some time and should be started early in the project!


**Sharing Models:** The DTS helps cities show how well their plan could work, and is adaptable to generate results which can be scaled up or down. The results can be used to show to the general public or targeted partners, also in an interactive online version for better engagement.


As part of the project, a 3D model of the Georgian Neighbourhood has been created by IES to enable the Limerick community to visualise energy use and carbon emissions. Alongside energy consumption data, the platform provides real-time information on renewable energy generation. Check out the interactive model on our website: [IES - 3D Model](#) - [+CityxChange](#)

## Factors for Success

Setting up virtual models for different scenarios can support the success of physical testing of PED components and the acceptance and understanding from the public and policy makers. Having clear data helps demonstrate why PED development is the future. The cities in +CityxChange approached modelling for the development of PEDs in different ways.

 **Project flavours: People**  
The addition of socio-economic data in the DST means that the effect of decreasing carbon emissions could include areas such as health, economic prosperity, or environment. Visualisations can be tailored to different users, enabling improved citizen participation and ownership of solutions for the transformation towards a PED.

 **Project flavours: Finance**  
Feasibility studies and investment pipelines for buildings and the whole district can be supported by data collection and digital tools and modelling.

 **Project flavours: Collaboration**  
DST modelling demonstrates viability and is a useful tool to help decision-makers visualise various outcomes and discuss them with different stakeholders. When displayed in the right way, models can help to secure support, and add arguments where necessary!



For example, in Trondheim, existing arrangements of stakeholders in the energy industry and in building selection allowed for more straightforward modelling. In Limerick, the process required more careful development and collection of data from various stakeholders and buildings.

### Want to learn more?

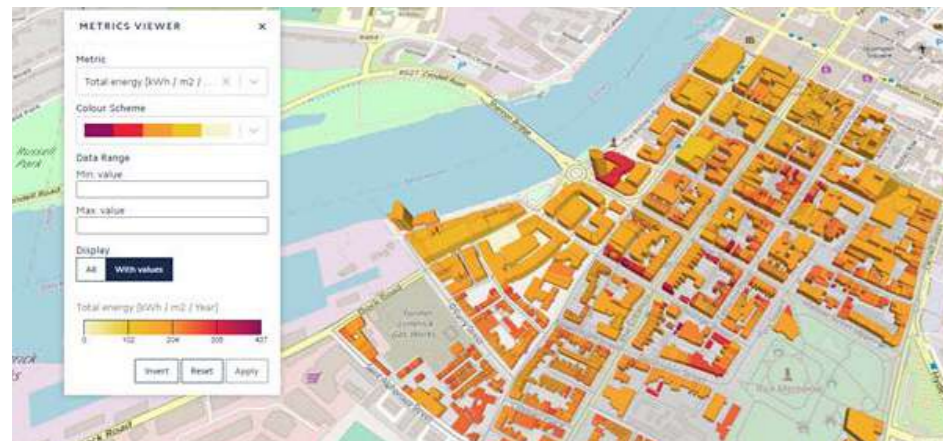
[D5.2: +Trondheim DST](#)

[D4.1: Limerick DST](#)



#### Tips + tricks:

Running DST studies can help support the development of a Bold City Vision since it can show stakeholders of all levels the expected impact.





# Engagement



Engaging PED stakeholders, including building owners, occupants, users and neighbours is essential in PED development so that people can develop a sense of ownership of the process of change. The engagement solutions demonstrated in +CityxChange have involved businesses, city officials, politicians, and locals of all ages in new modes of collaboration. They have created ways for stakeholders to learn more about PEDs, and to participate in the co-creation of PED solutions in their city.

## Ingredients

Citizen Engagement was identified as a core process of the Bold City Vision, meaning it takes a high strategic priority in the development of PEDs, and ensuring that the social and technical innovations necessary for PED creation can happen in an integrated way. The +CityxChange engagement approach, known as CommunityxChange, includes five distinct frameworks that can be implemented by municipalities as a group or as stand-alone programmes. Each can be adapted to suit specific city contexts. Their open innovation approach creates ways for citizens to co-innovate in the creation of PEDs, and for municipal and business stakeholders to access the local knowledge that is vital to realising a PED.

## Factors for Success

- Focus efforts on the PED – The Innovation Playground is a spatially defined area where a city can focus on creating the conditions for clean energy innovation.
- Create a roadmap of engagement processes - The Citizen Participation Playbook includes processes for continuing engagement which a city can implement to activate, mobilise and engage relevant stakeholders in PED development.
- Plan how new knowledge can be introduced into the PED using local actors and networks - The Framework for DPEB Learning and Education and the Positive Energy Champion Network describe ways to structure this.
- Create places for PED collaboration - The Innovation Lab physical space and digital platform support both face-to-face and digital engagement. Documenting collaborations on a digital platform can enhance transparency and amplify activities for increased impact.

The Structural Recipes show examples of how this can be translated into the Innovation Playgrounds and Labs.



## Project flavours: People

PEDs need people. An array of stakeholders contribute to their success, all with their own distinct ways of communicating. Finding ways to create points of understanding between actors is crucial. Ask yourself challenging questions. Who is talking? What narratives already exist? Who is trusted? How do different groups communicate? How can information be visualised? What do people want? What can be offered?




## Useful tools

### **Co-Design Workshops**

Co-Design Workshops have been a proven way to share knowledge across stakeholders. Cities have hosted workshops to explore the impact of different aspects of PED development with a variety of stakeholder groups, ranging from young people at local schools to city officials.









### **Community Mapping**

The +CityxChange  [Community Mapping Tool](#) is a mapping app that can be used on mobile digital devices to create a cumulative map of observations and ideas, or to gather data exploring a particular PED challenge. Community mapping events are a great way to introduce different PED solutions and to encourage a large number of stakeholders to imagine the impact of these in their area.

### **Gamification**

Gamification is a creative way to engage people in a topic that can seem complex. In LHC Trondheim, the board game Posti City, was used to demonstrate the local energy market. LHC Limerick used the City Energy Game – a game created by architecture stuseto explore how people can collaborate and negotiate decisions about how shared infrastructure and spaces in a city block can change. In Trondheim, NTNU with students developed the Positivity+ board game that plays through the steps of setting up a PED.

## **Want to learn more?**

-  [D4.10: Limerick Innovation Lab Solutions Catalogue 2](#)
-  [D5.10: Trondheim Innovation Lab Solutions Catalogue](#)
-  [D6.5: Report on community participation and playground results](#)
-  [D9.1 Framework for intra-project collaboration](#)
-  [D4.8: Limerick Citizen Observatory](#)
-  [D5.8: +Trondheim Citizen Observatory](#)
-  [SCIS Solution Booklet Citizen Engagement](#)
-  [Co-Creation of Positive Energy Blocks](#)



### **Tips + tricks:**

- Know your community – map PED stakeholders and design engagement activities to target these.
- Use existing engagement infrastructure and enhance this wherever possible – with digital tools and platforms.
- Design a mix of events to attract a broad range of stakeholders – people can progress to more complex or technical activities once they have been introduced to the PED concept.
- Develop ways for stakeholders to engage with new PED technologies and services – by inviting citizens to try out a new app or to use a digital tool.
- Invite your colleagues and city leaders to engagement events so that they too can learn more about the PED.





# Citizen voices in Smolyan

## Case Study

**In Smolyan, the +CityxChange project presented an opportunity to explore citizen engagement around energy transitions. The city ran extensive campaigns to platform the voices of its citizens and find ways to reach those who are less often involved in participatory process. A lot can be learned from Smolyan!**

The general approach in Smolyan to citizen engagement in the project was to make points of engagement exciting, fun, and of benefit to those who attended. In this sense, it was not only about presenting plans to citizens or extracting information to make strategies, but sharing information between the municipality and communities, building trust, and developing visions together.

Over the course of Smolyan's participation campaigns, it became clear that it was often the "usual suspects" who were attending events and engaging with the topics. The question became how to reach others and encourage them to get involved, or even consider behavioural

changes. Smolyan's answer to this was to run elaborate campaigns with children. Events were hosted to educate young people on energy transitions, challenge them to consider how they want their city to look in the future, and collect their feedback on plans.

The campaigns were extremely successful and the municipality learned a lot, not just on the topic of energy transitions, but also about the future of the city. Through children, they were able to reach parents and guardians and they saw a large knock-on effect of the campaigns. It became clear that it's not just about what is being said, but who is saying it!

### Resources:

- [D6.5: Report on community participation and playground results](#)
- [Flashback to see CxC progress from the city of Smolyan +CityxChange](#)







Business, partnership, and finance models are needed to support the direct development and implementation of Positive Energy Blocks, as well as for their scaling-up, growth, and replication of PEDs. In the best cases, this can be done through sustainable and self-supporting mechanisms.

### **Ingredients**

**Collaborative application:** Finding new forms of investment requires transparent cooperation with a variety of stakeholders. Connecting public, private, and knowledge partners can reveal alternative ways to finance change. Multiple cities or districts can also work together for better funding opportunities. Energy Communities are another emerging way in which citizen groups can involve themselves in the development of new energy concepts.

### **Factors for Success**

If we understand PEDs as part of a transition process, it is clear that they should continue to grow and connect additional buildings, people, and local renewables. Alternatively, cities or stakeholder groups can start new PED projects within a city to accelerate the growth and the energy transition.

Such funds can come in the form of different schemes and models, such as direct investments, funding (EU, national, local, etc.), and financing. An advantageous model is when the PED with its innovative solutions becomes able to pay for itself through, for example, energy efficiency, generation, and trading.

### **Useful tools**

- Different PED-specific innovative partnership or business models have been created:
- Integrated blended investment model across stakeholders and services (D2.4, see graphic on next page)
- Financing Risk Sharing Model (FRSM)
  - The model calculates the potential financial risks and benefits for stakeholders and gives guidance on how to optimise them. In Trondheim, it supported the decision-making process on whether to join the Local Energy Market. (D5.16)
- Green Investment Evaluation Model (GIEM)
  - The model provides a cost-benefit approach to possible trades in the local energy market or the sale of surplus to the power market. The GIEM can be used as a flow sheet that describes different priorities/pathways from



### **Project flavours: People**

How do you package your project so that it becomes appealing to potential investors, or part of a larger development instead of small interventions? Part of this requires constructing a compelling narrative. Projects like +CityxChange are highly complex, and it is important to understand the target audience and frame the problems and solutions accordingly.



### **Project flavours: Finance**

The right types of funding need to be available in the first place – which isn't always the case. An additional challenge is that the process of applying for investments often requires access to (financial) resources from the start, making it less accessible for cities that may already be stretched thin. How then can we ensure that (EU) money is used correctly, and how can we make what funding is available more accessible?



