INTERACT

Integration of Innovative Technologies of Positive Energy Districts into a Holistic Architecture

D 2.1 Competence Map

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Executive Summary

The first call of JPI Urban Europe on Positive Energy Districts and Neighborhoods (PED/PEN) (JPI Urban Europe, 2020) challenges the four funded projects (Cities4PEDs, PED-ID, TRANS-PED and INTERACT) to join efforts, ambitions and exchange their knowledge in order to contribute to the overall goal of reaching and establishing 100 successful PED projects across Europe by 2050 (JPI Urban Europe, n.d.).

Within the INTERACT project, the focus lies on establishing a guideline for the design and implementation of a specific Energy Community based on a holistic architecture approach, laying the foundation for Positive Energy Districts (PEDs) in a generally applicable version and in two special cases for the two focus areas in Austria and Sweden.

This deliverable comprises the results from an analysis of the state of the art of PED ambitions: we evaluated around 60 projects within Europe and chose 16 PED-approaches from the INTERACT-partner states Austria, the Czech Republic and Sweden including their international stakeholder community for a deeper analysis. Focusing on assessment criteria for success of PED projects, and based on derived project experience, this task serves as a basis for the INTERACT projects process in developing a roadmap for Energy Community implementation. Additionally, it is the ambition of INTERACT to complement insights on projects with regard to the knowledge building components in the PED/ PEN community in creating a competence map of PED personnel, as well as updating and reflecting on experiences, success factors as well as challenges in the projects pathway towards becoming a plus energy project.

A first step aimed at the identification of European projects with PED ambitions with potential, this task was conducted through desk research and existing collections of projects were taken as a starting point. From the around 60 initially described and recorded projects, 16 selected projects from the three countries represented in the INTERACT project consortium – Austria (6 projects), the Czech Republic (4 projects) and Sweden (6 projects) - were further investigated desk research, document analysis and described further in regard to their ambitions and implementation for energy and building performance, the energy provision. Focus was also to identify stakeholder and involved actors within the projects, identify their roles as well as discipline background, if available, as a basis for the competence mapping process. The interviews with project managers of various of the selected projects were conducted in order to further understand process of project, and reflect on crucial aspects for success, challenges, drivers and barriers. The results have been summarized in a table format following the style of the PED booklet (Gollner et al. 2020)

While Austria and Sweden showed already a number of entries in the above mentioned booklet and provided us a large scene of experienced PED personnel, there was no case mentioned yet for the Czech Republic. In identifying and describing projects with PED ambitions there, and identifying further projects in Austria and Sweden, an addition to the insights of the booklet and future potential added projects for the ambition of 100 PEDs in Europe could be discovered. The analysis of those projects fostered a direct communication,

knowledge exchange and connection between project personnel and introduced researchers and actors from PED approaches towards one another creating a knowledge community, which offers the possibility for joint learning and feedback opportunities. It is our aim to integrate those new projects into the PED competence network for a mutual exchange of knowledge and support in their ambitions.

The majority of analysed projects is either in planning stage or currently in implementation. It is therefore difficulty to reflect on the status of PEDs by reaching their set goals. As can be seen by the variety of key-aspects of the selected projects, the action fields to be addressed in order to reach a positive energy balance is wide. Most of the projects tackle new buildings structures and the use of energy for in-door-living, several projects focus also on mobility, while others address infrastructure measures and yet others focus on the community and community actions like energy sharing or shared services.

The visualization of competences within a competence network model shows, that most frequently architects, planners and project developers are included in the analysed projects. This goes in hand with the fact, that mostly new building areas are targeted, and the focus is laid on the building design and its technical features. We see the potential of integrating energy experts right from the start of such processes, putting a focus on the energy balance of the whole district with all its usages (habitation, mobility, infrastructure, general spending, ...), and helping shaping it towards a positive energy place.

Within the project INTERACT, the relationship of PED and PEN ambitions with energy communities is assessed and further work packages of the project will focus on energy communities. Energy Trading with production, storage and consumption on a local or regional level seems important, either for heat or electricity. Yet it still remains open to shed light on how far energy communities contribute to PED approaches, or to assess the potential of integrating energy communities as a base for areas with PED and PEN ambitions. Further work in the INTERACT project will contribute to this discussion.

This Deliverable is considered as a documentation of perspectives and analysis at a certain point, namely during summer 2021. It does not claim to be conclusive and includes various ambitions that are still work in progress. Therefore, this deliverable serves as a basis for discussion and feedback within the community.

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List of Abbreviations and Acronyms

DER	Distributed Energy Resources
DSM	Demand Side Management
DSO	Distribution System Operator
EC	Energy Community
P2P	Peer-to-peer
PED	Positive Energy District
PEN	Positive Energy Neighborhood
WP	Work package
ZEN	Zero Emission Neighborhood

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1 Introduction

1.1 Purpose of the document

The first call of JPI Urban Europe on Positive Energy Districts and Neighborhoods (PED/PEN) (JPI Urban Europe 2020) challenges the four funded projects (Cities4PEDs, PED-ID, TRANS-PED and INTERACT) to join efforts, ambitions and exchange their knowledge in order to contribute to the overall goal of reaching and establishing 100 successful PED projects across Europe by 2050 (JPI Urban Europe n.d.).

Within the INTERACT project, the focus lies on establishing a guideline for the design and implementation of a specific Energy Community based on a holistic architecture approach, laying the foundation for Positive Energy Districts (PEDs) in a generally applicable version and in two special cases for the two focus areas in Austria and Sweden.

This Deliverable comprises the results from an analysis of the state of the art of PED ambitions and their international stakeholder community as a baseline for the future holistic design of energy communities. The goal is to draw from experience of existing and already implemented PED projects as a knowledge basis and a foundation for reflections on success factors and challenges on the pathway to developing projects with a plus energy ambition. The PED- booklet "Europe towards positive energy district" (Gollner et al. 2020) with its collection of projects with PED ambitions across Europe at different implementation stages and their structured description was the starting point for our assessment in this task, and builds, through the collaboration with JPI Urban Europe, one of the crucial reference points.

The focus of our project assessment lies in the three countries represented in the INTERACT project consortium – Austria, the Czech Republic and Sweden. Each of those countries have a heterogeneous scene of project developments within their regulatory framings, their national and municipal ambitions, as well as a rich network of stakeholders and experiences from past energy projects. It is the goal of this Deliverable to present the results of our analysis of the background of these three countries, show and analyse selected PED approaches, give insights on the competences applied in those approaches, and lastly, summarize those country specific insights. INTERACT helps the emergence of Energy Communities as one important building block to achieve Positive Energy District. Therefore, a reflection on the potential learnings and current perspectives on energy communities was addressed during desk research and interviews with project representatives in order to contribute to the overall project goal of analysing energy communities as a building block for PED and PEN approaches, thereby building bridges between the so far distinct research foci and communities.

Additionally, it is the ambition of INTERACT to complement insights on projects with regard to the knowledge building components in the PED/ PEN community in creating a competence map of PED personnel, as well as updating and reflecting on experiences, success factors as well as challenges in the projects pathway towards becoming a plus energy project. As Bossi et al. (2020), capacity-building among decision-makers was mentioned frequently as a factor that determines successful implementation of PED

projects. The need for an analytical approach and guidance on the content of said capacity building in form of the identification of competences, disciplines but also informal skills that are core qualities to be invested in project development seems to be of high relevance in the still very dynamic field of PED. Results of such an analysis might support not only decision-makers but also project developers, and other crucial stakeholders in PED/ PEN approaches in forming their teams, investing in education and staff training throughout the process.

Lastly, the analysis of projects in the three participating countries fostered a direct communication, knowledge exchange and connection between project personnel and introduced researchers and actors from PED approaches towards one another, thereby creating a knowledge community, which offers the possibility for joint learning and feedback opportunities. This Deliverable is considered as a documentation of perspectives and analysis at a certain moment in times, namely during summer 2021. It does not claim to be conclusive and includes various ambitions that are still work in progress. Therefore, this deliverable serves as a basis for discussion and feedback within the community.

1.2 Relation to other project activities

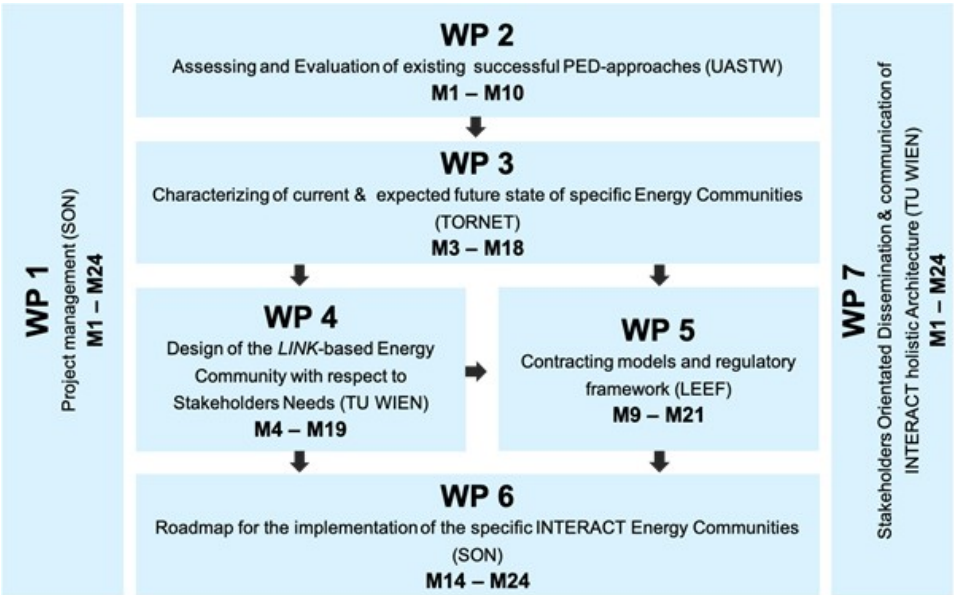


Figure 1: Overall structure of work program of INTERACT

The assessment and evaluation of existing PED and PEN approaches in work package (WP) 2 is one of the starting points for the complete work program of the INTERACT project, see Figure 1. It comprises an in-depth state of the art research process with various analytical steps on work done in the area, highlights the different existing PED approaches, and is evaluating and analysing them in order to describe and conclude success factors for future implementations. The discussion of success definitions and factors of reaching said goals will follow this task and will be presented in the deliverable D.2.3. of this project: „Key success factors and requirements for INTERACT energy communities“. It relates results from the analysis with a reflection on the derivation and application of relevant success factors for

INTERACT demo regions and ensures transfer of know-how within the established competence network.

1.3 Structure of the document

The Deliverable is structured in three main parts: firstly, an introduction to PEDs and the approach taken as basis for research, followed by the description of methods applied. Secondly, the description of projects with PED ambitions in chapter 3 presented in a structured manner and sorted by country, starting with Austria, followed by the Czech Republic and Sweden. Thirdly, the focus is set on PED as a knowledge network from various disciplines by a theoretical approach on competences and building up competences, as well as results on a competence mapping analysis within the presented PED projects. The Deliverable ends with a short summary of relevant insights and a discussion of limitations and further questions that could contribute to INTERACTs project work as well as to the PED knowledge community.

2 European PED approaches

The SET-Plan, adopted by the European Union in 2008 and revised in 2015, was a first step to establish an energy technology policy for Europe, with the goal of accelerating knowledge development, technology transfer and up-take to achieve Energy and Climate Change goals (SETIS 2021). The SET-Plan focuses on 10 key actions fields, of which action 3.2 on "Smart Cities and Communities" aims to support the planning, deployment and replication of 100 Positive Energy Districts by 2025 for sustainable urbanization (SETIS 2018, p. 1). Such PED/PENs could be new developments, but should also implement ambitious solutions for urban district renewal.

2.1 The process of establishing a PED definition

The reference framework of Positive Energy Districts (PED)/ Positive Energy Neighbourhoods (PEN) is defined in the "White Paper on PED Reference Framework" (JPI Urban Europe / SET Plan Action 3.2. 2020) as "energy-efficient and energy-flexible urban areas or groups of connected buildings which produce net zero greenhouse gas emissions and actively manage an annual local or regional surplus production of renewable energy. They require integration of different systems and infrastructures and interaction between buildings, the users and the regional energy, mobility and ICT systems, while securing the energy supply and a good life for all in line with social, economic and environmental sustainability." (ibid.) Positive Energy Districts and Neighborhoods are an integral part of comprehensive approaches towards sustainable urbanization including technology, spatial, regulatory, financial, legal, social and economic perspectives while optimizing three key aspects: energy efficiency, energy flexibility and energy production towards climate neutrality and energy surplus.

Until recently, a minimal consensus of a PED reference framework, with few common indicators (such as primary energy demand) for defining PEDs was given in order to accommodate local conditions and give way for various approaches of reaching and monitoring PED (Bossi et al. 2020). Various efforts for a joint definition on virtual and geographic boundaries as well as indicators on building performance and energy consumption are currently under discussion, e.g. through the JPI Urban Europe activities, IEA EBC Annex 83 activities and various other European and international networks (Hedmann et al. 2021). Next to the quantitative criteria of a positive energy balance (including its calculation methodology and boundaries), also qualitative criteria and complementary context factors are intended to be included (Alignment Core Group PED definition and integrated approach, 2021). For this deliverable the selection of project was done by its self-definition of ambition to reach PED goals. Furthermore, projects were included, that are not labelled plus energy however have interesting features that could contribute to this goal in the long-run (similar to the distinction of project selections in Gollner et al. 2020). Thirdly we added projects that provided relevant features that could be of interest in bringing PED ambition with energy community ambitions together. These projects were chosen also for their relevant insights for the two INTERACT demo regions and potentially relevant

networking communities. Therefore, our approach is less focused on the exact definition PED, their system boundaries or monitoring measures applied to ensure reaching the energy balance therein. Accordingly, projects definition of PED was not evaluated or matched with existing PED definitions. This broad perspective proves to bring in a rich variety of insights of projects pathways towards setting and establishing their ambitious goals and highlights learnings from the discussion of challenges and success factors.

2.2 Drivers and barriers for PED ambitions

Systematic approaches for analysing already implemented project approaches have been taken within the, above mentioned, PED booklet in which a framework questionnaire asked project representatives to also reflect on experience in establishing the PED through success factors and challenges in their PED projects and projects towards PED (Gollner et al. 2020, Bossi et al. 2020). Additionally, publications from work of the IEA EBC Annex 83 on Positive Energy Districts (Hedman et al. 2021) gives an analytical overview on challenges in PED.

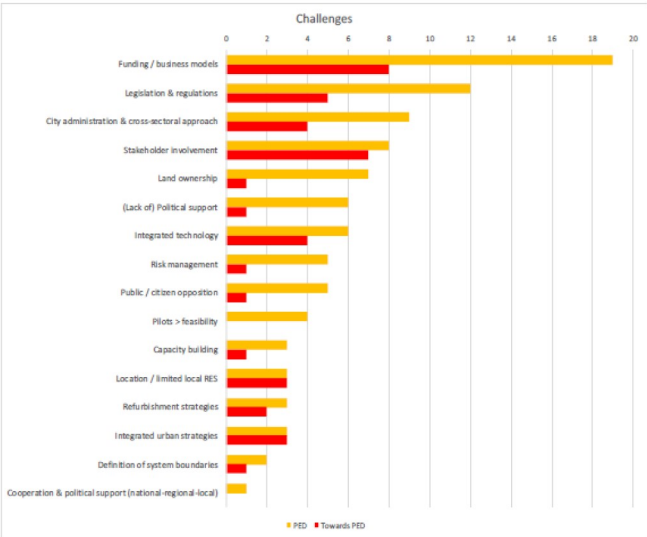


Figure 2: Challenges and barriers for implementation of PED and To-PED projects (Bossi et al. 2020)

Topic	PED in Planning	PED in Implementation	PED Implemented/in Operation
Administrative & Policy	Conflicts between different authorities involved in the project	Political management	Approvals and permits from municipality and other entities might lead to project timeline extension
Legal & Regulatory		Regulatory framework which governs involved actors throughout Europe	Regulatory barriers for piloting/testing
Technical	System boundary conditions defined Coping with rapid growth of new technologies	Identification and deployment of local feasible clean energy systems	Analysis required for hybrid energy system operations Analysis required for underground seasonal energy storage Energy generation system is far away from the consumers Thermal mining challenges in the urban areas to reduce the distance from energy generation system far away The electricity supply examined properly above 90 degrees Disallowing inefficient and high polluting energy generation systems
Environmental			Cultural differences between different cities involved in the partnership
Social & Cultural			
Information & Awareness		Local citizen acceptance towards new things in rural areas	
Economical & Financial	Economic feasibility Finance availing according to the project timeline	Finance dependence on private investors Local finance	
Stakeholders interest	Overlapping implementation with local ongoing constructions Encouragement of project drivers like real estate developers Uncertainty in stakeholder's commitment	Stakeholders and involved actor's commitment towards project goals Creating interest in project drivers like building owners and landlords	Conflicts due to lack of common interest between different landowners Strong collaborations needed between energy companies and real estate developers for fast implementation
Others	Active consideration of local knowledge Lack of supporting studies/knowledge for planning	Lack of supporting studies/knowledge for implementation	

Figure 3: Challenges and barriers in different stages of PED projects according to the main topic (Zhang et al. 2021)

Figure 2 and 3 show structured results of the challenges and barriers identified, emphasizing the frequency of mentioning some topic categories by Bossi et al. 2020 for PED and Towards PED projects, while Zhang et al. 2021 sort mentioned issues by topic as well as stage of development of analysed PED (Planning, implementation and in operation). Thereby, those two perspectives complement each other showing a quantitative dimension of challenges by frequency, as well as the rather descriptive aspects in Figure 3.

Central issue with high frequency is financing and business model of PED implementation, mentioned in both sources. "The economic and financial feasibility was crucial in both planning and implementation stages as well as supporting studies or knowledge." (Zhang et

al. 2021). In addition to funding the political commitment connected with relevant funding was considered as one of the central aspects for PEDs in Bossi et al. (2020).