# EIP-SCC

European Innovation Partnership on Smart Cities and Communities



the present situation and moving forward. (D5.16)

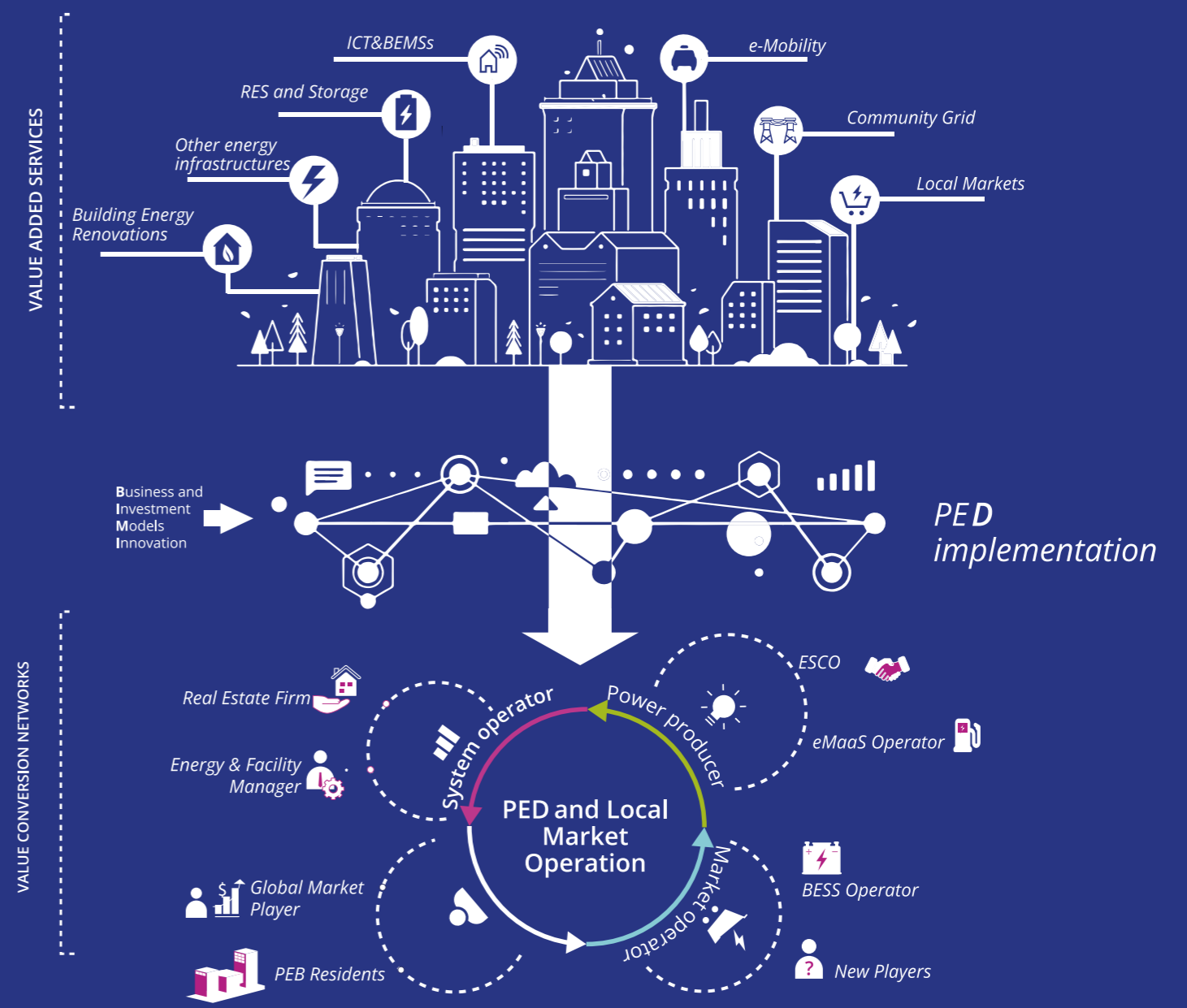
- Battery-Centric “Value Proposition”
  - This finance model allows for using batteries as storage in PEDs through the flexibility market, optimising buying and selling to help with grid balancing while generating returns. (D5.16)
- Open Calls for Citizen-Led Solutions
  - The open call process provides micro-grants to develop ideas that address a challenge in PED development. Collaborative processes of co-design and prototyping can engage a wide range of local stakeholders in localising the PED concept. (D3.6)

### Want to learn more?

- [D2.4: Report on bankability of the demonstrated innovations](#)
- [D5.16: +Trondheim sustainable investment and business concepts and models](#)
- [D6.3: Technical feasibility study of the potential PEB replications in each FC](#)

**Tips + tricks:**

A PED needs a lot of standard and innovative financing and investment models. Try to find the right mechanisms and funding schemes, and integrate them for different parts of a project. For example, ESCOs (Energy Service Companies) can reduce the need for large up-front costs to owners for energy retrofits or PV by covering installation costs and collecting benefits for a fixed contract length. In the best case, the PED will pay for itself in the long term.





# Securing investors in Sestao

## Case Study

**Securing investment to work on the development of PEDs is often one of the most challenging tasks. Sestao Berri faced this challenge head-on and has been able to secure a variety of funding opportunities for building renovation and efforts towards carbon neutrality. So what is the key to Sestao's success?**

Through the experiences of the +CityxChange project, Sestao Berri was able to discover various funding opportunities, beyond those apparent at first glance. Representatives from Sestao have worked on searching beyond the local and national funding opportunities to make steps in environmental development towards carbon neutrality. So where did the opportunities come from? Sestao has spent a significant amount of time searching for and applying for grants and funds from European initiatives and projects.

A key site in Sestao is the Escuela de Aprendices, a historically important building that has fallen into disrepair. Over the course of the project, Sestao Berri has been able to secure a portion of the total funding needed from the NextGenerationEU grant, which will be used to support its renovation, connect it to PED development in the city, and open up the space for citizens once again. Sestao has also had success through the EU Smart Cities Matchmaking initiative, receiving

funding from the European Energy Efficiency Fund – Technical Assistance Facility (EEEF - TA). The funds will support essential development towards Sestao's Smart energy management program (SeSmart) which will see innovations implemented in mobility, energy generation, and energy efficiency.

### Factors for success

The key learning from Sestao's experience is that funding is out there, and finding it is possible, with enough time and support. Often the main obstacle is not knowing what funds are available, which can be answered through networking and sharing experiences. If you don't ask, you'll never know!

*“Local authorities and regulations tend to move slowly, while the European Energy Efficiency Fund moves quickly and is more agile. It is great that we got to know the fund through the project, and it would have been even better to have gotten to know them sooner.”* - Andy Bäcker, Sestao Berri

### Want to learn more?

- [Successful Matchmaking Story from The City of Sestao +CityxChange](#)
- [Sestao Goes Matchmaking | Smart Cities Marketplace](#)





# Regulatory Sandboxes and Processes



+CityxChange demonstrates how a PED can be established in European cities within legal frameworks at European and national levels. The main challenges are related to the electric grid, local energy trading, and buildings, in particular when building or planning regulations have lower ambitions in terms of energy efficiency, renewables and flexibility. This made it crucial for the project to work from the early stages onwards with current and future legislation, and establish and uphold a constructive dialogue with the respective regulators.

Each of the seven cities in the project had to deal with a different legislative landscape and navigate unique forms of regulation. This meant that solutions had to be tailored to align with current (and future) regulations, or in cases where that was not possible, to work with the regulators to allow for some form of (temporary) special dispensation, regulatory exemption, sandboxes, or any other suitable mechanism. This was the solution that Trondheim ended up with, receiving an exemption from national regulatory body RME.

Continuous dialogue with the regulatory bodies and other stakeholders has proven essential. In fact, in our experience, it provides an opportunity to work with the regulator to contribute to the needed update of the regulations, and provides a living lab to better study the potential impacts

of different pathways for change. Regulatory districts help to understand and assess the impacts of different energy scenarios. In addition, they allow us to better involve experts and inhabitants in the energy system and contribute to creating consumer-driven PEDs.

## Ingredients

**Knowledge of Regulatory frameworks:** Awareness of current and upcoming regulations at the European, national, and local levels is key before starting the PED implementation process. This can impact PEDs both positively and negatively, for example on energy trading, integration of renewables, energy communities, building codes, working with heritage buildings, deployment of batteries, and more. A deep knowledge of regulations and dialogue with the regulators or permitting bodies is critical for developing a plan for change of regulations, exceptions, or workarounds.

**Regulatory exemptions for testing:** : Cities are learning and adapting every day! Getting permission to do something new and test ideas that do not necessarily conform to regulation is essential for innovation. One way to do this is to create a special regulatory district to work towards PED creation in localised test sites.



## Project flavours: People

Initiatives should create co-benefits and serve the greater good, such as enhancing energy resilience, reducing carbon emissions, creating local jobs, sharing benefits, developing towards the broader societal advantages, and empowering communities. This is vital for local acceptance and can also become crucial in securing regulatory approval.



## Project flavours: Finance

The lack of explicit regulatory support for PEDs or their components may lead to some uncertainty. This includes for example specific financial aspects of trading but also complexities arising from the relationship between local grid operators and energy suppliers. These uncertainties may act as barriers to innovation. Projects such as ours can help overcome some issues by giving the ability to experiment within and especially across organisations and to find new joint partnership models and fair risk/benefit distributions.



## Factors for Success

### **Patience & knowledge sharing:**

Change takes time and patience needs to be part of a project plan. Sharing knowledge with relevant stakeholders and decision-makers can help to form new understanding, create additional momentum, and support change processes.

### **Awareness of possible barriers:**

- Delay or uncertainty in the translation of European Regulations into national legislation
- Uncertainty of which possible pathways to take through regulatory processes
- Specific requirements of a regulator, for example for design criteria of local energy markets
- The need for a yes and anchoring your proposed solution, not only at the national regulator, but also at the TSO, the DSO, and the local actors in the regulatory district
- Need for long participation in processes with regulators, who will have to enact changes on a broader buy-in beyond only one project or city
- Willingness of other players to allow for testing
- Focus on financial aspects even in testing phases, mitigating initial higher investment cost factors and being willing and able to take a higher initial risk
- Longer processes to gain permits when trying to build with innovative solutions (including for example: complications in heritage buildings

when aiming for retrofits, fire codes when deploying container batteries, renewable production in the environment, changes in local regulations during a project, uncertainty over ownership of public grounds, etc.)

- Involvement of local inhabitants and other stakeholders such as grassroots organisations and businesses, ensuring early inclusion and awareness of local permitting processes, participation, and public hearing processes

These barriers can compound into longer delays or waiting times. However, the overall regulatory landscape is moving towards ambitious energy transformations and the PED concept, and we can share a number of success stories that will hopefully make it easier for others to do the same!

*“With the regulatory barriers, it took almost four years to partially work around them and to allow us to sell energy within the local market. This happened successfully at 4 am on July 4th 2022”* – Bernhard Kvaal, ANEO

## Important actors/relevant partners

This work involves joint work and efforts by municipal and regional administrations, local and national politicians, local stakeholders, and energy and tech providers – towards national authorities including the national energy regulatory body.

### **Want to learn more?**

- [D2.1 Report on Enabling Regulatory Mechanism to Trial Innovation in Cities](#)
- [D5.9: Playbook of regulatory recommendations for enabling new energy systems](#)
- [D4.9: White Paper “Regulations Unlocking Innovation Potential”](#)
- [D5.5: Energy Trading Market Demonstration](#)





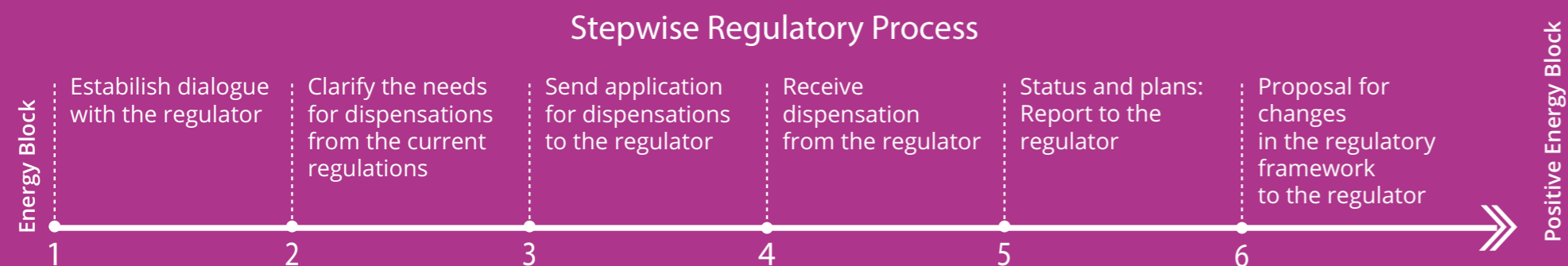
# Trondheim's Regulatory District for local energy and user flexibility trading

## Case Study

Trondheim has successfully established two designated regulatory districts as the +CityxChange PED demo areas to experiment with PED-enabling innovations. Both regulatory districts in Trondheim are composed mainly of commercial and industry buildings and do not yet extend to the residential areas of the PEDs, due to different building systems. The experiences in Trondheim show that special regulatory districts are crucial when working with energy sharing between buildings, diversified energy sources, and energy assets on the local scale, and performing local

energy and user flexibility markets. In order to perform this in Norway you need a) a special dispensation or b) an exemption from national energy legislation.

The true strength of what Trondheim has been able to achieve is in the effective collaborations forged. Working with energy experts and knowledge partners, Trondheim developed and applied a concrete stepwise regulatory process towards establishing a Positive Energy District in the city. Creating Special Regulatory Districts has been vital to trialling innovative smart city solutions such as PEDs in designated



areas by getting special permission from national authorities. The selection of areas was a key consideration in the process, with smaller areas and areas with more commercial building stock prioritised. Such areas are easier to establish as regulatory districts, rather than aiming directly for the city level.

Aneo secured a grant for exemption from the national regulator RME in February 2022, allowing the energy markets to run from July 2022. Trondheim's regulatory sandboxes have been essential to enable energy and flexibility trading in the PEDs. Establishing the areas as experimental spaces with adjusted regulatory control has allowed for the trading of energy between buildings and assets such as PV, heat pumps, EVs, batteries, HVAC systems and other flexibility systems. These areas have been extremely successful, arising out of extraordinary efforts:

- Stakeholder groups were formed to apply for dispensation or exemption, in a constellation of actors with joint needs that did not happen before (market operators, DSOs, municipality), presenting united progress.
- The dialogue was started early and took around four years to come to fruition, through collaborative and iterative development.

[D2.1 Report on Enabling Regulatory Mechanism to Trial Innovation in Cities](#)

[D2.2: Toolbox for design of PEB including e-mobility and distributed energy resources](#)

[D5.9 Playbook of regulatory recommendations for enabling new energy systems](#)

[D5.6: Trondheim Flexibility Market Deployment Report](#)





# Changing the rules in Võru

## Case Study

**Building PEDs is a new and sometimes complex process where many unforeseen challenges can arise. This was the case in Võru where grid constraints in the production of energy by solar PV disallowed the installation of rooftop PV in public buildings in Võru's PED. The key to solving this problem was active and open discussion with partners. Regulatory changes can be brought to life through discussions between relevant parties, especially when operating in unregulated or loosely regulated areas, or where regulation is becoming outdated. Võru is an example where innovative solutions were found by working with the regulator and local stakeholders.**

In Võru, at the beginning of the project the available grid capacities for solar PV were mapped with the local Distribution System Operator (DSO), with the aim to supply these with energy generated from public buildings in Võru's PED. However, within 12 months these capacities were booked by market participants who turned out to not be building PV, but holding unused capacities. This issue came to a head when the need for regulatory change was brought to the attention of the Ministry of Economic Affairs and Communications on multiple platforms. As a result of this targeted communication from multiple angles involving several different stakeholders, discussions were held by the ministry. The result was that a fee was established for holders

of unused grid capacity, which was subsequently implemented in local legislation.

The connections built through discussions held between Võru municipality representatives, the DSO and local ministries became useful once again as Võru underwent the reconstruction of public buildings to establish their first PED. The objective of the PED was to utilise energy generated within the buildings themselves. Buildings with larger roofs were favoured, as they allowed for bigger installations, but the amount of energy produced by a building did not always correspond with its required usage. Energy would then need to be exchanged between buildings in the PED. In Võru however, regulation stipulated that each building in the PED would be considered as a separate market participant, disallowing the exchange of electricity between them. Through collaborative and open discussions between stakeholders it was found that buildings in the PED could be considered as belonging to the same electricity supply portfolio, therefore allowing electricity balancing between a small group of buildings. As such, Võru was able to continue with the PED development while entering into discussions with service providers and local ministries, to look at how the rules can be changed to expand the development of PEDs in the future. Building something new sometimes requires creative and collaborative solutions!







# Structural Recipes



# Innovation Playgrounds & Labs



An Innovation Playground is an area in a city where city authorities can focus on clean energy innovation by assembling relevant data, enabling mechanisms, places, and activities to support PED development. The aim of the Playground is to create conditions where different groups of people can collaborate and experiment to progress the creation of a PED. Stakeholders can include regulators, energy companies, finance providers, city officials, researchers, businesses and entrepreneurs, along with community groups and citizens. Collaborations can be structured as Innovation Playground Journeys that involve cross-sectoral stakeholders in the co-design and prototyping of new PED technologies and services. The Innovation Playground is orchestrated through a programme of engagement delivered through the Innovation Lab. The Innovation Lab is a place where both virtual and physical activities related to PED development take place – a physical space that acts as a shop window to PED development so that the process can be open, accessible and transparent.

## Ingredients

**Data** - Energy data is vital to PED formation. Socio-economic and citizen-contributed data is important too. The Decision Support Tool creates

a place where relevant data can be analysed.

**Enabling mechanisms** - The funding and policy context of PED development can change at an EU, National and local levels. It is good to monitor these so that opportunities that enable PED formation can be identified and pursued.

**Activities** - These are planned to contribute to PED development and can include targeted and open activities.

**Places** - There can be numerous places within a PED where Innovation activities happen, however a dedicated physical and digital space within the city is essential for a successful innovation playground.

**Innovation Labs and Citizen Observatories:** When initiating these the following steps can be taken.

- Develop a brief – an innovation agenda to describe the thematic scope of the Lab
- Descriptive specifications
- Digital infrastructure
- Organisational structure – for the physical spaces
- Support for the citizen observatory – how to support the use of citizen observatories and activities



## Project flavours: People

Different cities have interpreted the framework for Innovation Playgrounds in ways that best meet their needs and local contexts. Localisation is key to successful playgrounds, and reaching citizens requires positioning playgrounds in a way that citizens are likely to accept. Presentation defines who will engage. It is important to consider if those with potential ideas for change are really being engaged.



## Project flavours: Collaboration

Proactive coordinators and project leaders play a key role in bringing together diverse stakeholders and fostering meaningful engagement. They also play an important role in creating opportunities for collaboration and to instigate concrete steps towards achieving goals for sustainable development. If you build it, they will come!





- Agree how the activities of the Lab can be monitored and evaluated.

### **Factors for Success**

Different cities will take different approaches in the development and operation of Innovation Labs and Citizen Observatories. While the methodology is similar, cities should be flexible and focus on aspects which work best in their local environment and that integrate with and enhance existing resources.

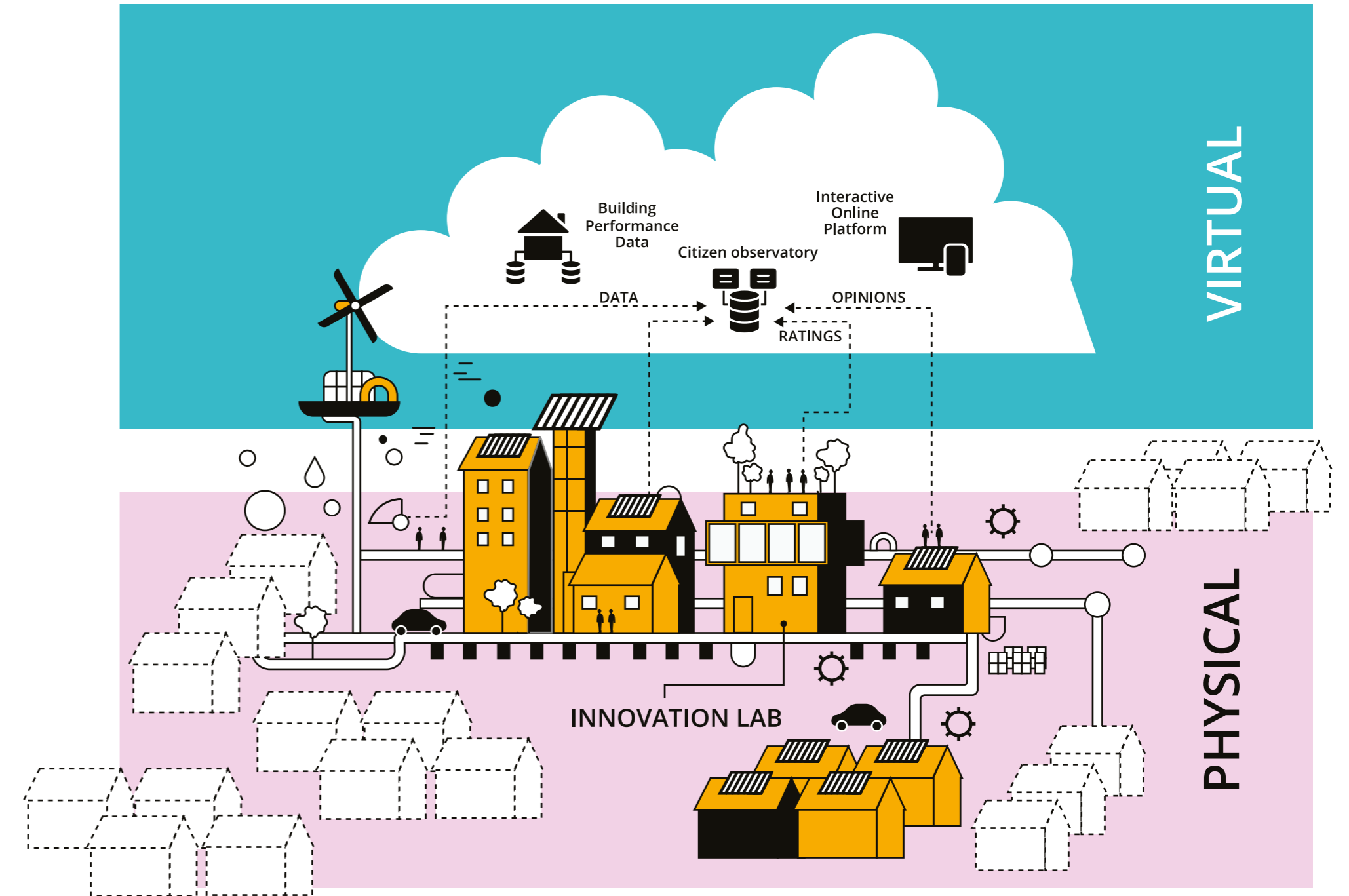
### **Want to learn more?**

- [D3.3: Framework for Innovation Playgrounds](#)
- [D3.6: Framework for DPEB Innovation Labs](#)
- [D4.8: Limerick Citizen Observatory](#)
- [D5.8: +Trondheim Citizen Observatory](#)
- [D6.5: Report on community participation and playground results](#)