Also, the aspect of stakeholders received much attention in both sources, these considered the involvement of stakeholders at all stages and Bossi et al. even mention "involvement processes (urban stakeholders, citizens) can be seen as defining elements for the success or failure of a project."(2020). Barriers showed a certain relevance at different stages of the development, while the regulative and legal aspects defined the planning, implementation and operation, barriers regarding environmental, social and cultural aspects only in the operation stages (Zhang et al. 2021). They also pointed out that "PED is highly dependent on local context with many impacting factors, such as the available renewable energy sources, energy storage potential, population, energy consumption behaviour, costs and regulations, which affect the design and operation of PEDs in different regions."

A report on the Zero Emission Neighborhoods (ZEN) contributes to the literature basis of drivers and barriers (Backe and Kvellheim, 2020). The concept of ZEN is relatable to PED as at its core it concerns the energy balance of an area (neighbourhood, district, quartier) with buildings that produce enough energy to compensate emissions from the building through its lifetime. Additionally, also European building regulations on nearly zero energy buildings with a neutral energy balance of energy production and requirement throughout the year is at the core of this definition.

As mentioned before, stakeholder involvement was frequently discussed as both relevant for the success, yet also as one of the challenges in PED approaches. Backe and Kvellheim (ibid.) illustrate in Table 1 the aspects of stakeholders' relevance further, and give relevant drivers that are decisive for success, yet their lacking may burden the projects development and therefore are considered highly relevant aspects for success or failure of a project. Drivers are assigned here to three different stakeholder groups: society and policy (S), infrastructure and supply (I), and owners and developers (O). The largest number of drivers is attributed to the group "society and policy" (row S in grey). There are two drivers, that have relevance to all of those three stakeholder groups, namely efficient investment in integrated networks based on smart meter data, as well as key personnel.

Table 1: A list of ZEN drivers and their relation to three stakeholder groups (Backe and Kvellheim 2020)

S	I	O	DRIVERS
		1	Attractive area as part of a larger project
		2	Extra value (in addition to energy and climate)
		3	Ambitious building- and area developers
	1	4	An innovative approach by the industry
	2	5	ZEN relevant technology development and cost reductions (e.g. solar PV)
1	3	6	Key personell
2	4	7	Efficient investments in integrated energy networks through smart metering
3		8	Building and construction agreements and contracts
4		9	Cooperation between municipality and building developer
5		10	Living labs can provide insight into how technology is used and understood
6		11	Budget incorporating ZEN measures
7		12	Municipalities and other building owners that build pilot projects
8		13	Engaged, involved and motivated citizens and communities
9		14	A broad framework which allows the inclusion of numerous different processes
10	5		Reduced need for grid investment (e.g. exploiting energy and flexibility mechanisms within the neighbourhood)
11	6		AMS/Elhub provides larger potential for new business models and demand response schemes
12	7		Higher export of renewable energy from Norway
13			Ambitious targets and standards on a national level
14			EU regulation and policy targets
15			External funding
16			Best practice cases (ZEN pilots)
17			Allocation of welfare through distributed energy resources

Note: Society and policy (S), Infrastructure and supply (I) and Owners and developers (O)

2.3 Energy Communities as a building block for PED/PEN

Climatic conditions worldwide force the comprehensive integration of renewable and distributed energy resources into the power system, as well as the effective use of energy and of the existing infrastructure. Business models in the energy sector are changing and becoming more customer-centric: The customers play an active role in energy supply (Stoverinck 2020). The way in which the power grid should be managed is changing, as also the rate of change in the electric power industry accelerates annually (Henderson et al. 2017). Driven by reduced costs of solar PV and storage Energy Communities are on the rise and disrupt the energy value chain, pushing energy retailers and DSOs towards deep transformation (Héliot 2017).

This deems of relevance, since the PED approach focusing on neighborhoods, various buildings, even districts or communities shows already various relevant insights on the relationship of stakeholders, the challenges of technical, organizational, regulatory, and social integration of various interests into overarching strategies.

Investments in sustainable infrastructure, production of green electricity and heat, social & environmental sustainability or self-sufficiency are drivers for the establishment of energy communities (Caramizaru and Uihlein 2020), which shall lead to the establishment of Positive Energy Districts and Neighborhoods.

Energy Communities have been currently formally acknowledged and defined within Europe as “renewable energy communities” and “citizen energy communities”, with the revised

Renewable energy directive (2018/2001/EU) and the Directive on common rules for the internal electricity market ((EU) 2019/944) which are currently being implemented within national law in the different European countries. At the same time a further revision of the Renewable energy directive was brought forward in July 2021, proposing to raise the target of renewables to 40% by 2030, further fostering the transformation of the energy system (European Commission 2021).

The European Commission is describing Energy Communities as follows: „Energy communities organise collective and citizen-driven energy actions that will help pave the way for a clean energy transition, while moving citizens to the fore. They contribute to increase public acceptance of renewable energy projects and make it easier to attract private investments in the clean energy transition. At the same time, they have the potential to provide direct benefits to citizens by advancing energy efficiency and lowering their electricity bills. By supporting citizen participation, energy communities can moreover help in providing flexibility to the electricity system through demand-response and storage.“ (European Commission 2020).

With the increase of renewables in the energy system as stated above, and the planned increase of electrification of energy (direct use of low-emissions electricity) as one of the most important drivers of emissions reductions (IEA 2021), the pressure and demands on electricity grids are increasing.

The implementation of Energy Communities in line with the European Directives is bringing a new actor into the electricity markets, and presents itself as a tool for citizen motivation, awareness raising, for increased financial benefit of local electricity generation and aligned consumption, and for further related positive impacts on the energy transition. All of these positive effects are clearly supporting the build-up of a PED/PEN.

Furthermore, and in line with the INTERACT approach, holistically structured energy communities can also support the regulation of Low Voltage electricity networks, helping to increase the usable capacity of the grid and helping to avoid congestion by improving the overall performance of reactive power control (Schultis et al. 2019).

The necessary ICT structure for a balanced and optimized electricity grid might therefore be one of the ICT systems to be integrated in a PED, enabling direct and indirect electricity services needed for an optimized usage of local resources and an optimized local energy balance. Having a holistically designed and structured energy community in accordance with the INTERACT project and the *LINK*-architecture increases the capacity of DER with the given power grid, offers energy services like flexibility trading, and therefore supports the ambitions of specific districts of neighborhood in becoming PED/PENs.

2.4 Methodology

WP 2 aims to assess the state of the art of current PED approaches and establish a network of international PED community in order to foster the knowledge exchange and learning opportunities. Focusing on assessment criteria for success of PED projects, and based on

existing project experience, this task aims to serve as a basis for the INTERACT projects process in developing a Road map for Energy Community implementation.

2.4.1 Identification and characterization

A first step aimed at the identification of European projects with PED ambitions with potential, this task was conducted through desk research and existing collections of projects were taken as a starting point. As stated above, a broad approach definition was taken in order to identify in projects that have PED ambition, yet also integrate projects focusing rather on their goal of an energy community. In the initial list of projects, PEDs/PENs, ZENs, ECs, smart city development projects as well as European eco villages were included. Identification of projects was therefore conducted through journal publications, internet search engines, on platforms displaying best practices (e.g. viable cities) and funding agencies (e.g. H2020). Search terms and keywords used were: PED, PEN, positive energy, plus energy, carbon neutral districts, local energy market, energy community, best practice... The identification process was a joint effort of all project partners in order to grasp different perspectives and apply a broad strategy for reaching different networks, national backgrounds and funding agencies projects. Each identified project was added in a pre-formatted excel sheet and characterized with its main information indicating the following information/ criteria to be filled out.

- Name, location, country of the project
- Stage of implementation
- Type of project
- Start date of project
- Green field or established project
- Project contact information and web links
- Initiators and organizations involved
- Funding agency (if given)
- Was it already included in JPI Booklet?

A list of over 60 projects and initiatives was identified through this process.

The second step was to select relevant projects for further investigation; therefore projects were chosen if they are based in one of the three countries of our consortium partners (Austria, Czech Republic or Sweden). Further selection was done based on status of the project development, giving preference to those who have are already in implementation or operative. Additionally, projects with mention of energy community approaches, local energy trading, flexibility trading, P2P trading intentions were included additionally. In all three countries, the stage of regulative implementation and pilot projects on energy communities vary; while in Austria a legislative change gave way for first actual implementations in fall 2021, both Sweden and the Czech Republic have not yet a legislative basis. Consequently, not all projects were in the stages of implementation. Yet, the inclusion of early-stage projects in relation to plus energy approaches deemed necessary anyhow for the sake of the projects focus on the relationship and alignment of both plus energy strategies and local energy markets.

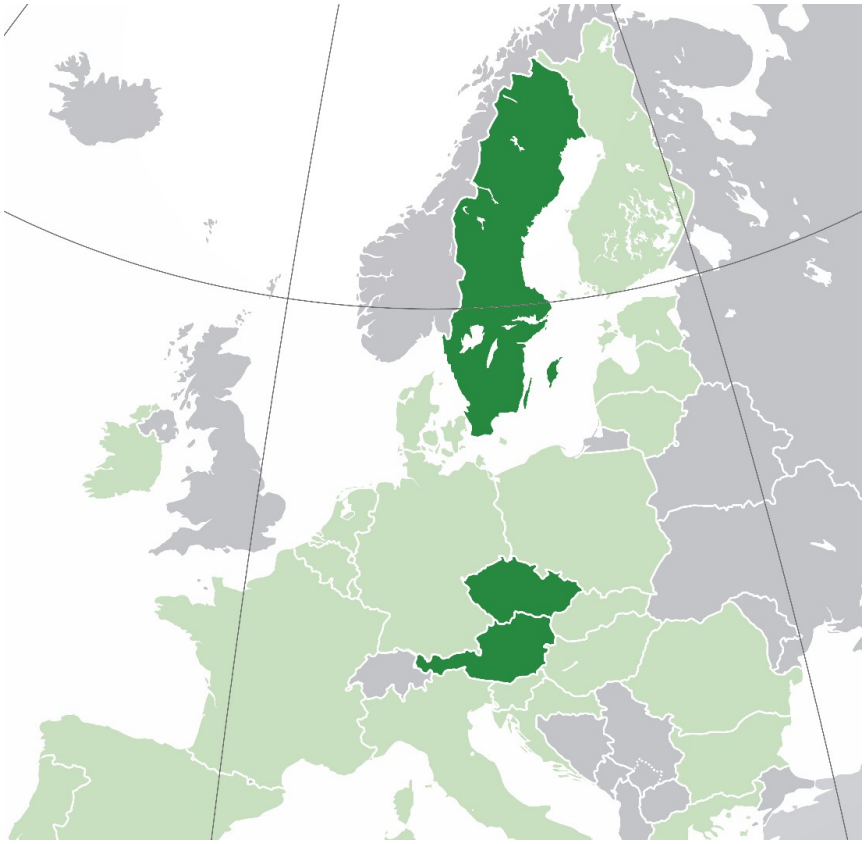


Figure 4: Country focus: Austria, Czech Republic, Sweden

2.4.2 In-depth analysis & Interviews

Selected projects from the three countries were further investigated through desk research, document analysis and described further in regard to their ambitions and implementation for energy and building performance, the energy provision. If applicable, their ambitions in regard to plus energy, regional energy systems, energy community and flexibility trading was described. Further aspects were covered by check-boxes indicating whether certain aspects were mentioned as their goals or to define further ambitions, similar to approach in JPI booklet. Focus was also to identify stakeholder and involved actors within the projects, identify their roles as well as discipline background, if available, as a basis for the competence mapping process (see chapter 4.2).

Interviews with project managers of various of the selected projects were conducted in order to further understand process of project, and reflect on crucial aspects for success, challenges, drivers and barriers. The process of agenda setting towards plus energy, interactions of stakeholder network, as well as definition of their success and how they monitor this (KPIs, data monitoring etc.) was discussed. Additionally, interviewees perspective on future implementation of energy communities within their approaches, as well as relevant competences in their projects were discussed. Results mentioning personal

skills, disciplines or competences that have proven to be crucial for the successful development have been taken as input for competence mapping as well.

Results from desk research and interviews have been summarized per project in a table format as displayed in chapter 3.

3 Analysis of PED ambitions

This chapter gives a structured overview on results from the analysis and interviews with PED and Towards PED Approaches sorted by country, starting with Austria, followed by the Czech Republic and Sweden.

3.1 Austria

In Austria we found and selected PED and PEN related projects and approaches in the following cities:

- Graz
- Innsbruck
- Maria Rain - Rosental
- Vienna (multiple projects)
- Wörgl

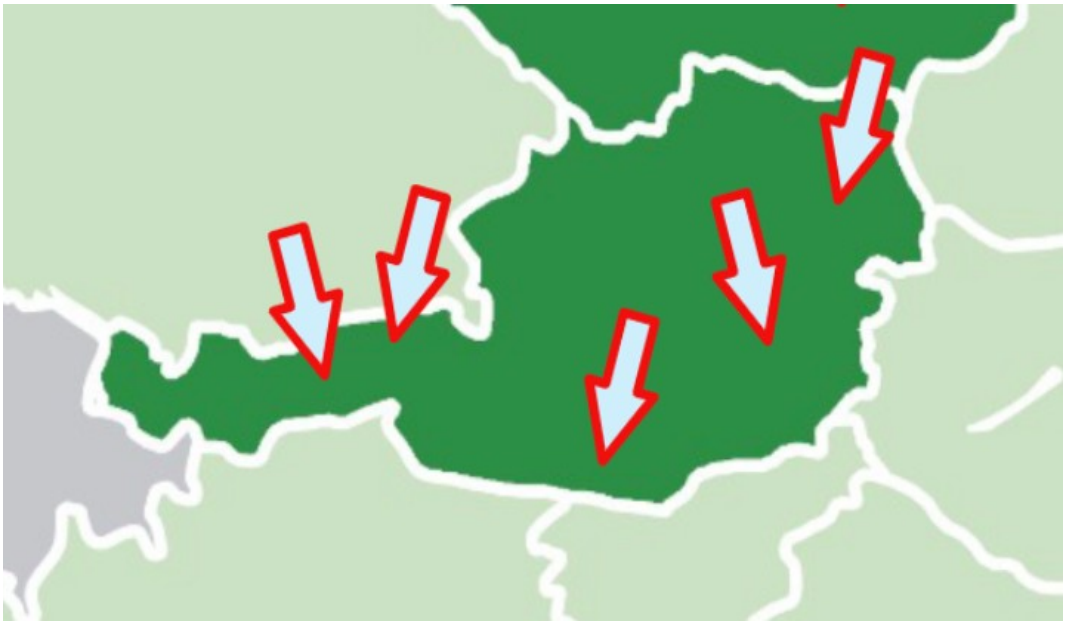


Figure 5: Location of Austria projects

3.1.1 Südtiroler Siedlung, Smart City Wörgl

Within its development project "Südtiroler Siedlung" the city of Wörgl was re-creating an energy optimized residential area: within the city in several buildings stages an old, outdated residential block gets replaced by new residential buildings. Passive house standard for the new buildings, own PV electricity production, battery storage and other optimizations are helping with the reduction of the ecological footprint and optimization of the energy balance.

Table 2: Südtiroler Siedlung, Smart City Wörgl

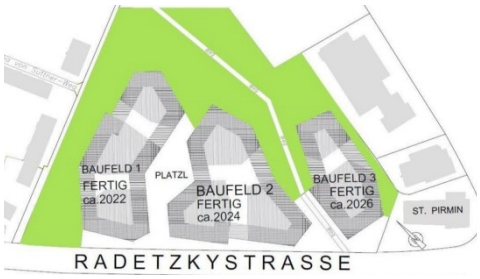
Location: Wörgl Timing: 2011 – 2012, implementation until 2025 Size of project: 2,7 ha Status: Implemented, In Operation Mixture of Usage: Newly build and existing neighborhood Status JPI Booklet: not included yet		
Initiator:	Stadtwerke Wörgl	Supplies electricity, heat, water, internet access, solves waste removal and offers mobility services, energy efficiency consulting and other services to citizens of Wörgl.
Funding:	Austrian Klima- und Energiefonds	
Actors involved:	Neue Heimat Tirol, City of Wörgl, University of Innsbruck, meo Smart Home Energy, Bluesky Energy	City Management, Housing Company, Research institutes, Smart Home Communication Technology, Battery and Storage Solutions
Stakeholder and Citizen Engagement	In accordance with the vision and mission of Wörgl, the new city development region "Südtiroler Siedlung" was going to be developed with a combination of modern technologies, which shall achieve in its combination a smart and energy efficient city district: distant heating from industrial waste heat and heat storage, photovoltaics including saltwater battery storage, ICT solutions for households, smart loading of e-cars and mobility services, and of course passive house buildings standard for all newly build houses	
Energy system		
Decentral/ local (renewable) resources: Y **Regional energy system: Y**	The project coordinator is the regional energy system provider and took care of this part: distant heating system with storage and usage of industrial waste energy; photovoltaics with storage and maximization of own usage of energy. Regarding the possible usage of geothermal energy, a study has been done, but the needed useful layers within the ground have been too deep, therefore this source of energy was dismissed for this city district.	
Plusenergy: Y	Thanks to passive house standard of the buildings, and an 29kWp photovoltaic installation on the buildings with 40kWh storage capability and further solutions to reduce distribution losses, the energy balance was optimized. Wörgl itself was setting a target to become energy independent (=producing more energy with local resources than consuming). As the project did not focus on plus energy, no calculation or measuring towards this topic has been done.	
Energy community, P2P trading,: Y **Flexibility trading: N**	Within the newest Smart City Project of the city an energy community together with the housing company "Neue Heimat Tirol" and renters of at least one building block is planned. Currently the project managers are waiting for the legal grounds to found the energy community. In the long run, the whole city district should be involved.	
Overarching strategies	Zero emission: ☐ **Energy neutrality**: ☒ **Energy efficiency**: ☒ Carbon free: ☐ **Climate neutral**: ☒ **Sustainable neighborhood**: ☒**Social aspects/ affordability:** ☐ Other: **Self- sufficiency**	
Further goals	**Building**: ☒ Materials: ☐ Renovation/refurbishment: ☐ **Sustainable production**: ☒	

and ambitions:	**Sustainable consumption/ procuring**: ☒ **(local) administration**: ☒ Legal framework: ☐ Business models: ☐ **Stakeholder involvement**: ☒ **Citizen involvement** ☒ indirect via housing company Other: **Mobility Services**
Success and ambitions	
Indicators and expected impact:	The targets of the project (development of a Roadmap and an energy development concept) have been achieved. Also, the implementation of the first stages of the city district has been achieved and the first buildings were handed over to the users in 2019.
Actual success & experience	Wörgl with its target of energy independence was far ahead in this area in comparison with other cities and municipalities in Tirol. Wörgl is e5 municipality, and also the project initiator Stadtwerke Wörgl is a certified "Klimabündnisbetrieb". Thanks to the close cooperation with the housing company within this project, a lot of understanding of the needs and possibilities of the project partners was developed, which lays a good ground for future projects and future collaboration.
Challenges and barriers	In order to have the legal grounds for moving forward, the formal commitment of the city council is needed, which has to be confirmed yearly. In the area of mobility, this commitment is not available currently. The target of bidirectional loading of e-cars was not achieved, as this was not supported by the e-cars within the project period, but would be possible nowadays. When the project received the funding decision, the housing company had already started with its planning and partially even building stage. A shorter period for evaluation would have been appreciated. Within this specific project, the ownership of the area was in two hands: partially with the housing company, and partially with the City of Wörgl. This was leading to frequent negotiations between these two parties, and was taking time and effort.
Sources: Links: https://smartcities.at/projects/suedtiroler-siedlung-smart-city-woergl/ https://www.energy-innovation-austria.at/article/smart-city-woergl/ https://www.woergl.at/aktuelles/news/smart_city_woergl_wird_realitaet Interview: Teuschel, P. 17.06.2021. Stadtwerke Wörgl.	