### **Tips + tricks:**

A good location is essential! Cities have found that accessible locations that can be seen from the street have had success in drawing in people to see what is happening in the space. Engagement spaces located within the PED system borders have been important and valuable in Trondheim and Limerick. Spaces designed for both physical and digital interaction are invaluable, and the more results and concrete outcomes presented, the better





# Citizen innovation in Limerick

## Case Study

**+CityxChange recognises the important roles of citizens and communities in the clean energy transition and the potential of empowered citizens to drive and to facilitate PED development. To explore these roles Limerick created the Citizen Innovation Lab. This is a place for observation, co-creation and experimentation where new clean energy technologies and concepts are explored. Through the Citizen Innovation Lab, new collaborations are nurtured, and ideas and local knowledge are shared, not only by citizens but by business, academia and the city too.**

The Citizen Innovation Lab is located in the city's Innovation Playground – an area in the centre of Limerick where ideas and technologies that support PED development are co-created, trialled, and evaluated by and with citizens. It has three components – physical space, a digital platform and a programme of engagement. The Citizens' Observatory allows people to share observations of their city through interacting with physical models and digital tools – like the city digital twin and the community mapping app. This way a wide range of stakeholders can envision how the city might change. The Engagement Hub is a space where people meet to collaborate and to co-create ideas to contribute to PED development. Co-design workshops and creative engagement events take place here. This space is also available for use by communities of interest or of place whose objectives align with

those of the Citizen Innovation Lab. Fab Lab Limerick is a maker space and digital fabrication laboratory run by the School of Architecture at the University of Limerick. The Fab Lab helps to demystify digital technologies and has a range of prototyping equipment that citizens can use to explore and refine ideas

The Citizen Innovation Lab programme of engagement is designed to explore particular aspects of PED development. It includes one-off activities, week-long programmes of themed events known as City Engage Weeks, and engagement processes like the Positive Energy Champion Campaign and Open Calls for Citizen-Led Solutions which can last over a year. The digital platform is where individual experiences of using the Citizen Innovation Lab are shared as Stories. This allows the activities of the Citizen Innovation Lab to be more accessible and transparent, and helps people to learn from the experiences of others in a way that can encourage them to take part.

The Citizen Innovation Lab team has observed that people who interact with the Citizen Innovation Lab navigate their own pathway through the programme, form new collaborations, and introduce others from their networks to the Citizen Innovation Lab. The Open Calls for Citizen-led solutions (see Business and Finance Models) have helped to initiate an e-cargo bikeshare project in Limerick, engaged a community in real world experimentation using sensors to better

understand the benefits of low-energy retrofit, and have led to the creation of a new energy community. The Citizen Innovation Lab will be a key driver in supporting the implementation of the Limerick Climate Action Plan. In particular its principles and collaborative approach are essential to ensuring a just transition.

- [Limerick Citizen Innovation Lab](#)
- [D4.8: Limerick Citizen Observatory](#)
- [D4.10: Limerick Innovation Lab Solutions Catalogue 2](#)





# Flexibility & Trading

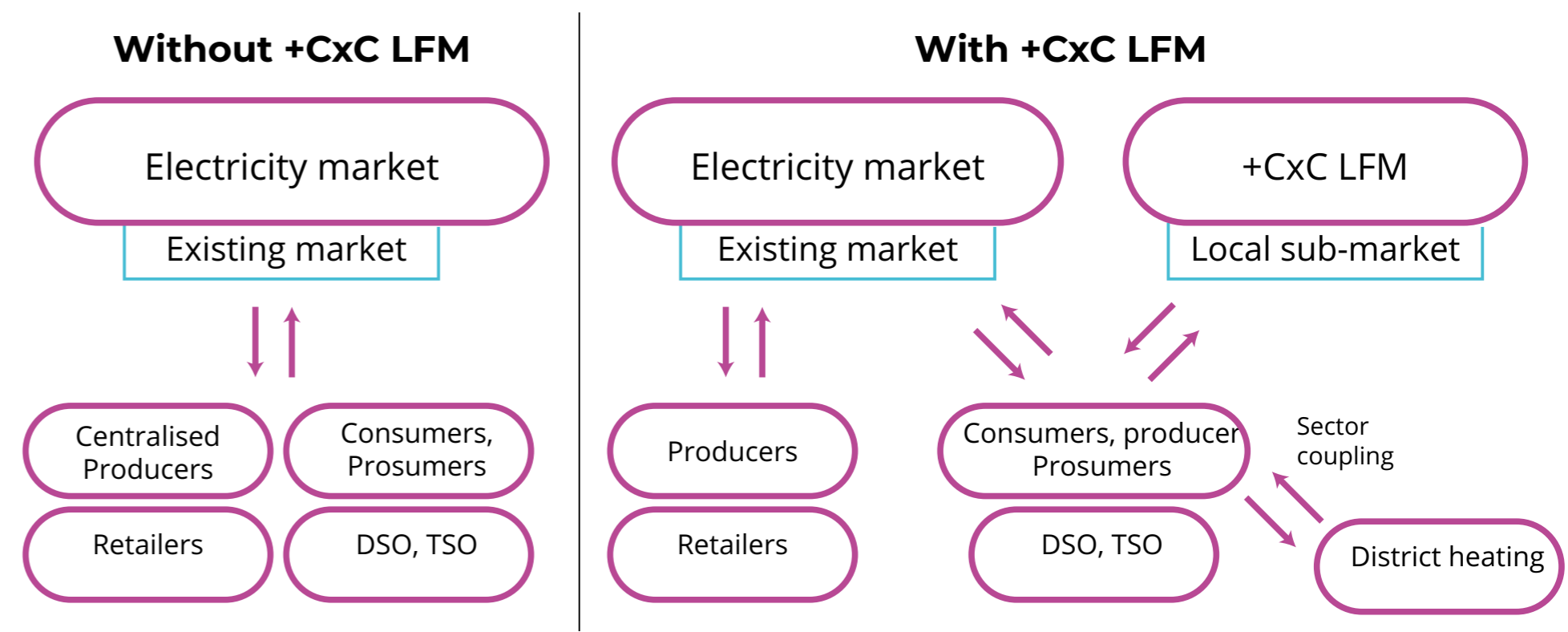


+CityxChange has tested and implemented the local trading of energy, user flexibility and system services, and the coordination of energy utilisation. Energy utilisation includes developing a local energy and flexibility market where neighbourhoods exchange energy capacity and system services through a local market. It essentially means adjusting energy use and production patterns to maintain grid stability, especially in the presence of significant renewable energy sources.

Deploying and operating a Local Flexibility Market is a pivotal step in opening up the flexibility market to small-scale local consumers and citizens. This initiative involves designing and installing the flexibility

market operating system, integrating control systems and trading platforms, as well as connecting the physical installations of the Distributed Positive Energy Blocks (DPEBs) with flexibility providers.

*Flexibility can be defined broadly, but in this book the term is limited to flexibility in time and in the type of energy carrier, both for production and consumption. This means that an owner of an energy asset can choose to consume or produce less or more or at different times. These forms of flexibility enable solutions to existing and future problems in the energy system.*





## Ingredients

**Regulatory Acceptance** - Obtaining regulatory approval is a fundamental step in the process of establishing a local energy and flexibility market. It can then be prototyped in a Special Regulatory District with dispensation or exemption from energy legislation.

**Shared benefits** - Providing incentives for all participants, including buyer, seller (prosumers), asset integrator, market operator and market platform, regarding economics and resources.

**Automated process** - Automating the bidding process, settlement, and invoicing within the market.

**Contractual Agreements between partners** - Are essential in getting an energy flexibility market up and running. Contracts support structured roles for each actor.

## Factors for Success

- Local trading of electricity and user flexibility: Once the regulatory issue is overcome, energy can be traded locally between buildings with different levels of efficiency and generation
- An overall distributed energy resource management system (DERMS) that connects and integrates all buildings, resources, and assets in the PED area, and the necessary components of the market.
- A functional market requires extensive exchange of signals from the assets at a high time resolution, meaning a connection to each building management system

- Battery storage is important to store and distribute excess energy from e.g. local production. Batteries can bring economic and environmental benefit by reducing the need for other grid hardware. Otherwise, if grid capacity is low or local grids suffer from bottlenecks local grid upgrades would be needed
- Integrating the electricity and thermal sector (sector coupling). This requires not only electricity smart metering, but also a smart thermal metering architecture and system locally, where digital communication is mandatory
- Automated trading algorithms, which are rules for trading; e.g. how much capacity can be taken from an asset at a certain time. Trading algorithms can use machine learning to learn and improve over time

### Want to learn more?

- [D2.3: Report on the Flexibility Market](#)
- [D2.7: Local DPEB trading market demonstration tool](#)
- [D5.5 Energy Trading Market Demonstration](#)
- [D5.11: Trondheim dPEB Demonstration](#)
- [D5.3: Campus Microgrid Model Prototype](#)
- [D1.2: Report on the Architecture for the ICT Ecosystem](#)
- [Deployment of Volue Energy Trading Platform](#)
- [New Energy Market in Trondheim is Now Being Tested](#)



### Tips + tricks:

It is essential to have economic incentives to encourage stakeholders to join the local energy market, as is used in Trondheim, both for producers/flexibility providers and buyers. The grid company provides this - in a time restricted period in order to test the impacts. Utilising user flexibility will contribute to peak shaving which reduces the grid tax costs. However, using flexibility for peak shifts - away from high peak periods - is another valuable means and provides incentives in terms of reduced grid tax costs, verified to reduce building owners' energy costs in Trondheim.







Project flavours:  
**People**

Flexibility trading requires a range of actors! Building owners, tenants, and real-estate companies are at the core. To establish PEDs, it is imperative to have these actors on board. Furthermore, a successful PED requires Energy trading platform (ETP) & Local Flexibility Market (LFM) developers and owners play key roles in developing market solutions for local energy and flexibility markets.



Project flavours:  
**Finance**

Sometimes actors need a little motivation to join in on a new idea. In the case of Trondheim's PEBs, rewards were offered for building owners engaging in flexibility trading. This was both to help prove the concept as part of +CityxChange and to incentivise private actors to get involved. The idea is to keep these incentives to be paid by the PEB operation itself where possible, as it also gives more certainty regarding for example building energy measures or increasing local renewables.



Project flavours:  
**Collaboration**

Communication plays a key role in establishing successful energy trading within Positive Energy Districts (PEDs). To initiate the operation of flexible systems, agreements must be forged among a diverse range of public and private entities. It's imperative to maintain a firm technical grip while also nurturing a clear, joint vision. Other recipes like modelling and visioning can be key here!



# Off the ground in Trondheim

## Case Study

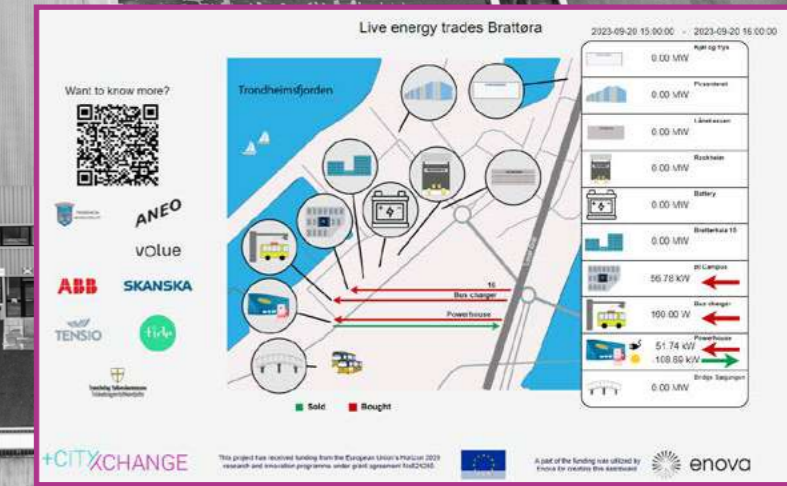
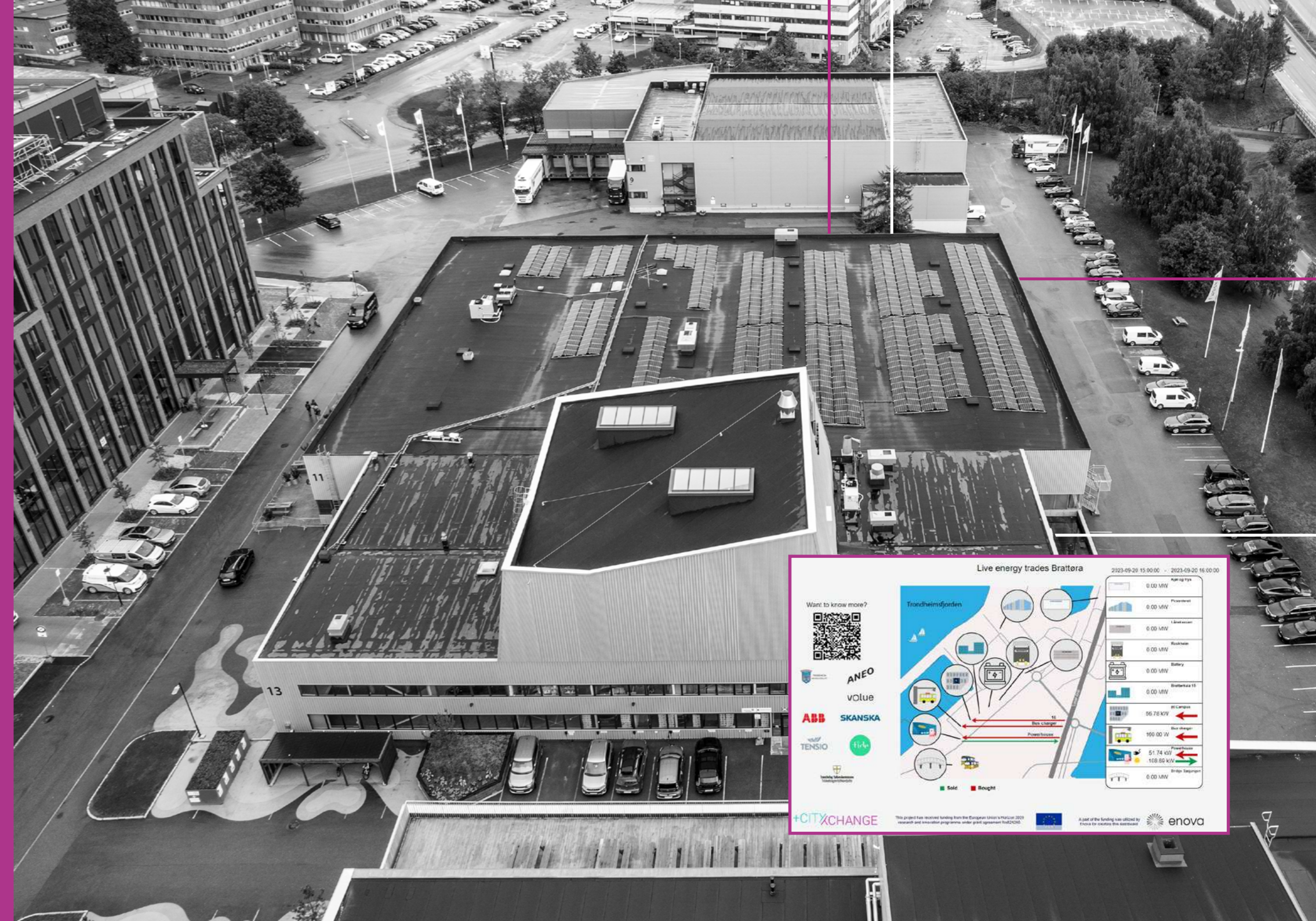
Trondheim's collaborative effort to establish its first PED has also created a robust and well-designed system for the trading of energy, flexibility, and system services. This is the result of hard work from many different public and private actors to establish the system, secure agreements and work with the regulatory landscape to accommodate these changes.

Through the +CityXChange project, Trondheim has established two Positive Energy Blocks/Districts (PEBs/PEDs): Brattøra and Sluppen. These are not separate, standalone achievements, but rather a joint system of innovations and well integrated measures performed by a variety of actors. The process to get Trondheim's PEDs off the ground has called for input from many different actors in a range of sectors. The regulatory and planning framework needed to be in place to allow for the developments to be envisioned. Physical changes also needed to be made using a number of digital modelling tools that combined data from various sources to support the implementation of the PED. Lastly, sufficient levels of stakeholder engagement have to be deployed, to collect ideas and feedback from different actors and ensure that all are in agreement on developments. Trondheim also

developed a brief handbook with guidelines to PEB development and implementation (within D5.11).

The Trondheim PEDs consist of a variety of mixed-use building types. Establishing a flexible system that allows energy and flexibility to be traded between PEBs, and the grid, means that changing demand can be consistently met and local energy production can be shared in local markets functioning in fact as small-scale power markets, as a guiding principle of Trondheim's Local Flexibility Market (LFM). The system design also allows for sector coupling, meaning shifts between electrical and thermal energy, for example by adapting the electricity use of heat pumps. The aim in Trondheim was not only to prove the concept but also create PEDs that will run effectively and allow for scaling up. With this in mind, the local markets are fully automated and operate at 15-minute resolution thanks to a series of advanced self-learning trading algorithms.

- 🔗 [D5.6: Trondheim Flexibility Market Deployment Report](#)
- 🔗 [D5.11 Trondheim DPEB Demonstration](#)
- 🔗 [Check out the live energy trades at Brattøra](#)





# River turbines in Limerick

## Case Study

In Limerick, the potential for building-integrated renewables is limited. Dedicated district-level renewable generation was planned in the form of a river turbine and additional PV. Hydroelectric tidal energy converter technology has been developed by GKinetic that can generate power at low flow speeds and naturally deflect debris with its counter-rotating turbines. It is prototyped in scales from a 1kW pico unit to a 60kW offshore unit. In Limerick, deployment of the technology was informed by adapting the turbine design to site specifications and according to citizen engagement programs. The turbine can float or rest on the riverbed to accommodate varying water levels. A low cost, high efficiency blade pitching system facilitates maximum power generation while maintaining the turbines at a low rotational speed, to minimise impacts to aquatic life. Power generation starts from low river flow speeds of only 0.6m/s, and in its current state reaches capacity at 2.2m/s.

The process to deploy the river turbine required many activities:

- **Resource assessment:** Hydrology studies and geographical assessment to understand the characteristics of the available resource and select a site.
- **Regulatory approval:** The project had to be acceptable to the main

regulatory agencies for an environmental installation. In Ireland there are many regulatory and state bodies who cover this area, but as this technology is new it did not fit the existing process. A novel stepwise approach was needed. Key environmental approval and planning permissions have now been granted.

- **Citizen engagement:** Early public consultation with community groups informed adjustments to address concerns before a full-scale system was deployed, including minimising impacts to aquatic life.
- **Continuous design and testing:** Iterative design and testing at an open water test site focused on minimising negative ecological and environmental impacts. The initial 60kW design was adapted to resource availability at the site, resulting in multiple smaller 12kW floating devices. This revision has led to the identification of a globally underutilised renewable energy resource in the form of freestream rivers and canals.

Want to learn More?

- [D4.11 Limerick DPEB Implementation Guide 2](#)
- [D4.9: White Paper "Regulations Unlocking Innovation Potential"](#)
- [D8.3: Report on replication assessment and profiles](#)





# e-Mobility



E-mobility as a service (eMaaS) is important to have integrated within a PED, providing people with climate-friendly mobility options. With an increase in e-mobility comes an increase in electricity demand. To account for this, PEDs must integrate charging infrastructure into their energy system designs. PEDs can also reduce mobility demands through effective urban planning that supports walking/cycling, and more efficient public transportation and car-sharing initiatives. In +CityxChange, eMaaS was tested using a digital mobility platform which can be used as an app on your phone, on an interconnected backend system. During the project we also tested energy integration into the PED by charging and discharging the batteries of electric cars (EVs) through chargers partially equipped with Vehicle to Grid (V2G) and Vehicle to Building technologies (V2B), meaning that energy can be supplied from the vehicles back to the PED. This allows EVs to provide additional battery storage, as well as extra support in case of grid stress or spikes in demand.

## Ingredients

### **Mobility Service App**

Work with the city to implement what they are looking for, with mobility providers to get data access, and with app developers to implement a working mobile app. Taking the time to test the app with the user group allows for time to find possible issues and adjust based on feedback. In small sprints, it is easier to engage the private sector.

**V2G and V2B technologies:** Bi-directional use of electricity stored in EV batteries, allowing for extra grid support and optimised energy efficiency management. A prototype charger, developed by partner ABB, was introduced to test V2G and V2B in a market and local energy microgrid setting.

### **Financial incentives:**

Have clear incentives to encourage consumers to participate in V2G, such as rewards for making their EV batteries available for V2G testing. This kind of incentive also supports lowering the overall cost of EV ownership.



### **Project flavours: Finance**

Financing integrated e-mobility can be challenging, especially if existing transportation systems are a mix of public and private. Certain grants exist for local governments at the European level to help to introduce connected and Smart mobility systems. Cities also have the power to set better local expectations and support structures.



### **Project flavours: Collaboration**

Collaboration and co-creation was the key to success with the Mobee app in Trondheim. The launching of the app required buy-in from stakeholders across the transportation sector in Trondheim and a common goal.



## Factors for Success:

- Think of the travel habits: Who is travelling when, with which modes of transportation? How can climate-friendly options be established? Think of the users and inhabitants: Provide good information and options: What transportation is available? People may already want to change, but may not have the right offers or information access.
  - Test new solutions and build easy-to-use alternatives and platforms. For example, Trondheim created a scavenger hunt to test out their Mobee app, for users to provide feedback and to learn from them.
  - Engage actors: Who is operating transportation options, how can you convince them to collaborate and build more integrated solutions?
  - Political landscape: How can you maximise benefits for many? How can businesses secure profits while supporting the city's strategies?
  - Look toward the future: How many parking spots will we need for a changing population? How will urban design change over time to accommodate different types of transportation?
- Look toward the future: how many parking spots will we need for a changing population? How will city design change over time to accommodate different types of transportation?
- Political landscape: who benefits from this? How can businesses secure profits while remaining in line with what the city wants?