3.1.2 Smart City Campagne Reichenau, Innsbruck

The city development project "Campagne Reichenau" is going to establish 1.100 new apartments in the city of Innsbruck and is therefore a central part of the city development strategy. Currently the first stage is in construction and shall be handed over to the new users in 2022. Passive house standard, close by infrastructure and social inclusion, or ecologic heating and cooling are some of the innovative aspects of this project.

Table 3: Smart City Campagne Reichenau, Innsbruck

Location: Innsbruck Timing: 2016 – 2020, implementation until 2029 Size of project: 8,4 ha Status: Implemented, In Building Stage Mixture of Usage: Newly build Status JPI Booklet: not included yet		
Initiator:	City of	City of Innsbruck together with its specialized real estate company

	Innsbruck	IIG (Innsbrucker Immobilien GmbH) and partly owned social housing company Neue Heimat Tirol
Funding:	Austrian Klima- und Energiefonds	
Actors involved:	Neue Heimat Tirol, Innsbrucker Kommunalbetriebe AG, University of Innsbruck, Bogenfeld Architektur ZT GmbH, regional building companies	City Management, Real Estate Development, Social Housing Company, City Community Services, Research institutes, Architects
Stakeholder and Citizen Engagement	The city development project was from the beginning aimed to integrate opinions and needs of local stakeholders and future citizens. Several events have been organized to gather ideas and suggestions. The planning was done in a cooperative way, where citizens from the neighborhood but also from whole Innsbruck where able to participate. 3 brochures have been developed for different target groups to get their vision of ideal living conditions. During the implementation stage a regular meeting opportunity has been established. And for the handover of the new buildings to their new users, a guide will help to trigger energy efficient behavior from the beginning of the new living environment.	
Energy system		
Decentral/ local (renewable) resources: Y **Regional energy system:**	For all four development stages a sustainable energy supply is planned. Heating will be solved with water-water heat pumps, PV on the roof shall cover electricity needs of airing and heat pumps, DHW will be powered by regional distant heating system, which is using industrial heat waste and ecologic energy.	
Plusenergy: **Y**	The basis for plus energy objects has been done: certified passive house building standard, helping users to optimize their behavior in an energy efficient way, using state of the art technology for energy efficient operation of the building. But due to the small roof area and not enough space for enough PV, a real plus energy building cannot be achieved.	
Energy community, P2P trading,: **Y** **Flexibility trading: N**	Next to the development projects are schools and kindergartens situated, which are equipped with PV. The excessive produced energy shall be used by the new buildings within an energy community. As there are still several open legal questions due to the new law, not everything is prepared yet, but the goal is to have a clear path how to establish the energy community until end of 2021.	
Overarching strategies	Zero emission: ☐ **Energy neutrality**: ☒ **Energy efficiency**: ☒ **Carbon free**: ☒ **Climate neutral**: ☒ **Sustainable neighborhood**: ☒**Social aspects/ affordability**: ☒ Other: **Ecological Quality, Renewable Energy,** Building and living in line with the 2000-Watt society[1]	
Further goals and ambitions:	**Building**: ☒ **Materials**: ☒ Renovation/refurbishment: ☐ **Sustainable production**: ☒ **Sustainable consumption/ procuring**: ☒ (local) administration: ☐ Legal framework: ☐ Business models: ☐ **Stakeholder involvement**: ☒ **Citizen involvement** ☒ Other: **Mobility services**	
Success and ambitions		
Indicators	Within the project an energy center has been established for the buildings, where heat and	

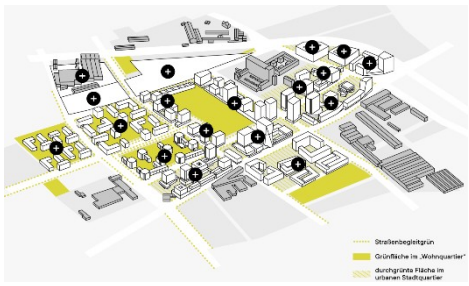
[1] https://ourworld.unu.edu/en/2000-watt-society

and expected impact:	electricity are monitored. The energy related targets of the project have been realized in the implementation stage now to 100%. The city district shall be certified with a "klima:aktiv" certificate with an overall rating in line with a 2000-Watt society.
Actual success & experience	With the project, a holistic planning has been achieved in accordance with the feelings-certification, especially during the architecture competition. With the results of the architecture competition, a lot of cornerstones are set, which cannot be changed anymore afterwards. Therefore, it is important to include environmental targets already in this early stage. In the meantime, a guideline was formally issued by the city council of Innsbruck, that all new development requests have to be checked on the environmental fit as well.
Challenges and barriers	Due to political change within the administration of Innsbruck there was a short delay of the project, otherwise there are no issues anyhow.
Sources: Link: https://www.stadtteilzentrum-reichenau.at/de/campagne-reichenau/campagne-reichenau/29-0.html https://www.energy-innovation-austria.at/article/campagne-reichenau-innsbruck-2/?lang=en https://blog.innsbruck.info/de/kunst-kultur/campagne-reichenau-ein-stuck-stadt-bauen/ Interview: Gstrein, H. 22.06.2021, Innsbrucker Immobilien Gesellschaft.	

3.1.3 City District Graz Reininghaus, Smart City Graz

Graz is having with the area "Reininghausgründe" its biggest city development project, which will be ongoing for several years in various stages. The planning stage was including strategic energy planning and using existing industrial waste energy for heating and powering of the district. Within the realization of the single building blocks, different private development companies will create their innovative projects based on the aims and targets set by the city of Graz.

Table 4: City District Graz Reininghaus, Smart City Graz

Location: Graz Timing: 2012 – 2014, implementation ongoing Size of project: 100 ha Status: Implemented, In Building Stage Mixture of Usage: Newly build and mixed usage Status JPI Booklet: yes, already included		
Initiator:	Asset One Immobilienentwicklungs-agentur	Former owner of the area
Funding:	Light tower Project "Energy City Graz-Reininghaus (ECR)", BMVIT, and further Austrian Klima- und Energiefonds	
Actors involved:	Stadt Labor Graz, Technical University of Graz, AEE Intec, architects, housing companies, Energie AG	Depending on the topic of the different subprojects: City Management and Research institutes during probing stage, afterwards real estate developers, architects, energy system planners, utilities, etc.
	Board of owners Reininghaus, c/o Kampus Raumplanungs- und Stadtentwicklungs GmbH, Graz	
	Contact Person City of Graz: Kai-Uwe Hoffer	

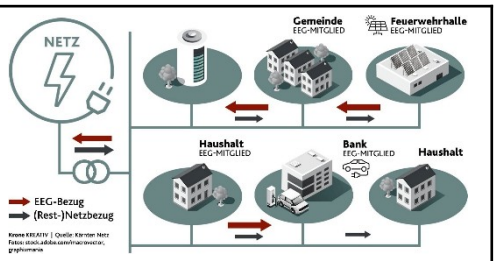
Stakeholder and Citizen Engagement	Text description of citizens, households, stakeholders were involved in the project (How are citizens, end-users, households and other stakeholders involved in the project? Who was co-producing, co-creating the projects goal? Who was consulted? Who received information?) As this is a huge area within the City of Graz, a long period of planning was performed, and all relevant stakeholders for the different types of usage have been involved: at the beginning city planner, road planner, sociologists, green area planner, etc. State agency for erecting new schools, city agency for erecting new sports facilities, social services, and many more. Citizen engagement was not possible, as this was a huge green field project, where agricultural grounds have been transformed into a new city district.
Energy system	
Decentral/ local (renewable) resources: Y **Regional energy system: Y**	Energie AG is the local energy utility company. The main supply of heat is secured with a low temperature distant heating network, which is powered by the steelworks Marienhütte. All project development partners have signed to use this distant heating network as energy source within their relevant subprojects of the area. Furthermore, there will exist PV installations, and geothermal probes. Distant cooling during summer was discussed, but dismissed, as it is financially not feasible.
Plusenergy: Y	The aim for the city district is to produce more energy throughout a year then there will be consumed, without considering mobility. To achieve this, a high amount of own produced energy is needed, and different renewable energy sources need to be used. The individual concepts have to be developed by the different real estate developers of the different sub projects.
Energy community, P2P trading,: Y **Flexibility trading: N**	During the planning stage of the project, energy communities were not possible. As there is the new legislation currently being finished, the base for such communities is here. The city of Graz will support energy communities, but the different development companies have to include this in their planning and finance it.
Overarching strategies	**Zero emission**: ☒ **Energy neutrality**: **Energy efficiency**: ☒ Carbon free: ☐ **Climate neutral**: ☒ **Sustainable neighborhood**: ☒Social aspects/ affordability: ☐ Other: **Self Sufficiency**
Further goals and ambitions:	**Building**: ☒ **Materials**: ☒ Renovation/refurbishment: ☐ **Sustainable production**: ☒ **Sustainable consumption/ procuring**: ☒ **(local) administration**: ☒ **Legal framework**: ☒ **Business models**: ☒ **Stakeholder involvement**: ☒ **Citizen involvement** ☒
Success and ambitions	
Indicators and expected impact:	This is a major city development project of Graz, where the whole infrastructure was necessary to set up and develop. Within sub projects, the individual blocks are developed in accordance with the city strategy for the area by different housing and real estate development companies. For the City itself it was important to have the access to major infrastructure enabled in time (public transport, streets, energy supply, etc), and in this field the development is progressing according to the plan. The development of the single blocks is in the competence of the various building owners.
Actual success & experience	The planning stage with the development of a systematic energy supply network of the whole area was vital, especially together with the contracts binding the future owners of the building blocks to use the developed energy system within their buildings. During the probing stage of the development project, different ways to solve the multiple use conflicts between industry and residential living

	have been applied. Thanks to the strategy of the City of Graz and the specific available infrastructure and companies around the area, a focus on optimal usage of energy was drawn from the beginning of the project.
Challenges and barriers	It takes a long time to prepare the ground for developing a completely new city district of this size in a systematic and optimal way. Within such a time-span, technologies and priorities may evolve or change. At the time being, the groundwork has been achieved within several years of planning. Now it is on the different building-owners to finish their individual projects and step-by-step bring the new city district to live.
Sources: Links: https://reininghausgründe.at/ https://de.wikipedia.org/wiki/Graz-Reininghaus https://www.graz.at/cms/ziel/8119891/DE https://www.oewg.at/graz-reininghaus Interview: Hoffer, K. 21.07.2021. Stadt Graz.	

3.1.4 MikroGrid, Maria Rain

In Maria Rain, a rather small municipality in Carinthia, the DSO of the region KELAG is implementing one of the first energy communities in Austria. Within the planning stage, discussions and simulations about usage of flexible energy has been done. The project results will be used during the implementation based on the new Austria Law EAG (Erneuerbaren Ausbau Gesetz).

Table 5: MikroGrid, Maria Rain

Location: Maria Rain, region Carnica-Rosental Timing: 2020 – 2021 Size of project: -- Status: ready to implement Mixture of Usage: Existing Neighborhood Status JPI Booklet: not yet included		
Initiator:	KELAG	DSO of the region
Funding:	FFG – Austrian Agency for Funding Research and Development	
Actors involved:	Bio Energy and Sustainable Technologies GmbH Myo Energy GmbH Municipality Maria Rain	Power System, Flexibility Optimization, Project Management.
	Project Management by Bio Energy and Sustainable Technologies GmbH	
Stakeholder and Citizen Engagement	One major goal of the project was to collect the feedback and needs of the various stakeholders regarding a potential energy community. Therefore, several meetings have been held to present the project, and workshops have been organized to gather information from the stakeholders. Citizen integration was not possible, as CoVid-19 was making the planned face-to-face interviews with private households impossible.	
Energy system		
Decentral/ local (renewable)	The main source of energy are PV installations, which are existing on various buildings in the municipality. The Energy Community should in an optimized way use the excess energy from these installations and try to use available flexibilities. A storage by power-	

resources: Y **Regional energy system: Y**	to-heat evaluated, as well as potential for optimization within the buildings.
Plusenergy: **N**	
Energy community, P2P trading,: Y	The project itself was about the establishment of an energy community in the best possible way.
Flexibility trading: Y	One of the project partners (Myo Energy GmbH) is specialized in flexibility trading and was performing simulations and calculations regarding this topic. Flexibility trading needs additional hardware in the system, as access to the identified flexible loads has to be established. Therefore, this adds chances for failures, and more need of technical assistance for the partners involved. A solution would be to first start with the energy community, and then, after some time of running, at flexibility trading as a separate stage of further optimization and savings.
Overarching strategies	Zero emission: ☒ Energy neutrality: ☒ **Energy efficiency**: ☒ Carbon free: ☐ **Climate neutral**: ☒ Sustainable neighborhood: ☐Social aspects/ affordability: ☒ Other: **Self Sufficiency**
Further goals and ambitions:	Building: ☐ Materials: ☐ Renovation/refurbishment: ☐ **Sustainable production**: ☒ **Sustainable consumption/ procuring**: ☒ **(local) administration**: ☒ Legal framework: ☐ **Business models**: ☒ **Stakeholder involvement**: ☒ **Citizen involvement** ☒
Success and ambitions	
Indicators and expected impact:	The project is already finished, and the aims and targets have been achieved. The necessary knowledge how to start with an energy community has been gained. Now the partners are waiting for the legal base in order to start with the real implementation of the energy community.
Actual success & experience	The entry barriers to the topic are still high, not because of the energy system, but due to the social aspects. For households which are not into energy business, thinking about an energy community and understanding its impact can be challenging. Everybody wants to save money but taking over responsibility is not that easy. Households cannot that easily replace the work of a utility company. When people are coming home from work, they want to relax and enjoy life, and not start doing the job of the utility. Social competence is very important, as the community has to come together in a legal form, e.g., within an association, where someone has to take over the lead and the responsibility. Then the accounting and energy trading has to be done in a transparent way, where people might start to quarrel. As system needs to be found, which is equal and fair to all members of the community. Here the experiences during operations will show, what is the best way to proceed. This cannot be planned easily ahead.
Challenges and barriers	Starting flexibility trading and energy trading at the same time without having the knowledge spread in the community might be too much at once. The suggested way is first to start with the energy community, settle the organizational and social processes and rules, and after this is working well, continue with flexibility trading as a second step.
Sources: Link: https://region-rosental.at/kem https://www.franzragger.at/ Interview: Wurzer, G., 30.06.2021. Kärnten Netz GmbH.	

3.1.5 Mühlgrundgasse, Vienna

In Vienna an innovative residential building block was realized in the street Mühlgrundgasse in the 22nd district. With a smart combination of modern building elements, a low-tech building was realized, which shall have a minimized energy footprint during operations. Cooling and heating are using the activated base plate of the building as well as the soil around the building as puffer storage. Passive house standard is reducing the needed heat energy, smart shading and the position of the windows are reducing excess heat in summer.

Table 6: Mühlgrundgasse, Vienna

Location: Vienna Timing: 2011 – 2019, Link: https://www.mgg22.at/informationen/ Size of project: 0,95 ha Status: In operation Mixture of Usage: Newly build Status JPI Booklet: not yet included		
Initiator:	M2plus Immobilien GmbH	
Funding:	Funding for innovative components during the building stage	
Actors involved:	Social housing company "Neues Leben", Architects Thalbauer, Architects Thaler Thaler, Architect Charamza, green space architect Barosch, Energy solutions Kuster, social planning wohnbund:consult, wind energy supplier WEB Windenergie AG, KNV Energietechnik, Porr Bau GmbH, Statics by Buschina Partner	Architects, Energy Systems, Social Planning, Construction, Energy Technology, Green space planning.
	M2plus Immobilien GmbH as project initiator	
Stakeholder and Citizen Engagement	The focus and main idea of the city block was set from the beginning by the initiator: low tech, community building in the housing block, community gardens for regional own supplies, energy efficiency. The targets have been developed afterwards by the specialized companies within the project team.	
Energy system		
Decentral/ local (renewable) resources: Y **Regional energy system:** **Y**	A low-tech energy system was realized. Excess energy from wind power is used to supply the 30 geothermal probes and its heat pumps. The concrete plates of the houses are acting as puffer storage and heating pipes are included in all concrete plates to activate them thermally. In the same way cooling is realized in summer, as 19-22°C warm water acts as cooling medium. The rather high temperature of the cooling helps keeping the efficiency of the whole system on a high level.	
Plusenergy: **N**		
Energy community, P2P trading,: **N**	Due to financial aspects, no PV installations are made. Consumers are having their own home management system, where they can heat and cool each room separately. Here the fine tuning of the system took a while, and the technology was not always working well at the start.	