## Want to learn More?

- 🔗 [D2.5: Seamless eMobility system including user interface](#)
- 🔗 [D4.5: eMobility in Limerick DPEB Implementation Guide](#)
- 🔗 [D5.13: +Trondheim eMaaS Demonstration](#)
- 🔗 [Challenges of Sustainable Urban Mobility Integration](#)
- 🔗 <https://mobee.no/>





# Mobee Trondheim Case Study

**Mobee is an e-mobility app featuring real-time information from city buses, as well as locations of e-scooters, bike share, car share, train, tram, ferry and taxi. It enables multi-modal mobility in the city through its simple and attractive interface. It was developed through a collaboration between Trondheim kommune and FourC. FourC is leading and coordinating the eMaaS development work, and led the development of the app. Trondheim kommune was responsible for setting up an advisory group and active user testing.**

When launching Mobee, the app needed to be user-tested. The user testing was conducted by Trondheim Kommune who set up a Mobee advisory group where they conducted a “bug hunt” which was to find

any issue within the app. The advisory group provided an opportunity for FourC to further develop the app based on user feedback. The app has been featured in local news articles and television. The design and branding have been impressive and have encouraged the public to test the mobility solution.

In addition to providing a useful public service, Mobee supports the activities of multiple stakeholders in the mobility sector. For the city itself, the app demonstrates the combined impact of green mobility solutions in Trondheim. Private mobility providers now have a platform to attract new users and gather new data. Distribution System Operators (DSOs) can manage electrical assets according to e-mobility availability, helping to keep them connected. The app has been a win-win for everyone involved!





# Písek's mobility Case Study

**For Písek, e-mobility was a major point of progress throughout the project. Through visioning processes and by working with a variety of public and private stakeholders, Písek has been able to revolutionise its electrical mobility infrastructure. This means supporting private e-transport and developing electric, smart public transport across the city.**

Smart Písek is the initiative launched in the city that focuses on modern technologies to improve the quality of life of the city's inhabitants, streamline management systems of public infrastructure, and make positive changes for the environment. A major aspect of Smart Písek's achievements is an efficient system to manage transportation in the city, including the introduction of a new all-electric public transport fleet.

The establishment of Smart Písek was a carefully designed process,

to make sure technologies were deployed efficiently and effectively. It began with a process of understanding the needs and demands of the city's transportation system. This led to the introduction of transport telematics, administrative measures and new urban transport infrastructure. When the initiative started to make changes in the city's mobility system, it was important that these were oriented towards easier use for residents. Not only did the city bring in a whole new electric public transport system powered by clean energy, but transport information was linked to smart management systems, so that residents would receive live updates on their journeys, integrated into existing infrastructure, such as solar bus stops. A campaign was also initiated to utilise these management systems beyond vehicular transport. Smart provisions to support cycling and walking in the city were introduced and linked to tourist industries in targeted places. The strength of Smart Písek is how it links to many different parts of life in the city and is a major achievement for Czech cities!







# Flavours from the Project





## Flavours from the Project: People

Creating Positive Energy Districts requires a multi-stakeholder approach that harnesses the collective expertise, resources, and perspectives of various actors. These stakeholders each play crucial roles in supporting climate-neutral Transitions. The overview on the opposite page shows the array of stakeholders that co-created PEDs in the +CityxChange project. Collaboration is key!

### Inhabitants and users are at the heart of PEDs.

New solutions must be accepted by community members and building owners (public and private) so it's important to consider how PEDs impact those who live in them. One way to communicate this is to consider how carbon neutrality can benefit health and economic prosperity. This is an important aspect to consider in both the design of PED solutions and the production of communication material to display progress made.

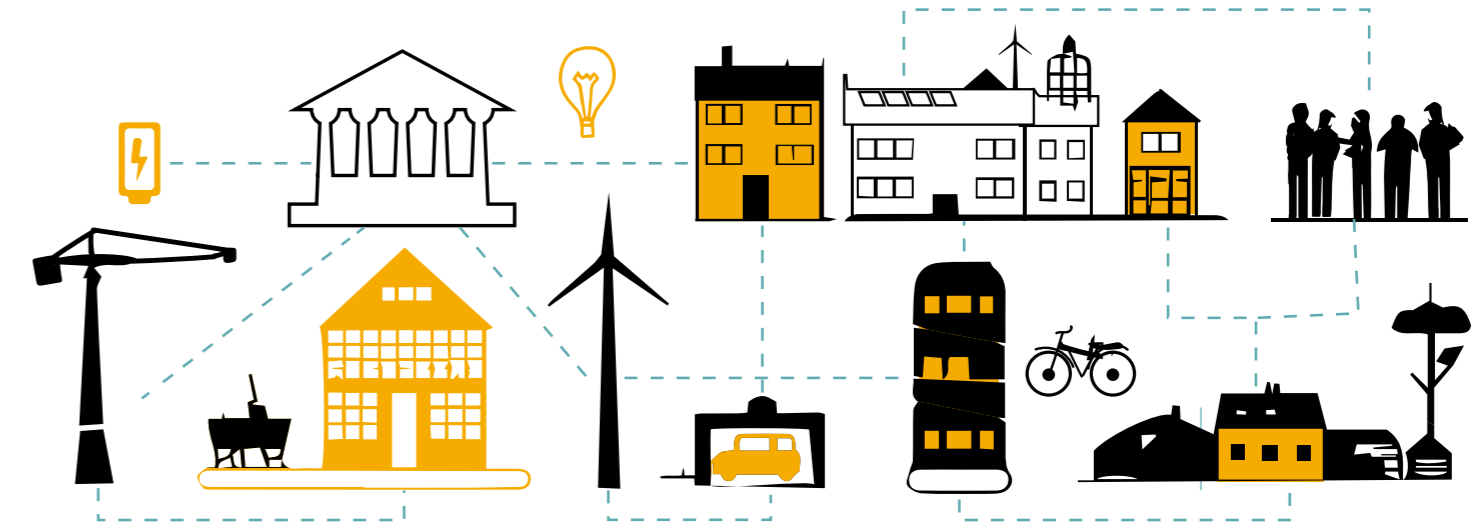
### Integrating local heritage and culture into PED projects is crucial.

Recognising and valuing the cultural heritage and traditions of a community can foster a sense of pride and ownership among residents, making them more likely to support and actively participate in sustainability efforts. Drawing on traditional knowledge, practices, and architectural styles that align with sustainable principles not only preserves the unique identity of the community but also showcases the compatibility between cultural heritage and climate action.

### The right people can open doors

It is important to make sure you have the right people involved from the start of the project. Key groups are: citizens, decision-makers, technical experts, and facilitators. Involving these actors early in the process will facilitate changes in culture, regulation and systems. Read more about working with diverse stakeholders in the Collaboration Flavour.

## Stakeholders from our Project



- Building Owners
- Local Market Operator
- Inhabitants & Communities
- Utilities and energy providers
- Energy and Facility Management Firms
- eMaaS Provider:
- Local permitting authorities
- Educators and Youth
- Battery Energy Storage Solutions (BESS) operator
- Energy Service Companies (ESCOs)
- Municipal urban planners & land use planners
- Financial institutions and investors (funding):
- Industrial companies:
- Prosumer
- Tech providers and innovators
- NGOs and Advocacy Groups
- Renewable Energy Systems (RES) Producers
- National governments
- Research and academic institutions (R&D)
- Transportation authorities
- Local governments
- Real estate developers and property owners
- Local businesses & SMEs & startups





## Flavours from the Project: Finances

Finances play a critical role in building PEDs, which often requires substantial investment in infrastructure, technology, and sustainable development. Adequate funding from public and private sources is essential to support the development, implementation, and ongoing operation of these sustainable urban initiatives. There are many different options to secure financing, and diversifying funding is important! In many cases, PEDs are not only useful for the energy transition and providing other societal benefits and pathways for the decarbonisation of our cities and towards climate-neutrality, but can even make all this economically beneficial.

### All financing options come with some trade-offs

The right funding option will vary depending on your specific situation and characteristics, whether public, private or a mix of the two. It is often worth considering whether the requirements of a particular funding option will work for you. Financial advisors and experts are worth consulting with regards to the various available options

### Find the right ways to model and communicate your project

Often to secure funding, novel ways of displaying importance, projected outcomes and progress are needed. Think about the forms of presentation that are familiar to your awarding body and consider how to use these forms in innovative ways, to maximise possible impact.

## Funding Sources



**Public funding & subsidies:** schemes designed for urban development/experimentation in new innovations, offered by national and international funding agencies



**Long-term maintenance grants:** financial support over the long term (costs of operation, maintenance, upgrades, etc.)



**Local investments:** upfront costs for building new infrastructure, installing renewable energy systems, and integration of smart technologies



**National and regional development funds:** grants and bursaries operated by national governments, often for land readjustment

**Public-private partnerships:** mechanisms where governments use resources, expertise, and funding of the private sector to develop, procure, or implement public infrastructure with suitable risk/benefit sharing



**Energy efficiency/green financing mechanisms:** bonds, loans, and grants specifically for environmental innovations and eco-developments



**Joint ventures with partners:** resource pooling between sibling/horizontal governance organisations to develop shared solutions or prove concepts together



**Sustainable business models:** innovative business models can spin off from the innovations around the PED ideas

**Land-based financing:** loans and grants awarded based on projected land value increase from developments, including value-based annual land taxes, betterment levies, and capital gains taxes.



**European funding schemes:** various EU schemes for sustainable urban development, including:

- HORIZON Europe
- EU Cities Mission
- Driving Urban Transitions (DUT)
- European City Facility (EUCF)
- NextGenerationEU
- European Energy Efficiency Fund (EEEF)
- European Regional Development Fund (ERDF)
- European Urban Initiative (EUI)
- European Investment Bank (EIB)
- Cohesion Fund (CF)
- European Social Fund (ESF)
- Urban Innovative Actions
- Smart Cities Marketplace LIFE
- and others





## Flavours from the Project: **Collaboration**

Collaboration is instrumental in ensuring the success of complex projects such as PEDs, where many different actors, ideas, systems, interests, experiences, requirements, limitations, processes, and solutions must be coordinated. Given the multifaceted nature of PED initiatives, effective collaboration creates wheels and linchpins for co-creation, in integrating the different expertise and aspects that will ultimately lead to successful PED development. Effectively managing the collaborative elements in your project can be challenging. Here are some tips from +CityxChange!

### **You may find that things work differently in your project**

The elements here help to give some ideas of how to coordinate collaborative efforts in PED projects. In practice, managing different actors and processes can lead to very different collaborative environments. Being able to pivot, to find creative workarounds, to work according to new developments as they emerge, and to find joint agreements is crucial.

### **Building PEDs is not an easy task and some setbacks are to be expected**

Giving yourself space to fail in certain tasks and to learn from this will help you work towards your goals in the long run, and may also help with organisational change. There is no right way to build a PED, but your context will define for you what is possible and what needs a different approach. Don't be disheartened by obstacles: pivot and overcome!