Flexibility trading: N	
Overarching strategies	Zero emission: ☐ **Energy neutrality**: ☒ **Energy efficiency**: ☒ Carbon free: ☐ **Climate neutral**: ☒ **Sustainable neighborhood**: ☒Social aspects/ affordability: ☒ Other: **Self Sufficiency, Community Building**
Further goals and ambitions:	**Building**: ☒ **Materials**: ☒ Renovation/refurbishment: ☐ **Sustainable production**: ☒ **Sustainable consumption/ procuring**: ☒ (local) administration: ☐ Legal framework: ☐ Business models: ☒ **Stakeholder involvement**: ☒ Citizen involvement ☐ Other: **Low Tech**
Success and ambitions	
Indicators and expected impact:	There was a monitoring of the energy management and the heating and cooling system done for two years. Especially cooling in summer within a city is working very well and has positive aspects for the comfort of the users.
Actual success & experience	For buildings with proven low heat and cooling needs, the activated building components can work as the single heating and cooling system of the object. Main factors are the building hull, the number of used windows, and – especially for cooling – the shading and sun covers. The storage capacities of concrete enable storing heat and cooling over several days. Therefore, such a system is ideal for combining with renewable energy, as the system can be loaded when energy is available. With the according steering system, the percentage of renewable energy can be increased significantly. Thanks to using geothermal probes, the excess heat of summer can be stored within the ground, and at least partially used for heating in winter. It would be great to link the public funding for building residential houses also to the environmental impact of the operational costs.
Challenges and barriers	There has to be one person in the project, who is really motivated and wants to push it forward. Otherwise, the effort to achieve such unique results is too high and not economical. On the other side, this project shows, that with a person like Nobert Maier, innovative companies and mutual motivation, great projects can be realized.
Sources: Link: https://www.mgg22.at/informationen/ Interview: Thalbauer, P. 30.07.2021. Thalbauer Architekten.	

3.1.6 Zukunftsquartier 2.0, Vienna

Following a probing and evaluation project (Zukunftsquartier) that has already been included in the JPI booklet, a follow up project ZQ2 was conducted in which on the basis of the feasibility study the pilot project has been selected for in-depth planning. The pilot area in Vienna's 21st district (Floridsdorf) has been planned as a plus-energy quartier. The aim of the project is to develop a concept for the grid-friendly integration of innovative (plus-energy) quarters with high on-site energy generation into the existing grid infrastructure (electricity and district heating) - creating a "win-win" situation for utilities and network operators as well as for users, investors and developers. The project is about to end in Winter 2021 and submitted now the application for building permit to the city administration. A future project that will accompany construction and measures building performance has already been granted and will start in fall 2021.

Table 7: Zukunftsquartier 2.0

<table>
<tr><td colspan="2">Location: Vienna, Austria
Timing: 2021
07/2018 – 06/2019 start of construction: Q3/2021; Finalisation Q3/2024
Size of project: size?
Status: Planning
Mixture of Usage: Newly built, existing neighborhood
Status JPI Booklet: Yes (at earlier stage)</td><td>Pilzgasse planning and its different usage (Schöffmann et al 2020)</td></tr>
<tr><td>Initiator:</td><td>UIV Urban Innovation Vienna GmbH</td><td>Urban Innovation Vienna is a subsidiary of Wien Holding and the group's innovation hub. Research Expertise, Innovationhub, advises policy-makers and administrators.</td></tr>
<tr><td>Funding:</td><td colspan="2">Stadt der Zukunft (“City of the future” - a research and technology programme of the federal ministry of transport, innovation and technology. Along with the Austrian Economy service Corporation (AWS), and the Austrian society for environment and technology)</td></tr>
<tr><td>Actors involved:</td><td>Fachhochschule Technikum Wien,
IBR & I Institute of Building Research & Innovation ZT GmbH, SÜBA AG,
Böhm Stadtbaumeister Gebäudetechnik GmbH,
hacon GmbH</td><td>Research and project development;
Property Developer
Building technology and Planners
Software Developer</td></tr>
<tr><td>Stakeholder and Citizen Engagement</td><td colspan="2">Developers and the relevant city administration involved right from the start in exploration phase, throughout planning process until Building construction permit.
Experiences and needs of developers and property owners, studying of user behaviour to develop an integration strategy for future users has been conducted in the previous exploratory study. As part of the project, actors and stakeholders will also be involved in further potential plus-energy districts.
Development of a concept for the integration of future users with the aim to optimize the user behaviour towards minimization of potential negative effects on the energy system (1).</td></tr>
<tr><td colspan="3">Energy system</td></tr>
<tr><td>Decentral/ local</td><td colspan="2">Distributed solar PV generation, geothermal heat pumps
regional generation and consumption are prioritized</td></tr>
</table>

(renewable) resources: Y **Regional energy system: Y**	
Plusenergy: Y	Photovoltaic systems, geothermal heat pumps, flexibilities to facilitate the usage of renewable energy locally generated through DSM techniques like Peak-Shaving. Goal to achieve plus energy over the complete year, with focus on economic feasibility.
Energy community, P2P trading: N **Flexibility trading: N**	Possibilities for "Mieterstrom" and Energy community has been assessed, however has currently not been focused on for further investigation, might be revisited later on.
Overarching strategies	**Zero emission**: ☒ **Energy neutrality**: ☒ **Energy efficiency**: ☒ Carbon free: ☐ **Climate neutral**: ☒ **Sustainable neighborhood**: ☐Social aspects/ affordability: ☐
Further goals and ambitions:	**Building**: ☒ Materials: ☐ Renovation/refurbishment: ☐ Sustainable production: ☐ Sustainable consumption/ procuring: ☐ **(local) administration**: ☒ **Legal framework**: ☒ **Business models**: ☐ **Stakeholder involvement**: ☒ **Citizen involvement** ☒
Success and ambitions	
Indicators and expected impact:	Primary energy balance of the whole quarter To differentiate the possibility to harvest on-site renewable energy in densely and sparely built regions, energy balance is calculated based on floor area of each house. Also, an assigned 'Energy credit' (net electricity generated) is also taken into the primary energy balance Economic feasibility checked through additional costs in comparison to a conventional energy supply
Actual success & experience	Considerable National recognition for the developed system boundaries for PED in densely populated area. Clear definition for PED measurements and therefore pragmatic system boundaries, monitoring and therefore less complex communication to stakeholders. Early and comprehensive involvement of the city administration, and all relevant actors – an important step to ensure realization. Vital in that regard is the role of project leader, in their close position as innovation hub institutionalized between City and Research, with good connection to various branches of city administration. Initial cost-effectiveness analyses show that the plus-energy concept in combination with a suitable business model is economically viable (in some cases even without subsidies) in the long term. Willingness and general interest of building developers, architects and planners in constructing for a climate neutral and sustainable city, with motivation to implement the concept as well as competences of practitioners in the process of planning, that keep the goal in their mind. Expertise and competence building for planners especially building and energy planners and early integration of vision Planning process is complicated
Challenges and barriers	On the one hand, it is very important to consider the topic of energy early in the planning process, on the other hand, it complicates the conception, as the future non-residential

	users are not yet known and their energetic behaviour (demand, synergy effects etc.) is therefore difficult to plan. Success factors in future realization projects will be the willingness of the quarter developers to accept longer payback times for their investment and put additional effort into the planning and innovation process. Currently, building material prices have spiked and therefore financial calculations for the planned realisation might not hold, there is considerable worry that these increased prices might endanger the feasibility of the project's implementation. Last but not least the engagement of the future users concerning energy consumption and technology usage as well as a long-term monitoring process are key to reach the planned efficiency in reality.
Sources: Link: https://nachhaltigwirtschaften.at/de/sdz/projekte/zukunftsquartier.php https://nachhaltigwirtschaften.at/de/sdz/projekte/zukunftsquartier-2-punkt-0.php Interview: Zelger, T. 09. 2021. FH Technikum Wien	

'Plusenergy' heavily relies on the increase of local production of energy, therefore a larger installation of PV is being planned, which still receives critical feedback or is being advised against by some city administrative actors, or even crosses limitations of maximum sizes for PV. As solution, PV was partitioned into 7 plants that then had to be submitted for permit as separate plants, which increases planning as well as financial burden.

An assessment for applying a "Mieterstrom" or Energy Community has been undertaken, however follow-up and continuation to implement this in the said project has been postponed by property owner and builder. Before mentioned issue with larger PV installation, as well as unclear organisational roles, administrative effort and ultimately unknown costs for the administration of the energy community and grid costs/ calculations overburdened the process. Efforts might be reconsidered at a later stage in process.

3.1.7 Summary & Analysis of PED Approaches in Austria

During the desk research as well as while conducting the interviews with the involved project actors the quantity and quality of the different project showed that the topic of energy efficient building, own local energy production, and smart living in a broader meaning is very high on the priority list within the building sector in Austria.

Within the described project in this chapter, we have public municipalities which are demanding ecologic and efficient building approaches when doing city development. We also have developers who are focusing on a smart combination of existing and innovative technologies to ensure comfortable, ecological, social, and affordable living. And finally, we also have building-owners or community managers, who are optimizing the energy balance of existing building units and communities.

Austria has a long history of state funding programs supporting ecological thinking and energy efficiency in the building sector. Therefore, projects in all stages are available in this field as best practice and examples for others: concepts, technical design studies, planned projects, projects currently being implemented, projects in operation and currently being

evaluated, as well as finished projects with or without evaluation of its achievements during the first period of usage.

With the concept of PEDs and PENs the next aggregation level is targeted: not only efficient single units, but harmonized and integrated districts and neighbourhoods, working towards the same goal in a systematic and structured way. New city development projects are going towards this direction, as the examples above are showing. Bringing existing buildings to the point where they cooperate and build up additional competence and resources in order to achieve a positive energy balance of their neighbourhoods together, is a more difficult task. Community leaders and opinion leaders (e.g. a mayor, a company owner, etc.) can help here establishing a structure and a common motivation to move towards this target. The emergence of energy communities and the new Austria Renewable Energy Law EAG (Erneuerbaren Ausbau Gesetz) are one possibility to integrate the energy infrastructure of neighbourhoods and in parallel establishing an organizational structure for combined efforts in this field.

We expect that the trend towards more ecological and more self-sufficient or energy neutral buildings will continue and getting stronger in Austria. There is a working motivational system with the state support linked to the energy performance of new build or renovated houses. There is a globally rising awareness of climate change and its impacts. And Austrian companies as well as the third sector including education, scientific institutes and other service organizations have proven with best practice examples, that the needed competences exist and work.

3.2 Czech Republic

There have been chosen four examples of towards-PED initiatives in the Czech Republic. Three of them are part of three different EU Horizon 2020 funded projects (SPARCS, +CITIxCHANGE, RUGGEDIZED) in the position of fellow city. All of them are in advanced planning stage. There have not been found projects in PED operating stage.

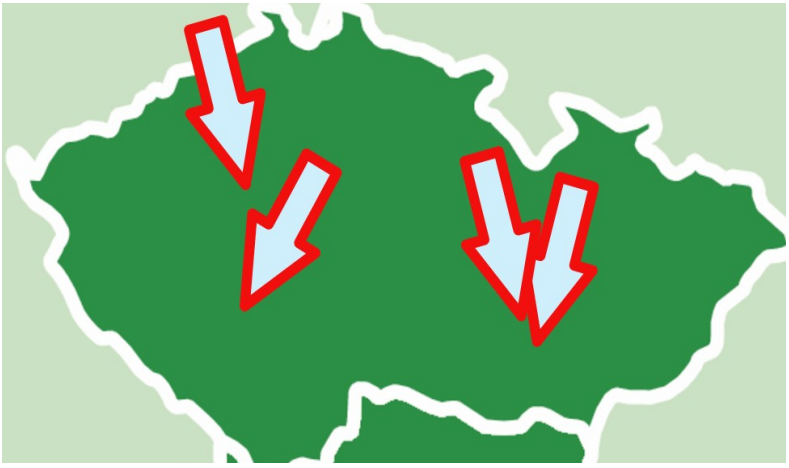


Figure 6: Selected projects in the Czech Republic

3.2.1 SPARCS, KLADNO

Kladno is one of the fellow cities in Horizon 2020 funded project SPARCS. It is the second-biggest city in the Central Bohemia region after Prague with 70k inhabitants. The project should contribute to preparation of a new vision of the city and energy strategy, proposal of investment plans, incl. feasibility studies and financial models, and in particular the Positive Energy District (PED) model. Some of the project goals have been already reached: in June 2021 the City of Kladno has completed a key strategic document - the Sustainable Energy and Climate Action Plan (SECAP) with a perspective to 2030 / 2050. There have been analyzed 8 city districts for possible PED model implementation. Two of the will proceed to further analysis.

Table 8: SPARCS, KLADNO

Location: Kladno Timing: 2019-2024 Size of project: selected city area (currently under evaluation) Status: Planning Mixture of Usage: Existing neighborhood Status JPI Booklet: another (Lighthouse) city of SPARCs projects was included (23 Espoo, Finland – SPARCs), Kladno as a fellow city in SPARCS was not covered.		SPARCS
Initiator:	Academic sector & municipality	City of Kladno and The University Center for Energy Efficient Buildings (UCEEB) of the Czech Technical University
Funding:	SPARCS (European Union's Horizon 2020; grant agreement No. 864242.)	
Actors involved:	City of Kladno UCEEB	Municipality, Academic sector
	The University Center for Energy Efficient Buildings (UCEEB) of the Czech Technical University has been an important partner of the city since the beginning.	
Stakeholder and Citizen	City Vision process was conducted by city administration and via city stakeholders	

Engagement	ecosystem. Several 1to1 meetings and city workshop took place to ensure top-down and bottom-up approach. Broad analysis was done (for the purpose of SECAP and city profile) – socioeconomic, population, local economy, etc. Posters and view from the future were prepared and discussed. There was a standard public consultation process before SECAP finalization (in spring 2021).
Energy system	
Decentral/ local (renewable) resources: Y **Regional energy system:** **N**	Rooftop FVE, energy storage, heat pumps, local distribution network and aggregation of consumption points will be considered
Plusenergy: **Y/N**	PED is an umbrella for partial innovative projects and services and it is part of the Kladno Action Plan (SECAP) with goals for 2030/2050. PED design represents an urban (energy) transformation concept in the city, and serves as a showcase of economic, social, urbanistic and energy balanced development direction in the city. The goals were elaborated within the Action Plan. There was a public discussion process before the formal approval.
Energy community, P2P trading,: **Y/N**	Currently, there is a missing legislative framework to implement it. However, there is an ambition to implement it in further steps.
Flexibility trading: N	To be decided in further steps
Overarching strategies	Zero emission: ☐ **Energy neutrality**: ☒ **Energy efficiency**: ☒ Carbon free: ☐ **Climate neutral**: ☒ **Sustainable neighborhood**: ☒Social aspects/ affordability: ☐ Other: **Mobility**
Further goals and ambitions:	**Building**: ☒ Materials: ☐ **Renovation/refurbishment**: ☒ **Sustainable production**: ☒**Sustainable consumption/ procuring**: ☒ (local) administration: ☐ Legal framework: ☐ **Business models**: ☒ **Stakeholder involvement**: ☒ **Citizen involvement** ☒
Success and ambitions	
Indicators and expected impact:	Kladno has approved a SECAP in June 2021 with following goals: • Reduce conventionally powered vehicles by 50% and CO2 emissions 60% by 2030 (40% reduction compared to 1990 levels); • Become carbon neutral before 2050; • 10% improvement in energy efficiency by 2025; • 30% of energy from RES by 2030; • Reduction of total CO2 emissions by 40% by 2030; • 10% of municipal vehicles and 80% of public transportation buses free of greenhouse gas emissions by 2025. There were analysed 8 areas for potential PED development. Two of the will proceed to further analysis. Generally, the goal is to set up a district that produces more renewable energy than it consumes.

Actual success & experience	In June 2021 the City of Kladno has completed a key strategic document - the Sustainable Energy and Climate Action Plan (SECAP) with a perspective to 2030 / 2050. The Action plan proposes specific measures in the sectors of buildings, housing, transport, public lighting, waste, and water management. Kladno also plans to support sustainable construction in the city, cost-saving measures in housing, installation of heat pumps and photovoltaics, the establishment of energy communities, e-bikes in the city, electro mobility, revitalization of the parking zones, and other projects. The preparation of SECAP was framed by SPARCS and it is in line with the visioning process and implementation plan in SPARCS activities. Out of 8 indicated geographical areas for PED within Kladno, two were selected for further analysis of the implementation of possible energy solutions and for negotiations with relevant partners in the area, incl. investors.
Challenges and barriers	Lack of measurement data, ownership structure, lack of expert knowledge.
Sources: Link: https://www.sparcs.info/cities/kladno Interview: Škorňa, D. 2.7. 2021, project coordinator, City of Kladno,	

3.2.2 +CityxChange, Písek

City of Písek act as fellow city in Horizon 2020 funded project +CityxChange,. The goal is to design PED project in which the Municipal house, newly designed parking garage and some of the primary school buildings or kindergartens will be engaged.

Table 9: +CityxChange, Písek

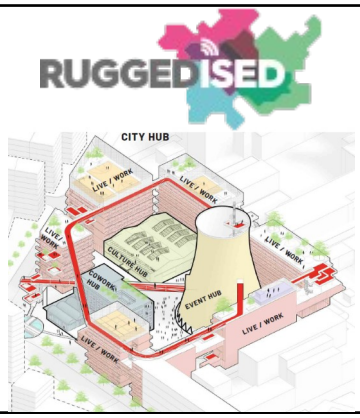
Location: Písek Timing: 2018-2023 Size of project: selected buildings Status: Planning Mixture of Usage: Existing neighborhood Status JPI Booklet: other (Lighthouse) cities of +CityxChange projects were included (13 – Limercs, Irland, 20 – Trondheim, Norway, 21 – Voru, Estonia), Písek as a fellow city was not covered yet.		
Initiator:	Municipality	City of Písek
Funding:	+CityxChange , funding from the European Union's Horizon 2020 research and innovation program under Grant Agreement No. 824260.	
Actors involved:	City of Písek The University Center for Energy Efficient Buildings (UCEEB) of the Czech Technical University	Municipality, Academic sector

Stakeholder and Citizen Engagement	An integral part of the project is the involvement of as many participants as possible in the construction of PEB / PED. For this purpose, several activities are planned within the project towards citizens, local government representatives and important business entities in the region.
Energy system	
Decentral/ local (renewable) resources: Y **Regional energy system:** **N**	Rooftop FVE, energy storage
Plusenergy: **Y**	The analysis of PED feasibility within Pisek will be focused only on the electricity as the heat is being centrally distributed from one heat source (currently fossil fuelled district heating with ambition to change into biomass- based district heating)
Energy community, P2P trading,: **Y/N** **Flexibility trading: Y/N**	Currently, there is a missing legislative framework to implement a P2P trading and energy community. However, there is an ambition to implement it in further steps. Flexibility trading to be decided in further steps
Overarching strategies	**Zero emission**: ☒ **Energy neutrality**: ☒ **Energy efficiency**: ☒Carbon free: ☐ **Climate neutral**: ☒ Sustainable neighborhood: ☐Social aspects/ affordability: ☐
Further goals and ambitions:	Building: ☐ Materials: ☐ Renovation/refurbishment: ☐ **Sustainable production**: ☒ **Sustainable consumption/ procuring**: ☒ (local) administration: ☐ Legal framework: ☐ Business models: ☐ **Stakeholder involvement**: ☒ **Citizen involvement** ☒
Success and ambitions	
Indicators and expected impact:	The goal is to design PED project in which the Municipal house, newly designed parking garage and some of the primary school buildings or kindergartens will be engaged. The analysis of PED feasibility within Pisek will be focused only on the electricity as the heat is being centrally distributed.
Actual success & experience	Necessary data is being collected in order to design a planned ecosystem of positive energy blocks and districts. The municipality buildings and schools have been revitalized recently through exploiting energy performance contracting. The parking house is in a planning phase. The Centre of Low Energy Buildings has large installation of PVs and battery storages. The Technology Centre is a data centre where necessary data are being collected in order to design planned ecosystems of positive energy blocks and districts. All these buildings are planned to be integrated into the PED solution.
Challenges and barriers	Lack of measurement data, more active DSO integration into the projects
Sources: Link: https://cityxchange.eu/our-cities/pisek/ Interview: Tencar, J. 16.6. 2021, project coordinator, The University Center for Energy Efficient Buildings (UCEEB) of the Czech Technical University	

3.2.3 RUGGEDIZED, Brno

Brno, with 378,000 inhabitants, is the second-largest city in the Czech Republic and is situated at the centre of the South Moravian Region. The Špitálka district is directly linked to the historical centre of the city. The long-term goal is to develop a pilot smart district that would grow up in the industrial brownfields.

Table 10: RUGGEDIZED, Brno

Location: Brno Timing: 2016-2021 Size of project: selected city area - 2,5 ha Status: Planning Mixture of Usage: Existing neighborhood/Brownfield Status JPI Booklet: not covered yet.		
Initiator:	Municipality	
Funding:	the European Union's Horizon 2020 research and innovation program under Grant Agreement No. 731198.	
Actors involved:	Municipality Brno University of Technology Teplárny Brno E.GD	Municipality, Municipal Heating Company (land ownership), DSO, Academic sector, Urban planners, Architects
Stakeholder and Citizen Engagement	Brno organized six experts round tables to discuss how a smart neighborhood should work, what it should be innovative about and what specific technologies and approaches should be used. Debates at virtual round tables with a number of experts from the private (e.g. local DSO, heating company), academic and non-profit spheres dealt with issues of heat supply and heating and cooling systems, as well as electricity sources and the promotion of electromobility. The participants also discussed the concept of public space, waste management and conditions for the development of community life. The topic of data collection and use and their security was also present.	
Energy system		
Decentral/ local (renewable) resources: Y/N **Regional energy system: Y/N**	Rooftop FVE, energy storage, excess heat usage (e.g. from data centre) – all possibilities currently under evaluation.	
Plusenergy: Y/N	Passive standard as a main goal, plusenergy as an ambition. Currently it is being analysed the feasibility of a PED.	

Energy community, P2P trading,: Y/N Flexibility trading: Y/N	Currently, there is a missing legislative framework. To be decided in further steps.
Overarching strategies	Zero emission: ☒ **Energy neutrality**: ☒ **Energy efficiency**: ☒ Carbon free: ☐ **Climate neutral**: ☒ **Sustainable neighborhood**: ☒Social aspects/ affordability: ☐
Further goals and ambitions:	**Building**: ☒ **Materials**: ☒ **Renovation/refurbishment**: ☒ **Sustainable production**: ☒ **Sustainable consumption/ procuring**: ☒ (local) administration: ☐ Legal framework: ☐ Business models: ☐ **Stakeholder involvement**: ☒ **Citizen involvement** ☒
Success and ambitions	
Indicators and expected impact:	A complex brownfield area transformation into a smart district area.
Actual success & experience	Active stakeholder and citizenship involvement reached by number of round tables. The planned smart district of Brno belongs to the category of top regional investments of the South Moravian Region. In 2019, International Open One-phase Urban Design Idea Competition organized.
Challenges and barriers	During the complex brownfield area transformation many issues to be solved (. In context of PED feasibility challenge is to define a project boundary
Sources: Link: https://ruggedised.eu/cities/brno/ ; https://respitalka.brno.cz/en/ Interview: 22.6. 2021, Ostrenko, Y, project coordinator, the City of Brno	

3.2.4 Chytré Líchy, Židlochovice

Židlochovice is a small city in the suburbs of the city of Brno. The municipal authority is an initiator of the development of a new city district called Chytré Líchy with ambitious emission and energy targets. One of the main goals of the Chytré Líchy district is to achieve carbon neutrality in the operation of buildings. The implementation stage is planned to start in 2023.

Table 11: Chytré Líchy, Židlochovice

Location: Chytré Líchy, Židlochovice Timing: 2018-2023 Size of project: 3,4 ha Status: Planning, implementation stage in 2023 Mixture of Usage: new municipal district Status JPI Booklet: not covered yet.	Chytré Líchy První udržitelná městská čtvrť v ČR 

Initiator:	Municipality	City of Židlochovice
Funding:	Funding provided my regional development fund (Jihomoravský kraj) and by Die Deutsche Bundesstiftung Umwelt (DBU)	
Actors involved:	Municipality Centrum pasivního domu s.z. UCEEB CEVRE Consultants, s.r.o. Asio	Municipality, NGO with focus on passive houses and energy efficiency in buildings, academic sector, consultancy company, wastewater treatment engineering company
Stakeholder and Citizen Engagement	Workshops with citizens of Židlochovice since 2019	
Energy system		
Decentral/ local (renewable) resources: Y **Regional energy system:** **Y**	Rooftop PV (buildings and parking sheds), local distribution area	
Plusenergy: **N**	Goal is the emission neutrality.	
Energy community, P2P trading,: **Y/N** **Flexibility trading: Y/N**	The establishment of energy community is planned, P2P is also being analysed – currently there is a missing regulatory framework for it. The project participants are in communication with the Ministry of Industry and Trade and Energy regulatory office to create a pilot area ("regulatory send box") to test the possible business models.	
Overarching strategies	**Zero emission**: ☒ **Energy neutrality**: ☒ **Energy efficiency**: ☒ **Carbon free**: ☒ **Climate neutral**: ☒ **Sustainable neighborhood**: ☒**Social aspects/ affordability**: ☒	
Further goals and ambitions:	**Building**: ☒ Materials: ☐ Renovation/refurbishment: ☐ **Sustainable production**: ☒ **Sustainable consumption/ procuring**: ☒ **(local) administration**: ☒ **Legal framework**: ☒ **Business models**: ☒ **Stakeholder involvement**: ☒ **Citizen involvement** ☒	
Success and ambitions		
Indicators and expected impact:	The goal is to implement the first ecologically sustainable city district in the Czech Republic, which is an example for all other similar plans. The operation of all houses will be carbon neutral, thus showing the way of development without greenhouse gas emissions. Houses will use renewable energy sources and smart technologies.	
Actual success & experience	Feasibility study in 2020, urban - architectural solution prepared, workshops with local citizens organized. Try to learn from abroad (e.g. innovative city district in Freiburg - Germany)	

Challenges and barriers	Limited funding for project development, lack of legislative support, lack of experience (both expert knowledge and real examples).
Sources: Link: https://www.chytrelichy.cz/ Interview: Bárta, J. 11.10. 2021, technical project coordinator, Centrum pasivního domu s.z.	

3.2.5 Summary & Analysis of PED Approaches in Czech Republic

There were described four projects in of innovative energy districts in Kladno (70k citizens), Písek (30k citizens) and Brno (380k citizens) and Chytré Líchy (4k citizens). All projects have in common that the PED- development activities are part of broader activities (e.g. approved SECAP, smart city initiatives, development of new city district etc.). Three of the discussed projects are part of the international Horizon 2020 funded consortia.

The current situation of all four projects is the analysis of the optimal and also feasible set-up. There are different approaches towards PED target that are determined by the chosen scope of each project. The project in the city of Pisek (CityxChange) will focus mainly on the electricity consumption optimization (with the integration of local PV production and energy storage) within the selected building with municipality ownership – there is a developed district heating system in the area with plans for biomass-based heat supply (currently coal-based). In Brno, PED development is a part of the complex brownfield area transformation (with many issues to be solved apart) within the city centre so that reaching the positive energy target will be the most difficult target among the analysed examples.

As the important competencies mentioned within the interviews there was often named the importance of a dedicated specialist with a full-time focus on the project developments with a broader range of competencies (energy systems, urban planning, regulatory issues). Public funding in all the projects enabled enhanced project development. Cityxchange project has several deliverables focused on flexibility markets and peer-to-peer trading development within the PED activities, the establishment of energy community is also planned in Chytré Líchy. Currently the biggest obstacle to close linkage between PED and energy communities is the lack of legislative support (the legislative changes introducing energy communities into the Czech legal framework is still to come).

3.3 Sweden

The booklet on “Positive Energy Districts” (Gollner et al.. 2020) mentions six Swedish project at different stages (implementation stage and already in operation) in Lund, Stockholm and Malmö. Of those, selected projects were analysed further and information were updated in comparison to the status of the last version of the booklet (ibid.). Additionally, three projects were identified through added and deemed relevant for the analysis: two projects in Gothenburg (IRIS and FED), as well as the bottom-up initiative of Re:kobyn in the rural village Röstånga just 50km from Lund.

Figure 7: Selected projects in Sweden

3.3.1 Access, Malmö

The project is being conducted within the ACCESS project, a joint effort of the North Sea Region local authorities (Amersfoort (NL), West-Suffolk Councils (UK), Malmö (SE) and Mechelen (BE)) in collaboration with knowledge partners from universities and research institutes in order to demonstrate how local projects can be scaled up. Pilot projects include local energy community hubs, peer-to-peer energy trading models, and local collaborative planning tools. The Swedish contribution to ACCESS is situated in Malmö. The city set their goal to be energy neutral by 2020 and 100% RES by 2030. The pilot built by Parkering Malmö will be a new parking facility, acting as a local energy hub in a new residential area (Sege Park, Kirseberg). It is envisioned as a local energy hub with renewable generation, charging infrastructure and storage in order to reduce power peaks and losses locally. Scalability of such solutions is considered an important aspect, since the city's growth in inhabitants and therefore energy demand requires solutions, and it is expected that measures of smarter and more efficient use of energy might reduce overall consumption by 25%.

Table 12: ACCESS, Malmö

Location: Malmö, Sege park Timing: 2020-2023 Size of project: Status: Planning Mixture of Usage: Newly build Status JPI Booklet: not included yet		 Rendering from parking garage in project (ACCESS)
Initiator:	City of Malmö	
Funding:	Interreg North Sea Region	
Actors involved:	VITO (1) Johannesberg Science Park (2) Aarhus University (3) IfM Engage (4) Mechelen (5) West Suffolk Council (6) Malmö (7)	(1) Independent research organization, cleantech, smart urban energy planning, energy policy and energy planning; (2) Meeting point for enterprise, research and development: Urban Development, Energy, Material, Nanotech. (3) Social science group at Aarhus University has extensive expertise in energy and climate governance, energy economics and environmental sociology, including research on coordination and stakeholder involvement in multilevel governance; upscaling of climate adaptation models; the effectiveness of innovative business models in integrating energy from different sources into the smart grid; (4) IfM Education and Consultancy Services have expertise in developing and applying a variety of management tools and methodologies such as road mapping (focus on knowledge transfer; result driven approaches) (5) Mechelen is a city and municipality in the province of Antwerp, Flanders, Belgium. (6) Council in the UK. (7) The city of Malmö has been intensively involved with energy transition-related projects
Stakeholder and Citizen Engagement	Seven delegates from the City of Malmö (reference group), who represented different stakeholder groups, participated in a process of identifying energy strategy, based on the city and national goals and strategies through a guided process of back casting and scenario building for concrete measures to reach targets. Stakeholder workshops with contractors was planned, however not yet conducted due to CoVID19. No citizen engagement planned at this stage of project.	
Energy system		
Decentral/ local (renewable) resources: Y **Regional energy system:** **N**	Solar panels, parking spots with charging possibilities and an energy storage solution. Self-sufficient at least half of the year through solar panels and the load control system, using cars as batteries. In the pilot, different optimization scenarios will be tested, where the load control system will steer the energy loads of the building both to reduce the building's carbon footprint and to reduce the carbon footprint from the entire energy system in Malmö.	
Plusenergy: N		

Energy community, P2P trading: N **Flexibility trading: N**	
Overarching strategies	Zero emission: ☐ Energy neutrality: ☐ **Energy efficiency**: ☒ **Carbon free**: ☒ Climate neutral: ☐ **Sustainable neighborhood**: ☒Social aspects/ affordability: ☐ Goal: 100% renewable energy in Malmö by 2030, 15% solar.
Further goals and ambitions:	Building: ☐ Materials: ☐ Renovation/refurbishment: ☐ **Sustainable production**: ☒ **Sustainable consumption/ procuring**: ☒ **(local) administration**: ☒ **Legal framework**: ☒ **Business models**: ☒ **Stakeholder involvement**: ☒ Citizen involvement ☐ Water recycling, green facades
Success and ambitions	
Indicators and expected impact:	Monitoring and data assessment is conducted by research partner from Johannesburg Science Park.
Actual success & experience	Professionally guided and well-organized consortium throughout the whole project, with instructive and well managed information blog and webpage for public information. Another parking project has already been started, learning from the process of this project. Knowledge exchange and network within the Access networks has been very fruitful, mainly through monthly meetings. A publication on the experience of knowledge exchange states: Secure resources and knowledgeability from the start, or alternatively allocate time and money for competence development Importance of identifying and including stakeholders from beginning (obvious and not obvious ones), explicit internal processes for stakeholder engagement and task distribution. Engage with stakeholders every step of the way and reaffirm a common understanding of the project objectives. Include green solutions at the planning stages so their specificities can be accounted for when it matters
Challenges and barriers	Main challenge in this process was considering procuring and how the descriptions for builders and technology providers would be specific enough as well as provide relevant and measurable guarantee to reach success.
Sources: Rabasch 2020; Rabasch 2021; Link: https://northsearegion.eu/access/ Interview: Axelsson,H.,9.9.2021. City of Malmö, Environment Department.	

3.3.2 Brunnshög, Lund

The city of Lund is developing a new city district on previously undeveloped land with the focus of a “vibrant and sustainable district” (City of Lund n.d.) in the north-east. The development happens in stages, each part will be developed iteratively (Southern Brunnshög, Central Brunnshög, Science Village, MAX IV and ESS, etc.) There are various projects in Lund, that contribute to the long-term development of the city development of Brunnshög: in the JPI booklet especially COOL DH project is closely intertwined. The

municipality of Lund is involved in the award-winning Cityfied, which is about energy efficiency of older homes on Linero, Cool DH which concerns low-temperature district heating at Brunnshög. This fits in well with their existing plans for Brunnshög, such as the "vision of having an energy production of 150% in the area" (Futurebylund 2018). In Brunnshög part of the city development has already been undertaken and residents have moved to the area.

Table 13: Brunshoeg, Lund

Location: Lund Northeast, Brunnshög Timing: 2009 -2049 overall Size of project: 2.250.000 m^2 Status: in Implementation Mixture of Usage: newly built Status JPI Booklet: yes	 Map of Brunnshög, Delomraden (City of Lund)	
Initiator:	Lund Municipality	
Funding:	Private	
Actors involved:		
Stakeholder and Citizen Engagement	Very high public acceptance and trust in municipal actors to construct and build good solutions. Citizens, industry, investor/real estate, business, research	
Energy system		
Decentral/ local (renewable) resources: Y **Regional energy system:**	Solar Thermal Energy, Heat pump system, District heating/local heating, Industrial waste, heat, Photovoltaic (coverage about 70% buildings). Large scale low temperature district heating network, based on waste heat: World's largest low temperature district heating network, temperatures as low as 5-10 degrees to heat or cool buildings, waste heat from research facilities ESS and MAX IV, storage of thermal energy.	
Plusenergy: Y	PEDs in southern part of Brunnshög, area next to ESS, Medicon village (Ecogrid for research area).	
Energy community, P2P trading:N **Flexibility**	No. Due to legal restrictions not applied. Also does not meet very high interest currently from side of city administration.	