### **Stay open to collaboration through co-creation and open innovation**

In our project, we often saw successes in environments where stakeholders worked closely together, while more challenges were created when stakeholders were detached or at odds. Accommodate alternative ways of working, new constellations, and new collaborative partnerships. Building PEDs is complex and cannot be done alone!

### **Many of the recipes in this cookbook are exercises in good collaboration**

Tools for visioning, modelling, engagement, innovation and deployment can help to find new ways to work together and reach common goals. If you find yourself at a loss for how to navigate an obstacle in your project, take a look back through the recipes here!

## Collaborative cooking

**Continuous communication & transparency.** In +Cityxchange, maintaining open and continuous communication with citizens, along with transparency in decision-making processes, helped to build credibility and trust. Sharing open data can often enhance transparency and enable others to replicate successful initiatives. Methods to do this include:

- Regular and detailed reporting and documentation to show developments
- Holistically planning for the integration of different aspects, e.g. energy production, building design, transportation/infrastructure systems, community engagement



**Multiple narratives to explain to different stakeholders.** We found that developing an understanding of target audiences when framing project details helped greatly to get people on board. This meant phrasing some information based on different important factors, like job creation, the greater societal good, etc.



**Stakeholder diversity.** A diverse range of stakeholders is often needed to build PEDs, such as private companies, universities, residents, youth organisations and community groups. We found that solutions to challenges often came from the range of expertise in our project.



**Localisation is key.** In +CityxChange, contextual differences meant solutions looked very different in different regions. It is important to tailor visions, models, and participatory approaches to your city's specific needs, interests, geographies, legislature, etc.



**Storytelling as a way to communicate the journey.** A key outcome from our project is that PED projects rely on the right stories and emotion to connect to people. Creating a story around PED creation can help people to identify with and understand what's going on.



**Digital tools demonstrate benefits.** Using innovative digital tools helped us to navigate a lot of complexity in the project and communicate plans for PED development to stakeholders. Finding the right tool to demonstrate the value of PEDs and using forms of understanding specific to stakeholder landscapes is important. Think about what might work for you!



**Strong leadership.** Strong management and coordination can help a lot to navigate the scale and complexity of PED projects. Leaders often have a key role in bringing people together, managing time and resources, budget setting, overcoming bottlenecks and mitigating risks.



**Commitment to the process.** We have seen the process of building PEDs often become a long one. Without the continued commitment of many stakeholders, we would not have been able to achieve our outcomes. Stay dedicated!







Serving up PEDs





## Now you try!

This +CityxChange cookbook aims to support you in building PEDs in your city. The learnings in this book are based on our experiences throughout the last five years. Put together, the recipes show a roadmap for creating PEDs, even if the exact way to build a PED will look different in every European region and city. We don't have all the answers, but we have learned a lot from our processes.

We hope you can learn from us, from the processes, results, and motivations shared in this book, and the detailed technical steps and descriptions in our project reports. Reflecting on each of the recipes in the cookbook, our main steps to build a PED were these:

### Our main steps in PED Development:

**Build your network:** Collaboration is key to building PEDs. Starting the process with a strong team will set you up for everything that comes next. There's no I in PED!

**Define your purpose:** Setting your expectations for the project will help to stay on track throughout. Why are you interested in building PEDs? What is the value? These questions are crucial.

**Define your vision:** What do you want the outcomes of your efforts to look like? Create a shared vision so that everyone understands what you're pushing to achieve.

**Understand your environment:** Building a PED inevitably comes with unforeseen challenges. Understanding the local environment physically, socially, and institutionally will help to navigate these challenges. Think early on of possible limitations!

**Assess regulatory environment and urban planning practices:** Governance and decision-making look different in every city. Before starting on your PED development, get to know the legal and regulatory process and how urban planning works in your region.

**Model your process and outcomes:** Models help to predict and explain. Get creative with your methods of modelling, ensure good data, and try innovative methods for different phases of the process.

**Get people on board:** All the prior steps help to convince others of what you are aiming for. Use your resources and network to get key actors on your side and secure commitments to change.

**Secure investment:** With a proper design and model, finding investment opportunities becomes a little easier. Utilise your networks to see what options you have and promote your concept to secure funding.

**Test your concept:** When you can roll out your PED development on a small scale, work closely with your network to test your concept. Keep expansion in mind while doing so, to make sure everything runs smoothly.

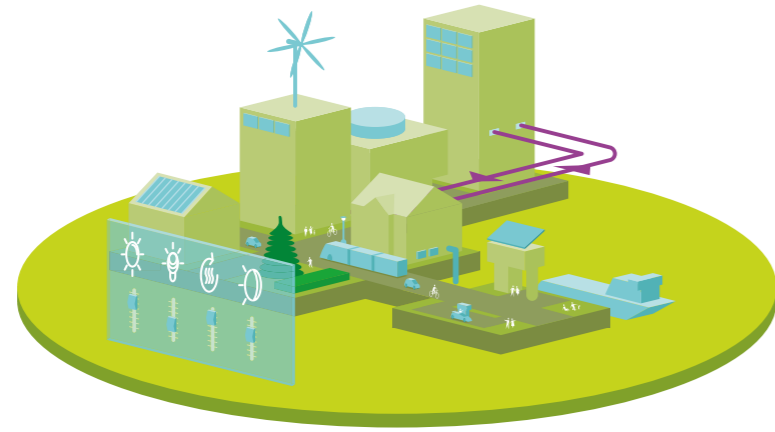
**Connect with citizens and inhabitants:** As you develop your PED, it is important to reach out to citizens in your city. The aim is to have communities on-board with changes, include them in development, co-create necessary behavioural changes, while being transparent at every step. Remember this requires a two-way relationship with citizens and you may learn a lot in exchange.

**Stay committed:** Building PEDs is a complex process, but with a strong team and an effective process much is possible. There may be setbacks along the way, and most can be overcome!

**Scale up:** Once you can prove the concept and have models established to expand your PEDs, you are ready to scale up your solutions and move to other areas to make the larger changes that are needed.

**Share your outcomes and learn from others:** As you start to achieve results, share these with those building PEDs in other areas. Progress is happening everywhere and there are many opportunities to learn from each other. Many other projects and cities are also piloting PEDs and have a wealth of knowledge to offer.





## The Future of PEDs

+CityxChange has left a lasting impact in all of its cities, and all cities made substantial progress towards PEDs and realised a lot of other (unexpected) co-benefits and impacts from their journey. Trondheim with its achievement to fully serve up two working PEDs is just the start and is one significant step forward in the overall transition. Setting the grounds to build upon the innovative ideas tested is a starting point for future innovation. Working through the barriers that arose provided learning that will last through future projects. Cities were able to demonstrate to their local stakeholders why investing in projects like +CityxChange can have lasting impact, lead to other projects and funding opportunities, and help cities in the journey to climate-neutrality.

PEDs have the potential to support a carbon-neutral future whilst

improving standards of living, building resilience, and improving our cities. There is no denying the complexity of building and sustaining PEDs, but with commitment and collaboration, it is both worthwhile and attainable, as our demonstrators show.

With this cookbook, we have outlined some of the recipes that can contribute to building your own PED. Mix and match them, rearrange them, add your own flavours, and most importantly, remember that a PED is a process, not just an outcome!

We'd love your feedback! Let us know what was useful and what you'd like to learn more about when it comes to building your own PED. And don't hesitate to share your results, challenges, and experiences, so that we can collectively make a difference!





# Project partners

We would like to acknowledge all the project partners who contributed their hard work and dedication to creating Positive Energy Districts over the last five years.

## Coordinator



NTNU

## Cities

### Limerick



Limerick City & County Council

### Trondheim



Trondheim kommune

### Alba Iulia



Alba Iulia Municipality

### Písek



Město Písek

### Sestao



Sestao Berri

### Smolyan



Municipality of Smolyan

### Vöru



Municipality of Vöru

## Trondheim Partners



Volue AS



Trønderenergi AS (Now ANEO AS)



ABB AS



AtB AS



Avis Budget Group



Statkraft Varme AS



FourC AS



R. Kjeldsberg AS



NHP Eiendom AS - RELOG

## Limerick Partners



Integrated Environmental Solutions Ltd



University of Limerick



Future Analytics Consulting Ltd



ESB Innovation RoI Ltd



ESB Networks DAC



Space Engagers



Colaborativa SL



Smart M Power Co. Ltd.



GKinetic Energy Ltd



GoCar Carsharing Ltd

## Transversal Partners



Research2Market



ISOCARP Institute Centre for Urban Excellence



Energy Agency of Plovdiv



Officina Verdi Group



IOTA Foundation



Ove Arup & Partners SAU



**This is a selection of sources for this book. You can find all our material online in the Knowledge Base** <https://cityxchange.eu/knowledge-base/> **including the project reports under** <https://cityxchange.eu/article-categories/deliverables/>

D2.1 Report on Enabling Regulatory Mechanism to Trial Innovation in Cities. BO. Bertelsen, K. Livik, M. Myrstad. (2019) <https://cityxchange.eu/knowledge-base/report-on-enabling-regulatory-mechanism-to-trial-innovation-in-cities/>

D3.1 Framework for Bold City Vision, Guidelines, and Incentive Schemes (SDG City Transition Framework). Ø. Tanum, K. Mjøen, B.O. Berthelsen, K. Reeves, K. Solhaug Næss. (2019) <https://cityxchange.eu/knowledge-base/framework-for-bold-city-vision-guidelines-and-incentive-schemes/>

D2.2 Toolbox for design of PEB including e-mobility and distributed energy resources. KE. Dahlen, K. Livik, N. Purshouse, M. Antolic. (2020) <https://cityxchange.eu/knowledge-base/d2-2-toolbox-for-design-of-peb-including-e-mobility-and-distributed-energy-resources/>

D2.3: Report on the Flexibility Market. S. Hackett, B. Kvaal, M. Runnerstrøm, H. Grøttum, N. Økstad, K. Livik, S. Danielsen, S. Wright, L.M. van Vuuren, D. Stewart, M. Antolic, S. Backe, G. Kara, P. Crespo del Granado, M.E. Nyrø Fossum, M. Lauvland, H.E. Frøyen, J. Helde, T.R. Skoglund, M. Eljueidi. (2019) <https://cityxchange.eu/knowledge-base/report-on-the-flexibility-market/>

D2.4: Report on bankability of the demonstrated innovations. V. Cimini, F. Giglio, G. Carbonari. (2019) <https://cityxchange.eu/knowledge-base/report-on-bankability-of-the-demonstrated-innovations/>

D1.2: Report on the Architecture for the ICT Ecosystem. S. Abbas Petersen, A. Junior Bokolo, D. Ahlers, A. Shams, M. Helfert, I. Alloush, Z. Pourzolfaghar. (2021) <https://cityxchange.eu/knowledge-base/d1-2-report-on-the-architecture-for-the-ict-ecosystem/>

D3.3: Framework for Innovation Playgrounds. A. Mee, P. Crowe. (2020) <https://cityxchange.eu/knowledge-base/d3-3-framework-for-innovation-playgrounds/>

D3.6: Framework for DPEB Innovation Labs. H. Fitzgerald, J. Burón García, M. Sánchez Mora. (2020) <https://cityxchange.eu/knowledge-base/d3-6-framework-for-dpeb-innovation-labs/>