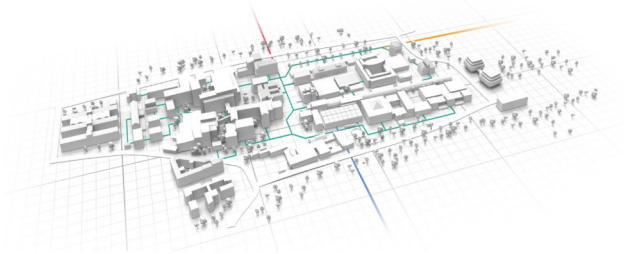
trading: N	
Overarching strategies	Zero emission: ☐ Energy neutrality: ☐ **Energy efficiency**: ☒ Carbon free: ☐ Climate neutral: ☐ **Sustainable neighborhood**: ☒Social aspects/ affordability: ☐ Knowledge intensity, sustainable urban development and regional attractiveness
Further goals and ambitions:	Building: ☒ Materials: ☐ Renovation/refurbishment: ☐ **Sustainable production**: ☒ **Sustainable consumption/ procuring**: ☒ **(local) administration**: ☒ **Legal framework**: ☒ **Business models**: ☒ **Stakeholder involvement**: ☒ Citizen involvement ☐
Success and ambitions	
Indicators and expected impact:	Simple annual energy net calculation (heat, cooling, electricity, car use) Environmental, Social, Services.
Actual success & experience	City is landowner and energy supplier. Strong impact on built environment and sustainability: high competition for buying land (higher ambitions are competitive advantage) High public acceptance for climate action (political mandate for SDG, City Goals for Renewables etc.) Lund has long experience in stakeholder processes, information campaigning and seminars for stakeholders. Now less engagement is necessary. "The sustainability framework for the municipality of Lund is called Lundaeko. This framework is structured into eight different focus areas: Involvement, sustainable consumption, clean water and clean air, minimizing climate impact, decreasing chemical stress on the environment, sustainable city, climate change adaptation and biological diversity. The different focus areas are taken into account in the yearly planning process of the municipality. The yearly progress is described and evaluated in a sustainability report and is processed in an evaluation with top city management and decision-makers. Internal and external revues are performed on a regular basis."
Challenges and barriers	Step-up with "encourage" to build more renewable production plants: 70% have their own PV planned VS. need higher amount of energy production (currently energy analysis of earlier areas with residents on energy performance) LTDH is in competition with heat pump system (independence from grid, subsidies for heat pumps for rental apartments, etc.)
Sources: Link: https://www.lund.se/en/brunnshog/ https://www.lund.se/globalassets/brunnshog/engelska/201204ir_eng.pdf https://lund.se/globalassets/brunnshog/marknadsmaterial/visions_eng_web.pdf https://www.euroheat.org/knowledge-hub/case-studies/lund-brunnshog/ https://www.lund.se/globalassets/brunnshog/engelska/201204ir_eng.pdf Interview: Dalmen, E., 08-2021, City of Lund. Paulsson, M. 9.7.21, City of Lund, Energy Department.	

3.3.3 Fossil-Free Energy District (FED), Gothenburg

At the Campus of Chalmers University in Gothenburg, a local digital market place was created in which the energy system was connecting electric power, heating and cooling using renewable energy, pumps and storages in order to demonstrate a Fossil-Free Energy District (FED). The approach seeks to reduce peak energy loads and fossil

primary energy that could be replicated and deployed at a city scale to make Gothenburg a carbon neutral city. Thereby, the solution aims to showcase an energy transition and its business benefits and thereby, ensuring and addressing interests of stakeholders. The market was connecting already existing units (market entities) that were in place before the project started, additional investment was undertaken for a new heat pump that recovers heat from the cooling system, two new Li-Ion batteries, solar PV installations, a PCM storage, upgrade of control systems, solar PV inverters with grid service. The solution was trading consuming or generating energy between entities based on a fully automated ICT solution

Table 14 Fossil-Free Energy District (FED), Gothenburg

Location: Gothenburg Timing: 11/2016 – 10/2019 Size of project: Status: implemented Mixture of Usage: yes Status JPI Booklet: no		 FED demonstration site in the City's university area © Johanneberg Science Park.
Initiator:	City of Gothenburg	
Funding:	Urban Innovative Actions, UIA (EU). Total budget is 5,8 million €, of which 80% is from the UIA.	
Actors involved:	Johanneberg Science Park, Göteborg Energi, Business Region Göteborg, Ericsson, RISE Research Institute, Akademiska Hus Housing Association, Chalmersfastigheter, Chalmers University.	
Stakeholder and Citizen Engagement	Around 15.000 end users have advantages from FED energy trading system at location.	
Energy system		
Decentral/ local (renewable) resources: Y Regional energy system: Y	FED developed a local energy system combining three energy carriers: electricity, heating and cooling. A digital marketplace for the three energy carriers was established. Generation/production and storage of all three energy carriers. FED optimized use of energy storage. FED uses energy efficiently and avoids fossil fuel peak. "Since implementation, the area has achieved a local heating system which is connected to the general district heating network and all roofs are covered with solar panels, which will serve as 30% of the base load of electricity demand. The marketplace for electricity is connected to a variety of data, including weather forecasts of different production sites to optimize energy production."	

Plusenergy: N	
Energy community, P2P trading: N Flexibility trading: Y	Flexibility marketplace (both for electricity and heat on hourly basis). Assessment of various features such as integration of 100% renewables into the same system, power balancing with energy storages, reduced import of external fossil peas, successfully connecting different energy carriers, local heat recovery, stabilizing the electricity grid (market service)
Overarching strategies	**Zero emission**: ☒ **Energy neutrality**: ☒ **Energy efficiency**: ☒ **Carbon free**: ☒ Climate neutral: ☐ Sustainable neighborhood: ☐Social aspects/ affordability: ☐
Further goals and ambitions:	Building: ☐ Materials: ☐ Renovation/refurbishment: ☐ Sustainable production: ☐ **Sustainable consumption/ procuring**: ☒ sustainable consumption, exploit technological opportunities in a sustainable manner (local) administration: ☐ Legal framework: ☐ **Business models**: ☒ planning of business models with reduced technical and financial risks Stakeholder involvement: ☐ **Citizen involvement** ☒
Success and ambitions	
Indicators and expected impact:	Proof of concept: Working, stable and robust marketplace for electricity, heating and cooling. Inclusion of approx. 50 market entities. 80 % of fossil energy peaks avoided
Actual success & experience	Ripple effects: Twelve new projects based on FED, among those six EU funded projects, company partnerships and implementation of FED-like systems in a larger scale. Success factors: Local team, native language, established relations among partners and close location. Strong cooperation and close work between experts from various fields necessary. High level of complexity of the process, therefore suggested to start in a simple, limited approach and expand stepwise.
Challenges and barriers	Monitoring, measurements of base line and evaluate success was posing challenges, e.g. data collection was not modern enough. Complex and not clear results. Upgrading existing buildings to a FED-like system may be too high effort since there is need for equipment update in order to connect all entities, and installation effort is high. However, new-built areas can easily integrate a further small investment, that can pay off in energy efficiency and peak shaving. Capacity building and social acceptance are highly important for further development. It is suggested that a community solution is preferred, since it takes away the responsibility from the end users and puts it on the property owners, which reduces the need for public acceptance. Additionally, the cognitive gap of the property owners may be smaller than those of the average property owner, at least in terms of technology for energy Market operator is often missing. If possible, identify and include this organization from the start. Challenges and barriers for future implementation: Legislative basis is not given. Lack of incentives for property owners, local actors, network companies to procure flexibility. Unclear roles of aggregator, balance managers, etc. No real incentive to promote energy efficiency. Unclear responsibilities when it comes to load management, energy storage, switchable electricity. Lack of boundaries of local energy market, geographical system boundaries might create difficulties.
Sources:	

Link: www.johannebergsciencepark.com/fed https://area21-project.eu/wp-content/uploads/AREA-21_Good-Practice_Fossil-Free-Energy-District_Gothenburg.pdf https://www.uia-initiative.eu/en/uia-cities/gothenburg Interview: Rydberg, S., 21.09.2021. Johanneberg Science Park.

3.3.4 IRIS, Gothenburg

Within the HORIZON 20202 funded project IRIS; the city of Gothenburg is one of three lighthouse cities that collaborate with city administration, industries, research organisation and citizens to work in the areas of energy, mobility and ICT towards the overall goal of sustainable liveable cities. There are various focus topics, of which one is dedicated to "Renewables and energy positive districts" with a pilot case in Gothenburg.

Table 15: IRIS, Gothenburg

Location: Gothenburg Timing: 2017-2022 Size of project: 2.250.000 m^2 Status: in Implementation Mixture of Usage: yes Status JPI Booklet: yes		City of Gothenburg IRIS Gothenburg
Initiator:	Municipality of Utrecht (UTR), The Netherlands	Project leader in IRIS project
Funding:	Horizon 2020 EU	
Actors involved:	TYRENS CHALMERS UNIVERSITY AKADEMISKA HUS Göteborgs Stad Johannesberg Science Park Riksbyggen Trivector HSB METRY	Organizational Structure: 43 partners from 9 different European countries form the Consortium for the project IRIS. All partners, originating from diverse backgrounds and disciplines, combine the required knowledge and experience to accomplish the project's ambitions. Gothenburg is one of the 'lighthouse' cities along with Utrecht (NL) and Nice (FR), where the case study is actually implemented, and if successful, would be then implemented in one of the similar 'Follower' cities – Vaasa (FI), Alexandroupolis (GR), Santa Cruz de Tenerife(ES) and Foscani (RO).
Stakeholder and Citizen Engagement	Large number of activities have been planned and already conducted to improve the involvement of the stakeholder and citizens in the city. Workshops for interested people, idea generation activities for citizens ranging from school children to old people have been conducted. City Information Model to collect, process and visualize vast amounts of data.	
Energy system		
Decentral/ local (renewable)	Decentralized rooftop Solar PV installations – Larger capacities are connected with a DC network, decentralized heating from geothermal heat pumps, Solar Thermal, Wind and Energy Management systems. Priority for regional generation, storage and consumption of	

resources: Y Regional energy system: Y	electrical energy.
Mobility: Y	Sustainable mobility strategies – rental E-cars, E-bikes and E-scooters. The taxi-pod Bzzt service provider has their charging stations at the University (Chalmers) campus area, with 9 miniature battery-powered taxis powered by green electricity generated locally. There are also two e-car pools, one e-bike pool and e-goods vehicles.
Plusenergy: Y	Overall goal of energy positive district. Several planned and existing infrastructures designed to be energy positive (positive energy balance in districts). Reach this goal through increase share of locally produced and consumed energy, save energy at building level, save energy at district level, storage and transfer of surplus energy between buildings. It includes plus-energy blocks with integration of solar PV and in a second location the refurbishment of NZE offices.
Energy community, P2P trading: N **Flexibility trading: N**	
Overarching strategies	**Zero emission**: ☒ **Energy neutrality**: ☒ **Energy efficiency**: ☒ Carbon free: ☐ Climate neutral: ☐ **Sustainable neighborhood**: ☒Social aspects/ affordability: ☒
Further goals and ambitions:	Building: ☐ Materials: ☒ (climate-enhanced concrete with 30% less CO2 emissions) Renovation/refurbishment: ☒ **Sustainable production**: ☒ **Sustainable consumption/ procuring**: ☒ sustainable consumption, exploit technological opportunities in a sustainable manner (local) administration: ☐ Legal framework: ☐ **Business models**: ☒ planning of business models with reduced technical and financial risks Stakeholder involvement: ☐ **Citizen involvement** ☒ workshop with school children, using "Minecraft" video games
Success and ambitions	
Indicators and expected impact:	KPIs: technical, economic, environmental, social, ICT and legal baseline to compare with is a reference building that would have been built without all the innovation work (allowed energy use is 90 kWh/m2 and year, according to the Swedish Board of Housing) Degree of energy self-supply by RED, Peak load reductions, reduced costs for consumers, carbon dioxide emission reductions
Actual success & experience	PV, Heat pumps, and district heating 100% renewable! HSB Living lab: A 3rd generation living lab, where the designing the housing of the future and the research is partly conducted by committed residents. Min stad: a digital bulletin board with an interactive map to provide information.
Challenges and barriers	Development of management and control system ensuring the working of the combination of small-scale RES production (PV, Wind etc.) with large scale supply (External grid, district heating etc.) Different types of storage for heating and cooling have to be tested, and the integration and expand the management scope. Low or zero parking quota to promote different shared e-mobility solution, electric buses and the development of smart charging infrastructure. To ensure increased availability for citizens and developers of services, city platform and

	services need to be developed according to the challenges within the district. Integration of energy efficiency measures, storage for grid flexibility and sustainable mobility needs essential integrated urban planning methods and data sharing tools. Reinforcement of citizens for engagement and their integration in urban planning process to expand beyond the district to the whole city is a final challenge. To overcome such challenges, the aim has been set to create solutions that will enable a positive energy balance in the district all the while creating an attractive, social inclusive campus and neighborhood. Demonstrations of integrating storage capacity and responsible management at district scale will also be conducted.
Sources: Link: https://www.irissmartcities.eu/content/gothenburg-leading-smart-city-iris-case-study https://irissmartcities.eu/content/gothenburg-sweden-0 https://www.irissmartcities.eu/content/iris-track-1 https://irissmartcities.eu/sites/default/files/documents/d7.1_report_on_baseline_ambition_and_barriers_for_gothenburg_lighthouse_interventions.pdf https://irissmartcities.eu/sites/default/files/documents/d7.1_report_on_baseline_ambition_and_barriers_for_gothenburg_lighthouse_interventions.pdf https://irissmartcities.eu/content/gothenburg-sweden-0 Interview: /	

3.3.5 Re:kobyn, Röstånga

In the rural community of Röstånga, the vision of an eco- village was created and lead by a group of bottom-up organized people from civil society in a close partnership with municipality, local businesses and industry, and academia. Rekobyn's vision is housing for all ages, which together create the conditions for ecological, social and economic regeneration and sustainability. R:eko stands for "reconstructing" the traditional and common village life in a modern way. In the course of creating a strategy for reaching their goal of a resilient and sustainable energy system for the whole of Röstånga by 2030 and the implementation of a green-field project with residence for about 40 households. A feasibility study (R:energi) has been conducted in which the projects vision combined with an energy study was undertaken in order to identify the basis for decision making on at the energy system that could support their ambitious goals regarding the energy provision and investigated therein the potential for plusenergy. In parallel, a long-term rural development process has been undertaken until 2021 for a “new detailed plan for the site” including technical solutions for heating, energy, sewage and construction technology and address the question of financing the construction and sustain a long-term financing strategy.

Table 16: Re:kobyn

Location: Röstanga, Sweden Timing: 2018-2019 (Feasibility study) Size of project: 40 households, Status: Planning (feasibility study) Mixture of Usage: Newly built Status JPI Booklet: No		
Initiator:	Rästanga tillsammans (Local Community organization)	Association based on local residents, interested people with vision and idealism for the future of their rural community. Founded around ten years ago.
Funding:	Leader region, European Union (Viable Cities – the strategic innovation program for climate-neutral and sustainable cities)	
Actors involved:	Rästanga tillsammans (Local Community organization) Eval Part (consulting) Lund Universitet (academic research) Kraftringen FOJAB arkitekter (Architect) In addition: municipality, local businesses, infrastructure provider (grid operators),	
Stakeholder and Citizen Engagement	Living in community and enjoyable living space are main goals. Very active engagement, bottom-up community that initiated and keeps on engaging in was engaged in envisioning, planning, etc. Main work has been done by volunteers. Through projects they acquire consulting info for project development and expertise in energy etc. Village members are informed and invited to raise opinions in various ways.	
Energy system		
Decentral/ local (renewable) resources: Yes	Distributed Solar PV Generation and Solar thermal, Regional generation and consumption are prioritized. Solar, and PV Heating, Biomass: plentiful Ground heat and shallow geothermal heat. Less to no potential for small scale hydro and wind power. The master thesis consists of a case study where four different proposals for energy systems are evaluated and compared, with regards to self-sufficiency rate, climate impact and costs. Based on load profiles, a first scenario has been developed where all electricity is bought from the electricity grid and heat is supplied by heat pumps. Solar cells are then added to the system to investigate how the energy system changes. "The result shows that scenario one, with a heat pump, at present is both the most cost-efficient option and the alternative with the lowest climate impact, compared to the other scenarios. However, this system does not contribute with any system benefits in surrounding systems, unless heat load management is used. The heat load management makes the system more flexible and should therefore be further investigated in the future. The energy system in scenario two, solar cells added, can also be motivated to be the alternative with the lowest climate impact and lowest costs compared to the other scenarios, depending on what assumptions are mad	

Regional energy system: Y	Yes. Improve overall energy
Plusenergy:	Long term ambition, however currently not close to reaching it.
Energy community, P2P trading:	General interest in the topic of community energy exchange, currently however no concrete plans.
Flexibility trading:	No
Overarching strategies	Zero emission: ☐ **Energy neutrality**: ☒ **Energy efficiency**: ☒ **Carbon free**: ☒ **Climate neutral**: ☒ **Sustainable neighborhood**: ☒Social aspects/ affordability: ☒ Other: self-sufficiency
Further goals and ambitions:	**Building**: ☒ **Materials**: ☒ Renovation/refurbishment: ☐ Sustainable production: ☐ **Sustainable consumption/ procuring**: ☒ (local) administration: ☐ Legal framework: ☐ Business models: ☐ **Stakeholder involvement**: ☒ **Citizen involvement** ☒
Success and ambitions	
Indicators and expected impact:	Continuation of vision until and beyond construction of eco-village.
Actual success & experience	Goal of a self- organized community Process of the project mainly through individuals volunteering, additional consulting organizations through funding Procuring energy technologies under fair market prices: energy association buys PV on market. Experience exchange from buying, installing, etc. Local planners and installer included. Study visits, excursions and learning groups Highly interested in energy community and flexibility sharing.
Challenges and barriers	Rural area, therefore no district heating or cooling, higher initial investment necessary and expensive investment. Sustainable funding needs to be found. Limited capacities (e.g. for applying and management of research projects). Process of the project relies mainly on individuals volunteering. Need for striking balance between pragmatic solutions and not giving away communities' decision- making power. Sceptical about the role of big enterprises (builders) in their approach. Procuring energy technologies under fair market prices in a rapidly changing technology market Few oppositions from neighboring parties that are against change in their vicinity, however is being addressed
Sources: (Errikson 2019) Link: www.rekobyn.se https://en.viablecities.se/foi-projekt/energilosning-rostanga Interview: Stenqvist, C., 8.9.21. Evalpart.	