D4.1: Limerick DST (Integrated Modelling and Decision Support Tool) including training manuals/videos. R. Kerrigan, N. Purshouse, L. De Donatis, O. Neu. (2020) <https://cityxchange.eu/knowledge-base/d4-1-limerick-dst-integrated-modelling-and-decision-support-tool-including-training-manuals-videos/>

D4.5: eMobility in Limerick DPEB Implementation Guide. R. Montgomery. (2023) <https://cityxchange.eu/knowledge-base/d4-5-emobility-in-limerick-dpeb-implementation-guide/>

D4.7: Limerick 2050 Vision, Integrated Action Plan and Digital Guide. K. Reeves, M. Woods, A. Goggin, M. Singh, J. Buron Garcia. (2022) <https://cityxchange.eu/knowledge-base/d4-7-limerick-2050-vision-integrated-action-plan-and-digital-guide/>

D4.8: Limerick Citizen Observatory. S. Hourigan, J. Tierney, H. Fitzgerald. (2022) <https://cityxchange.eu/knowledge-base/d4-8-limerick-citizen-observatory/>

D4.9: White Paper “Regulations Unlocking Innovation Potential”. P. Stephens, G. Kerin, G. Brennan, F. Egan, D. Stewart. (2023). <https://cityxchange.eu/knowledge-base/d4-9-white-paper-regulations-unlocking-innovation-potential/>

D4.10: Limerick Innovation Lab Solutions Catalogue 2. G. Walsh, H. Fitzgerald, M. Lyes, Alan Mee. (2022) <https://cityxchange.eu/knowledge-base/d4-10-limerick-innovation-lab-solutions-catalogue-2/>

D5.2: +Trondheim DST including training manuals/videos. N. Purshouse. L. De Donatis, O. Neu, R. Kerrigan. (2021) <https://cityxchange.eu/knowledge-base/d5-2-trondheim-dst-including-training-manuals-videos/>

D5.3: Campus Microgrid Model Prototype. E. Næss Gulbrandsøy, P. Crespo Del Granado, R. Alonso Pedrero, S. Backe, D. Pinel. (2021) <https://cityxchange.eu/knowledge-base/d5-3-campus-microgrid-model-prototype/>

D5.13: +Trondheim eMaaS Demonstration. A.B. Sørnum, B.O. Berthelsen, T.R. Skoglund, E.A. Bratseth, T. Nørbech. (2022) <https://cityxchange.eu/knowledge-base/d5-13-trondheim-emaas-demonstration/>

D5.5: Energy Trading Market Demonstration. S. Danielsen, O. Hendseth, K. Livik, B.O. Berthelsen, G. Sizov. (2022) <https://cityxchange.eu/knowledge-base/d5-5-energy-trading-market-demonstration/>

D5.6: Trondheim Flexibility Market Deployment Report. E. Næss Gulbrandsøy, E.L.H. Rørvik, B.O. Berthelsen. (2023) <https://cityxchange.eu/knowledge-base/d5-6-trondheim-flexibility-market-deployment-report/>

D5.7: +Trondheim 2050 Bold City Vision and Guidelines (Vision for Sustainable Urban Transition) A. Haugslett, K. Riedesel, B.O. Berthelsen. (2022) <https://cityxchange.eu/knowledge-base/d5-7-trondheim-2050-bold-city-vision-and-guidelines-vision-for-sustainable-urban-transition/>

D5.8: +Trondheim Citizen Observatory. A. Haugslett, S. Rønningsen, K. Riedesel, C. Grabinsky. (2021) <https://cityxchange.eu/knowledge-base/d5-8-trondheim-citizen-observatory/>

D5.9: Playbook of regulatory recommendations for enabling new energy systems M. T. Myrstad, K. Livik, A. Haugslett. (2021) <https://cityxchange.eu/knowledge-base/d5-9-playbook-of-regulatory-recommendations-for-enabling-new-energy-systems/>

D5.10: Trondheim Innovation Lab Solutions Catalogue (+Trondheim Implementation of Innovation Playgrounds). C. Grabinsky, K. Riedesel, A. Haugslett. (2021). <https://cityxchange.eu/knowledge-base/d5-10-trondheim-innovation-lab-solutions-catalogue/>

D5.11: Trondheim dPEB Demonstration. M. Lauvland, B.O. Berthelsen, E. Næss Gulbrandsøy, V. Mortensen Gråberg, S. Leonhardsen, M. Fossum, T.R. Skoglund. (2022) <https://cityxchange.eu/knowledge-base/d5-11-trondheim-dpeb-demonstration/>



D5.16: +Trondheim sustainable investment and business concepts and models. B.O. Berthelsen, K. Livik, T. Jensen, K. Riedesel, R. Casapietra, F. Giglio, V. Cimini, G. Martino, V. Scavelli.(2023) <https://cityxchange.eu/knowledge-base/d5-16-trondheim-sustainable-investment-and-business-concepts-and-models/>

D7.18 Reporting to the SCIS system 10 – Overall project KPI monitoring results. (2023) <https://cityxchange.eu/knowledge-base/d7-18-reporting-to-the-scis-system-10/>

D8.3: Report on replication assessment and profiles for each +CityxChange demonstration project. (2023) <https://cityxchange.eu/knowledge-base/d8-3-report-on-replication-assessment-and-profiles-for-each-cityxchange-demonstration-project/>

D4.11 Limerick DPEB Implementation Guide 2. (2023) <https://cityxchange.eu/knowledge-base/d4-11-limerick-dpeb-implementation-guide-2/>

D5.15 Trondheim Project Documentation Repository 5. (2023) <https://cityxchange.eu/knowledge-base/d5-15-trondheim-project-documentation-repository-including-project-status-reports-5/>

D6.2: Bold City Vision 2050 for each FC (BCVs for Alba Iulia, Smolyan, Vöru, Písek, and Sestao).T. Dommerholt, S. Amin, A. Muresan, T. Drambarean, M.Prokýšek, T. Hroudová, S. Meeliste, B. Spasova, A. Bäcker. (2023). <https://cityxchange.eu/knowledge-base/d6-2-bold-city-vision-2050-for-each-fc-bcvs-for-alba-iulia-smolyan-voru-pisek-and-sestao/>

D6.3: Technical feasibility study of the potential PEB replications in each FC. Energy Agency of Plovdiv, Representatives of Municipality of

Alba Iulia, City of Písek, City of Sestao, Municipality of Smolyan, City of Vöru. (2023) <https://cityxchange.eu/knowledge-base/d6-3-technical-feasibility-study-of-the-potential-peb-replications-in-each-fc/>

D6.5: Report on community participation and playground results. A. Mee, M. Sánchez Mora, F. Giglio, J. Burón García, M. Prokýšek, T.Hroudova, E. Petkova, B. Spasova, A. Bäcke, S. Meeliste, T. Drambarean, L. Stanciu. (2023) <https://cityxchange.eu/knowledge-base/d6-5-report-on-community-participation-and-playground-results/>

D6.6 Report on management of +CityxChange replication in Alba Iulia. (2023) <https://cityxchange.eu/knowledge-base/d6-6-report-on-management-of-cityxchange-replication-in-alba-iulia/>

D6.7 Report on management of +CityxChange replication in Písek. (2023) <https://cityxchange.eu/knowledge-base/d6-7-report-on-management-of-cityxchange-replication-in-pisek/>

D6.8 Report on management of +CityxChange replication in Sestao. (2023) <https://cityxchange.eu/knowledge-base/d6-8-report-on-management-of-cityxchange-replication-in-sestao/>

D6.9 Report on management of +CityxChange replication in Smolyan. (2023) <https://cityxchange.eu/knowledge-base/d6-9-report-on-management-of-cityxchange-replication-in-smolyan/>

D6.10 Report on management of +CityxChange replication in Vöru. (2023) <https://cityxchange.eu/knowledge-base/d6-10-report-on-management-of-cityxchange-replication-in-voru/>

## Other selected material

+CityxChange Demonstration Projects: <https://cityxchange.eu/demo-projects/>

Check out our YouTube channel for +CityxChange videos:

<https://www.youtube.com/@PositiveCityxChangeH/featured>

Our YouTube playlist shares related videos from our partners and sister projects: <https://www.youtube.com/ch?v=sORICf0czPk&list=PLBosuckwgWkFvUUUsmyALVs24DHzgrg3LM>

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*The Sense and Non-Sense of PEDs — Feeding Back Practical Experiences of Positive Energy District Demonstrators into the European PED Framework Definition Development Process.* Han Vandevyvere, Dirk Ahlers, Annemie Wyckmans. *Energies*. 2022, 15(12), 4491. Special Issue “Advanced Energy Systems in Zero/Positive Energy Buildings, Communities and Districts” <https://doi.org/10.3390/en15124491>

*Co-Creation of Positive Energy Blocks.* Dirk Ahlers, Patrick Driscoll, Håvard Wibe, Annemie Wyckmans. In Proceedings of the 1st Nordic conference on Zero Emission and Plus Energy Buildings. IOP Conference Series: Earth and Environmental Science. 2019. Volume 352. <https://doi.org/10.1088/1755-1315/352/1/012060>

*A Smart City Ecosystem enabling Open Innovation.* Dirk Ahlers, Leendert Wienhofen, Sobah Abbas Petersen, Mohsen Anvaari. 19th International Conference on Innovations for Community Services (I4CS 2019). Springer, CCIS, volume 1041. 2019. [https://doi.org/10.1007/978-3-030-22482-0\\_9](https://doi.org/10.1007/978-3-030-22482-0_9)

See a wider overview of research publications in our [Knowledge Base](#).

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*Positive Energy Districts Solution Booklet.* Han Vandevyvere, Dirk Ahlers, Beril Alpagut, Veronika Cerna, Vincenzo Cimini, Sindi Haxhija, Mari Hukkalainen, Michal Kuzmic, Klaus Livik, Marielisa Padilla, Marije Poel, Cecilia Sanz Montalvillo, Socrates Schouten, Marit Teigen Myrstad, Mark van Wees, Karen Williams, Annemie Wyckmans, Andrea Gabaldon, Nora Fernandez Perez, Sari Hirvonen Kantola, Sophie Dourlens, Els Struiving. Technical Report, EU SCIS Smart Cities Information System. 2020. <https://smart-cities-marketplace.ec.europa.eu/insights/solutions/solution-booklet-positive-energy-districts>

*Citizen Engagement Solution Booklet.* Jelle Jaubin, Dirk Ahlers, David Crombie, Savis Gohari Krangsås, Roel Massink, Eda Ozdek, Leen Peeters, Willem-Jan Renger, Maria Sangiuliano, Agata Smok, Annemie Wyckmans, Han Vandevyvere, John Zib. Technical Report, EU SCIS Smart Cities Information System. 2021. <https://smart-cities-marketplace.ec.europa.eu/insights/solutions/solution-booklet-citizen-engagement>

[Systemic Changes in Governance. Equipping local governments for realising climate-neutral and smart cities.](#) Policy Paper. Scalable Cities, EU Smart Cities Marketplace, 2013.

The State of European Smart Cities. Policy Paper. Scalable Cities, EU Smart Cities Marketplace. To be published.

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The H2020 SCC1 sister projects of +CityxChange:

[SCC1 Lighthouse Projects – Smart Cities Marketplace](#)









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