3.3.6 Royal Seaport District (Norra Djutgårdsstaden), Stockholm

Royal Seaport is a large city development project, aiming at 12.000 homes, around 35.000 work places. The Stockholm Royal Seaport is planned to be a fossil-free district, with low resource use and minimal climate and environmental impacts. To minimize and reduce the energy use, all the newly planned buildings will be designed according to 'passive house requirements', with improved insulation in building envelopes and energy-efficient appliances. Furthermore, renewable energy is also planned to be generated locally, mainly with Solar PV panels. Stepwise development of areas allows for improvements and learning through monitoring, the annual sustainability report gives insight on the process of development. Stockholm Royal Seaport is also part of the JPI funded project Cities4PEDs (Stockholms stad, 2021a).

Table 17: Royal Seaport District (Norra Djutgårdsstaden), Stockholm

Location: Stockholm Timing: 2011 – 2030 Size of project: 236 hectares Status: Implementation Mixture of Usage: Mixture Newly build/ existing neighborhood Status JPI Booklet: No		 Aerial view of Stockholm Royal Seaport, photo Jansing & Hammarling (Stockholm stad 2021e)
Initiator:	Stockholm City Administration - Urban Development Division	
Funding:	City of Stockholm – environmentally friendly construction and housing in Norra Djurgårdsstaden	
Actors involved:	Östermalm District Administration. Others include Property developers, infrastructure owners, consultants, academia and suppliers The City Development Administration of the City of Stockholm will participate with focus on the development of Loudden within Stockholm Royal Seaport. Also participating from the City of Stockholm, are the Environment and Health Administration, subsidiary company Stockholm Vatten och Avfall, and KTH Royal Institute of Technology. Overall development with over 40 project developers.	
Stakeholder and Citizen Engagement	Activities like competitions and workshops were regularly held open to people of all ages to promote the project idea. Various activities listed in among those, capacity development for around 10 participants in 2019 and overall 1,3443 participants, involvement of pre-school pupils, pop-up stores etc.	
Energy system		
Decentral/ local (renewable) resources: Y	All the newly planned buildings will be designed according to 'passive house requirements', with improved insulation in building envelopes and energy-efficient appliances. Furthermore, Renewable energy is also planned to be generated locally, mainly with Solar PV panels.	

Regional energy system: N	
Plusenergy: Y	The city shows two buildings by developer Stockholmshems in the Brofästet phase that aim to reach plus energy through solar panels, geothermal heat, efficient insulation and ventilation, as well as recycling of excess heat from wastewater. Furthermore, balcony setting as part of the façade, roof angle at 30 degrees are just some of the innovative energy solutions. "Energy calculations show that the building uses around 14.8 kWh/m² per year, heating, building electricity and hot water included. Energy produced by solar panels is calculated at around 16 kWh/m² per year. This means that over the course of a year, the building generates excess energy. Around 30 per cent of energy produced by solar panels can be used directly to meet the properties' power needs for lighting, heat pumps, and fans. […] Over the course of the year, solar panels produce more energy than the properties need." (Stockholm stad 2021c)
Energy community, P2P trading: N **Flexibility trading: N**	No
Overarching strategies	**Zero emission**: ☒ **Energy neutrality**: ☒ **Energy efficiency**: ☒ **Carbon free**: ☒ **Climate neutral**: ☒ Sustainable neighborhood: ☒Social aspects/ affordability: ☒
Further goals and ambitions:	**Building**: ☒ **Materials**: ☒ Renovation/refurbishment: ☐ **Sustainable production**: ☒ **Sustainable consumption/ procuring**: ☒ (local) administration: ☐ Legal framework: ☐ **Business models**: ☒ **Stakeholder involvement**: ☒ Citizen involvement ☐
Success and ambitions	
Indicators and expected impact:	5 Strategy areas to measure achievements: 1. Vibrant City, 2. Accessibility and Proximity, 3. Resource efficiency and climate responsibility, 4. Let nature do the work, 5. Participation and Consultation. Energy use is presented in kWh/m² A_{temp} and per year and includes energy for heating, hot water, property electricity, and comfort cooling. Additions for air circulation in commercial premises may be made according to the National Board of Housing's. In strategy area "3. Resource efficiency and climate responsibility" the efficiency of energy use in buildings, for example, shows: "Measured (requirement 55kWh/m²/year Norra 2) =70kWh/m² A_{temp} per year (purchased energy). Dwellings, average measured energy use 22% under applicable Swedish building code regulations in Norra 2." (Stockholm stad 2021b)
Actual success & experience	Development project is being showcased internationally and receives high interest, various innovation and R&D projects. Iterative development and two-year mandatory monitoring of energy performances of buildings allows for testing and learning of new methods: "Monitoring after properties have been commissioned is vital to identify deficiencies in energy systems and undertake remedial work. At the same time, there must be a checklist for measurement data/measurement plan for monitoring of all energy items so that they can be compared with previous energy calculations. The division of responsibilities between energy co-ordinators, contractors, and developers is also important." […] "These dialogue meetings have provided important insights and learnings for the construction of energy-efficient buildings throughout the entire construction process – from design and construction to operation and management. Potential exists to improve all parts of the construction process from project planning, energy co-ordination, as-built documentation, to handover to maintenance staff and management. "(Stockholm stad 2021d)

	"Stockholmshem's plus-energy buildings had a recorded, normalised, and adjusted energy performance of 32 kWh/m2 (factor 2- weighted for electrical heating). The buildings have a good form factor, high performance construction and technical installation parameters in combination with minimised distribution losses. The efficiency of solar cells is increased through recycling of excess heat from inverters that recharge boreholes and optimise geothermal heat pumps for hot water production in the summer. Good experience of wastewater heat exchangers and solar panels that performed better than projected. An energy co-ordinator was available throughout – from project planning to monitoring and a measurement plan that was drawn up at an early stage in the process. Management and monitoring of measurement were important as well as regular quality checks and an organization for monitoring from occupancy, with continuous monitoring meetings at least once a quarter. Favourable experiences with performance contract have provided improved opportunities to control key sub-systems." (Stockholm stad 2021c)
Challenges and barriers	"Recent monitoring of Norra 2 two years after its occupation shows that goals were exceeded: "Metered energy use in Norra 2 was on average 70 kWh/m² per year Atemp and is therefore 27 per cent higher than Stockholm Royal Seaport's target. However, this is 22 per cent better than applicable Swedish building code regulations." […] "Energy performance has improved successively from phase to phase, at the same time as Swedish Building Code regulations have become stricter. Reported values are for purchased energy. This would mean that the buildings in the area meet the zero-energy directive." (Stockholm stad, 2021d) "Dialogue continued with developers on troubleshooting and corrective measures. Proactive and transparent collaboration between all parties has created an important knowledge platform. This work shows the most significant deviations from target values are due to substantial use of heating and metering errors" […] "Shortcomings also exist in the handover from project planning to construction and from construction to property management. Developers will present the results of this work after the 2021 heating season." (ibid.)
Sources: (Stockholms stad, 2021a-d) Link: http://www.stockholmroyalseaport.com/ https://www.norradjurgardsstaden2030.se/en/ Interview: /	

3.3.7 Summary & Analysis of PED Approaches in Sweden

Sweden has ambitious national goals regarding climate goals, as well as also experienced, highly educated and well-connected professional organizations ranging from city administration, businesses and organizations. Also, cities have been pioneering in solutions, international reputation for being on the forefront of cities to foster climate neutrality. Strong, well-educated and interdisciplinary working teams from various departments are formed to bring together interdisciplinary teams that guide city development processes.

The analysed approaches all showed a very high level of public acceptance, with only few issues or oppositions being raised in formal manner. Especially in Lund and Malmö, project representatives mentioned the high trust in municipality organizations for finding solutions and making the right decisions. The long-term experience also shows now a high degree and sensibility towards monitoring and measuring actual success of projects, e.g. in regard to actual building performance for energy use due experience with underachievement of set goals in earlier projects. Main point of successful implementation was mentioned to be the central role of public ownership of organizations and institutions relevant in the process, e.g.

ownership of land, grid service providers and energy service providers being partially owned by cities in various of the examples. Innovative solutions are being asked for and are now making the mark when businesses compete for properties on which to build, so that competition does not range from price but for best and most innovative solutions.

Therefore, various project mentioned the professional partnerships and joint learning approaches with builders and architects. On the other hand, procurement was mentioned as a knowledge intensive and critical task for complex technological setups.

Regarding energy communities, few practical insights could be acquired due to the lack of a legal basis, the sharing of energy among neighboring buildings is mentioned to be of low relevance yet. General doubt on the concept was raised in regard to the relevance of the concept of energy communities in Sweden for the sake of its already high level of renewable energy production, and additionally for a general understanding that citizens and consumers shouldn't be overburdened with a task easier performed from other entities, and rather use measures of civic engagement for issues where actual influence and interest match.

4 Competences and competence building in identified PED-approaches

As PED/PEN is a rather new term in the field of sustainable development of urban areas and cities, it is important to follow and support its development by a systematic analysis of ongoing and – if available – already completed and implemented projects. The overall goal of achieving a surplus of energy within a functioning district or neighborhood is requiring the alignment of multiple different actors from different industries and sectors, as all actions of the different consumers, producers and storage providers influence the energy balance.

Competence is a concept coming from psychology and used since several decades in businesses for building and development of human resources or complete organizations. With the specialized concept of core competences Prahalad and Hamel (1990) tried to define what differentiates single enterprises from each other and is building up the foundation of its success. Competences in general can be defined as a series of knowledge, abilities, skills, experiences, and behaviours, which leads to the effective performance of individual's activities. Competency is measurable and could be developed through training (Maaleki 2018).

Within INTERACT we are taking a deeper look into selected PED/PEN projects to first identify and then in a second step assess the competences available within those projects. For the visualization of this network within the analysed PED/PEN projects the method of competence mapping was used.

4.1 Ways of building competence

As outlined in the introduction to Chapter 4, we differentiate between the competences of the individual and the competences of the (project) organization. In the rather new area of PED and PEN implementations, individual competences can be developed line with the experiential learning model from Kolb (1984) (see below, Figure 8). In this model, knowledge is coming from the combination of grasping and transforming experience. It is therefore important to interact with similar projects and challenges, to receive insights and further information either by direct involvement or from best-practices and first-hand storytelling. For the (project) organization, competence building takes a view on the necessary set of skills and resources to achieve the given goal, which is in our case the successful implementation of a PED / PEN, compares this with the available skills and resources and thereby identifies gaps.

conceptualization

Figure 8: Learning Cycle according to Kolb (1984)

4.2 Methodology of competence mapping

The following section describes the methods and the results for the Competence Network. The main goal was to assess competences which are relevant for the development of PED project approaches on both scientific and practical levels in projects where implementation and monitoring were addressed. The approach to exploring actual competences as collective skills in the context of PEDs was heavily based on desk research (identifying and collating information based on available project data) and techniques of qualitative content analyses which focussed on text-based quantifications of predefined terms of interest. Thereby, main competences in the context of developing and operating PEDs were identified and quantified. Another goal of this process was to allocated sets of competences to specific projects, project functions of involved stakeholders and hence provide an exploratory basis for comparison on an international scale. The main limitations of the analysis process opted for by the INTERACT project is 1) available PED project information and 2) the selected set of projects included in the analysis process. The first limitation directly relates to second as documentation of relevant and involved competences of immediate PED project partners and essential external stakeholders is limited at best. Moreover, only projects were information central to the present task was readily available.

The first step was to extract PED relevant competences from information provided by the INTERACT project partners, reports and project proposals of relevant research projects in Austria, Sweden and the Czech Republic. Further a coding system was created (table 18), which is classified in project function, competence level, competences, project and country.

Project function defines different roles of PED project partners. Competence level is classified by 3 levels: formal, informal and institutional level. Formal competences are qualifications employees learned in their academical education. Informal competences comprise non educated competences, e.g. social competences, communication. Institutional competences can be understood as every competence which brings institutions themselves (not the employees?).

Figures were created with MaxQDA visual tools: MaxMaps named code relation model. The frequencies of connections of selected codes were compared. Hence the line width of all figures is relative to the number of relations, not the importance, of the extracted competences. If a code has no connection, it exists in the projects, but not in connection with other codes.

4.3 Identified relevant competences

The coding system displayed below shows categories of competences identified in course of the review process of accessible project description data. The core aspects of the PED/PEN projects taken into account in the competence mapping process include which characterize the involved institutions: project function and country association. The project function relates to main role of an involved project partner organisation in the PED/PEN project (i.e. university partner as academia, architects as planners). The country variable relates to the specific use cases assessed in course of the projects (i.e. the Royal Seaport District is associated as Swedish use case with the respective country variable in the mapping process).

As competences are generally divided into subject-specific, methodologic and social competences forming systemic problem-solving competences (Richter 2008) the competence level distinction relates to these levels. Hence, informal competences relate to the social level of competences (i.e. soft-skill related interaction with stakeholders and end-users), formal competences are related to methodological expertise and application-oriented competences and institutional competences which represent the core strategic competences of the involved actors. Moreover, these competences are specified based on available data relating to tangible sublevels of skills.

Table 18 Coding system

Code System	
	Project function
	Academia
	Competence center
	Energy supplier
	Funding bodies

	Housing companies	
	Local stakeholders	
	Planners (architects, specialist planners)	
	Private research center	
	Project development	
	Public authority	
	Real estate developers	
Competence level		
	formal	
	informal	
	institutional	
Competences		
	Academic research	
		Probing and testing of technologies
		User research
	Architecture / building	
	Consulting	
		Gender & Diversity consultation
		Policy consultation
		Scientific consultation
	Education	
	Energy	
		Energy efficiency
		Energy planning
		Power storage
		Renewable Energy Sources
		Smart Grid
	Governance	
	Legislation and regulatory framework	
		Missing legislation / framework
	Mobility	
	Network	
		Within the project
	Organisation and administration	
	Project development	
	Social competences	
	Software	

	Simulation (Photovoltaics and building systems)
	Stakeholder management (interface function)
	Trading
Project	
	+CityxChange, Pisek
	Brunshoeg, Lund
	Hammarby Sjöstadt 2.0
	IRIS, Gothenburg
	MikroGrid Maria Rain
	Mühlgrundgasse
	Re:kobyn
	Royal Seaport District
	Smart City Campagne Reichenau
	Smart City Graz
	Smart City Wörgl
	Solar Region Skane, Skane
	SPARCS, KLADNO
	Zukunftsquartier
	Zukunftsquartier 2.0
Country	
	Austria
	Czech Republic
	Sweden

The final code of the competence map specifies the actual involved project and allows for specific use case centred analysis of accessible competences.

4.4 Competence Network

The results of the competence mapping process are visualized for a better understanding and transparency in three different ways:

- a code-relations-model for competences versus project functions
- a code-relations-model for competence level versus competences, and
- a code-relations-model for competence level versus project functions.

Figure (8) shows the complexity and the variety of connections, which the selected competences have among themselves and with different project functions. The most frequent connections between competences and project function linked “Planners” with “Architecture/building” and “Planners” with “Energy”. “Planners” have also a significant connection to “Network within the project” and “Energy planning”.

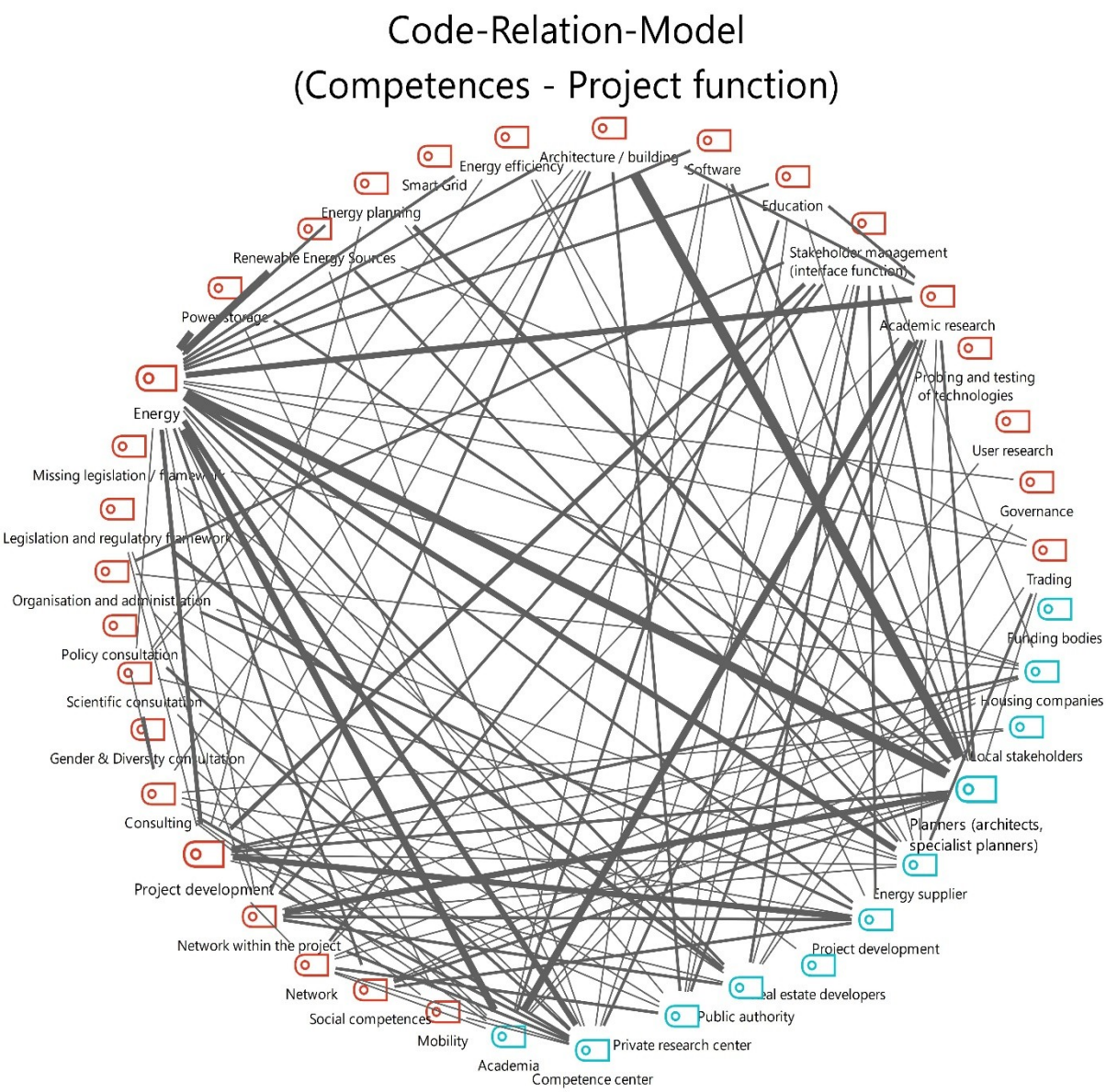


Figure 9: Code – Relation Model: Competences – Project Function

It is noticeable that a large number of thick lines start from “Energy” and “Planners”. The competence “Energy” is well connected with the project functions “Academia”, “Competence center”, “Energy supplier” and especially with “Planners”. Many connections to other competences are “Academic research”, “Project development” and to energy subcodes such as “Power storage” and “Renewable energy”.

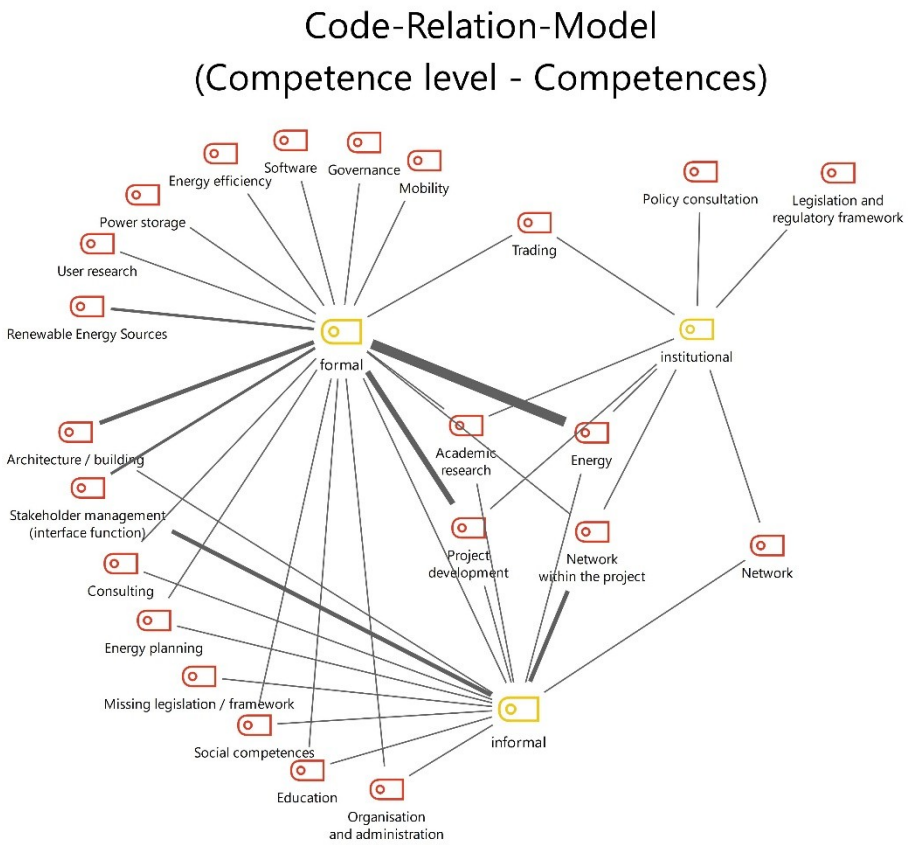


Figure 10 : Code – Relation Model: Competence level - Competences

Figure 10 indicates that the formal competence level represents the most frequent connections. Especially the competences "Energy", "Project management" and "Architecture/building" are to be highlighted by their frequency with this competence level. "Stakeholder management" and "Network within the project" are the most important competences within the informal competence level. Institutional competences seem to have a balanced distribution.

There are four competences, that are involved to all three competence levels: "Academic research", "Energy", "Network within the project" and "Project development". Every other competence is either once or twice related to the competence levels.

Seven out of eleven project functions are related to each competence level . “Planners” and “Project development” can be highlighted in high connection with both formal and informal competence level. “Competence center” and “Energy supplier” tend more towards the formal competence level.

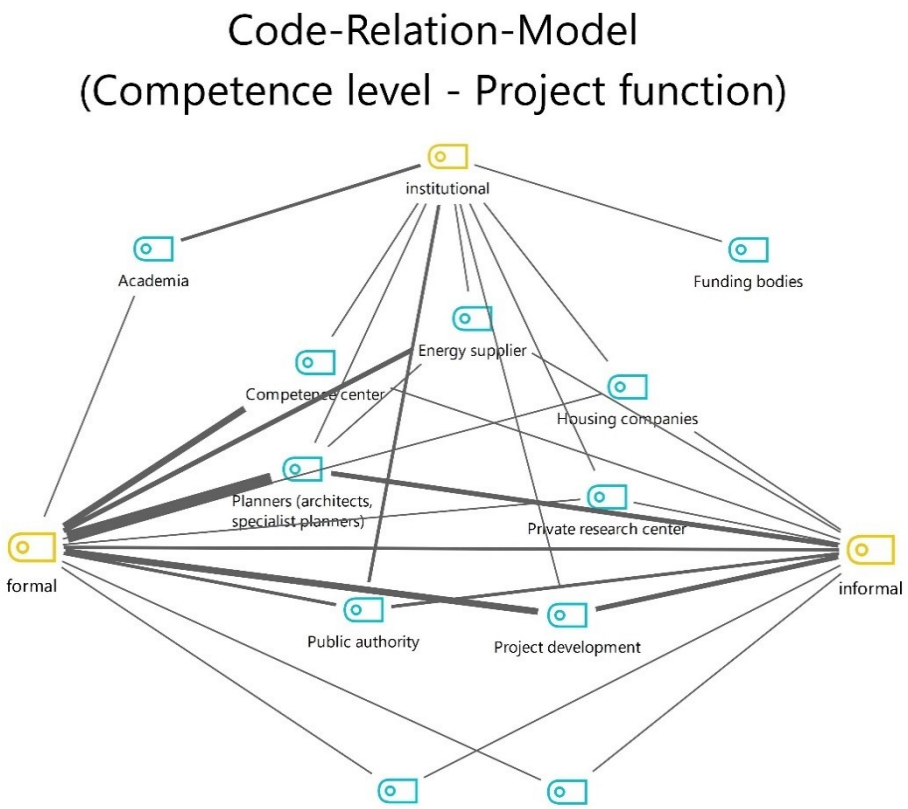


Figure 11: Code – Relation Model: Competence level – Project Function

“Funding bodies” is the only project function with just one connection in total, namely institutional level. “Academia” and “Public authority” have the most frequent connections to the institutional level than the other project functions.

5 Summary, outlook & conclusion

This document comprises the results from an analysis of the state of the art of PED ambitions and their international stakeholder community as a baseline for the future holistic design of energy communities. The goal was to draw from experiences of existing and already implemented PED projects from Austria, the Czech Republic and Sweden as a knowledge basis and a foundation for reflections on success factors and challenges on the pathway to developing projects with a plus energy ambition.

While Austria and Sweden showed already a number of entries in the above-mentioned booklet and provided us a large scene of experienced PED personnel, there was no case mentioned yet for the Czech Republic. In identifying and describing projects with PED ambitions there, and identifying further projects in Austria and Sweden, an addition to the insights of the booklet and future potential added projects for the ambition of 100 PEDs in Europe could be discovered. It is our aim to integrate those new projects into the PED competence network for a mutual exchange of knowledge and support in their ambitions.

The analysis of projects in the three participating countries fostered a direct communication, knowledge exchange and connection between project personnel and introduced researchers and actors from PED approaches towards one another creating a knowledge community, which offers the possibility for joint learning and feedback opportunities. As shown in Summary Table 20 in Annex, the majority of analysed projects is either in planning stage or currently in implementation. It is therefore difficulty to reflect on the status of PEDs by reaching their set goals. As can be seen by the variety of different key-aspects of the selected projects, the action fields to be addressed in order to reach a positive energy balance is wide. Most of the projects tackle new buildings structures and the use of energy for in-door-living, several projects focus also on mobility, while others address infrastructure measures and yet others focus on the community and community actions like energy sharing or shared services.

Even though, the general topics covered in projects experience seem to be similar, e.g. legal basis, support from strong central actor or municipal support, as well as complexities from technical solutions in contrast to the legal situation, etc., the details and experiences of locations, project approaches and stages of implementation make a concrete comparison flawed and would obscure the rich insights gathered from the analysis. “The significance of drivers and barriers is […] likely to be better understood if analysed qualitatively and cannot be compared solely by numbers.” (Backe and Kvellheim, 2020).

In that sense, there is still need for further, in depth analysis of experience in the process of development, implementation and operation of PED/PEN in a qualitative way in order to have sufficient knowledge basis for various locations and types of projects (e.g. greenfield, renovation, brownfield; village or urban, dense or spacious neighbourhoods; or different countries). This deliverable has proven to further expand this knowledge basis of experience from project analyses.

As mentioned in chapter 2.2, Backe and Kvellheimt (2020) identified key personnel as one of the two drivers for the success of project implementation that is relevant in all stakeholder groups. Even though occurrence of this aspect in all three groups does not necessarily give the importance of this aspect; yet it relates with the insights from various interviews in this PED analysis – formal, informal and personal competences of key personnel played a crucial role in envisioning, initiating, advancing, communicating and/or implementing projects.

This concerns, for example, the mention of the complex and intertwined role of stakeholders that are drivers of further development and spread in the market of ZEN (ibid.). Yet, the authors emphasize, that "challenges and possibilities are diverse and complex, and hence no single stakeholder group would be likely to drive this development alone" (ibid.). With regard to our assessment of PED approaches and ambitions, the interplay and core function of various actors has been mentioned. For example, the role of public administration like municipal organisations and their commitment to lead PED ambitions was mentioned frequently in interviews with project personnel. The relevance of this insight remains unquestioned, however there is need to be aware that from the single perspective of only one project representative, a full picture of stakeholders' roles in contributing to the success of a process cannot be reported. Within the INTERACT project, the stakeholder analysis with interviews with representatives of stakeholder groups from the two demo regions about their perspective on their own role and their assessment of the relevance of other stakeholder groups in their opinion will shed light on these complexities, thereby brining crucial insights for preparation of the implementation. The results of said stakeholder mapping will be part of Deliverable 2.2 in fall/winter 2021.

The visualization of competences within competence network models shows, that most frequently architects, planners and project developers are included in the analysed projects. This goes in hand with the fact, that mostly new building areas are targeted, and the focus is laid on the building design and its technical features. We see the potential of integrating energy experts right from the start of such processes, putting a focus on the energy balance of the whole district with all its usages, and helping shaping it towards a positive energy place.

Based on the limited available information accessible via project leaflets, deliverables and reports, a network of associated variables linking specific competences with thematic characteristics, country and partner function associations could be established in the current field of PED/PEN projects.

The selected methodological approach to competence mapping proved to be not only of exploratory value as findings underline the expected interconnections between functions of organizations/project partners and specific sets of formal, informal and institutional expertise conflated in interdisciplinary research and development projects. Aided by basic methods of qualitative content analysis, visualisations between a chosen set of variables are possible to establish systemic and comprehensible relations between competences, functions and their potential relations to successful PED/PEN implementation.

As expected, based on the thematic focus of considered PED/PEN projects, competences in the fields of energy (power storage solutions, renewable energy sources, smart grids, etc.), project development and architecture represent significant fields of expertise. Moreover, the main project functions identified within the PED/PEN initiatives academia, planning, project development and funding are also directly associated with these competences. These insights serve in the later stage of INTERACT for the creation of a Roadmap to describe the key competencies needed for successful project development.

The chosen approach is mainly limited by the above-mentioned constraints: access to project information and data on successful implementation. Based on more in-depth information on success-factors a normative level associated with the identified competences can strengthen the mapping process substantially and support the establishment of good-practice constellations in PED/PEN initiatives.

Within the project INTERACT, the relationship of PED and PEN ambitions with energy communities is assessed and further work packages of the project will focus on energy communities. Energy Trading with production, storage and consumption on a local or regional level seems important, either for heat or electricity. Yet it still remains open to shed light on how far energy communities contribute to PED approaches, or to assess the potential of integrating energy communities as a base for areas with PED and PEN ambitions. Further work in the INTERACT project will contribute to this discussion.

This Deliverable is considered as a documentation of perspectives and analysis at a certain point, namely during summer 2021. It does not claim to be conclusive and includes various ambitions that are still work in progress. Therefore, this deliverable serves as a basis for discussion and feedback within the community

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7 Appendix

Table 19: Overview-Table of analysed PED-Approaches - Selected projects

No.	Name	Location, Country	Status	Key-Words
1	Südtiroler Siedlung	Wörgl, AT	Implemented	Newly built, Residential Houses, PV, Storage
2	Campagne Reichenau	Innsbruck, AT	Implemented, in building	Newly built, Residential Houses, Cooperative Planning, Mobility
3	Reininghaus	Graz, AT	Implemented, in building	City Development, Distant Heating, Infrastructure
4	MikroGrid	Maria Rain, AT	Ready to implement	Existing Neighborhood, Energy Community, PV, Storage
5	Mühlgrundgasse	Wien, AT	Implemented	Newly Built, Residential Houses, Low-Tech, Energy Efficient
6	Zukunftsquartier	Wien, AT	Planning	Energy Balance, Plus Energy, PV, Feasibility
7	Sparcs	Kladno, CZ	Planning	Existing Neighborhood, Energy Reduction, PV, Storage, Local Community
8	+CityxChange	Písek, CZ	Planning	Electricity Trading, P2P, PV, Energy Storage
9	Ruggedized	Brno, CZ	Planning	Brownfield, Smart Neighborhood, PV, Storage, Usage of Waste Heat
10	Chytré Líchy	Židlochovice, CZ	Planning	Newly Built, Carbon-Free, Smart, Mobility, Long-term operating costs
11	Access	Malmö, SE	Planning	PV, Storage, E-Mobility, Smart Load-Control
12	Brunnshög	Lund, SE	In implementation	Newly Built, Distant Heating, PED, Solar Thermal Energy
13	Fossil-free Energy District	Gothenburg, SE	Implemented	Energy Trading, local market, flexibility, Energy Community
14	IRIS	Gothenburg, SE	In implementation	Existing Neighborhood, Mobility, PED, PV, Energy Management System
15	Re:kobyn	Röstanga, SE	Planning	Newly Built, energy Balance, Community, Biomass, PV, Heat Pump
16	Royal Seaport District	Stockholm, SE	In Implementation	Existing and new buildings, Passive Houses, PV, Iterative Development

Table 20: Overview of analysed PED approches – projects non included in the detail analysis

No.	Name	Location, Country	Status	Further info
1	Itz Smart	Salzburg, AT	Planning stage	https://nachhaltigwirtschaften.at/en/sdz/projects/itz-smart.php
2	City of Tomorrow - otto wagner area	Wien, AT	Planning stage	https://nachhaltigwirtschaften.at/en/sdz/projects/otto-wagner-areal-plus.php
3	Energy Autark Region Carnica Rosental	Region Carnica Rosental, AT	Implementation stage	https://region-rosental.at/kem
4	TRANS-PED/ Dorferweiterung Schwoich, Tirol - „Sonnendorf“	Sonnendorf, AT	Planning stage	https://sustainable-buildings-and-cities.netlify.app/project/transped/
5	LEC in Parking Lot	Mechelen, BE	Planning stage	https://northsearegion.eu/access/pilots/mechelen/
6	Zemesouzneni	Peckovice, CZ	Planning stage	https://www.zemesouzneni.cz
7	+CityxChange	Võru, EST	Implementation stage	https://cityxchange.eu/
8	Ilokkaanpuisto	Tampere, FI	Implementation stage	https://stardustproject.eu/
9	Making-City	Oulu, FI	Implementation stage	https://makingcity.eu/
10	mySMARTlife	Helsinki, FI	Implementation stage	https://www.mysmartlife.eu/cities/helsinki/
11	Fleuraye west	Carquefou, FR	Implementation stage	https://biit.l//2Fsdcq8; http://www.quarterlafleuria/e.fr/
12	Dietenbach	Freiburg im Breisgau, GE	Implemented/ In Operation	https://www.freiburg.de/pb/,Lde/495838.html
13	EnStadt:Pfaff	Kaiserslautern, GE	Planning stage	www.pfaff-reallabor.de / www.pfaff-quartier.de
14	+CityxChange	Limerick, IE	Implementation stage	https://cityxchange.eu/
15	Gloughjordan	Gloughjorda, IE	In operation	http://www.thevillage.ie/
16	Castelletto	Parma, IT	Planning stage	--
17	Santa Chara Open Lab	Trento, IT	Implementation stage	http://www.comune.trento.it/Comunicazione/Il-Comune-informa/Ufficio-stampa/Comunicati-stampa/S.-Chiara-Open-Lab-approvazione-dei-

No.	Name	Location, Country	Status	Further info
				progetti
18	Sharing Cities	Mailand, IT	Implemented/ In Operation	www.sharingcities.eu
19	Sinfonia	Bozen, IT	Implementation stage	http://www.sinfonia-smartcities.eu/en/project
20	STARDUST	Trento, IT	Planning stage	https://stardustproject.eu/
21	ATELIER	Amsterdam, NL	Implementation stage	https://smartcity-atelier.eu/
22	De Groene Mient	The Hague, NL	In operation	http://www.groenemient.nl/
23	MAKING City	Groningen, NL	Implementation stage	http://makingcity.eu/
24	P2P electricity Trading	Amersfoort, NL	Planning stage	https://northsearegion.eu/access/pilots/amersfoort/
25	PoCiTYF	Alkmaar, NL	Implementation stage	https://pocityf.eu/city/alkmaar/
26	Soesterkwartier	Duurzaam Soesterkwartier, NL	In operation	https://fmezen.no/campus-evenstad/
27	Zuiderlicht	Zuiderlicht, NL	In operation	www.zuiderlicht.nu
28	+CityxChange	Trondheim, NO	Implementation stage	https://cityxchange.eu/
29	Campus Evenstad- ZEN Pilot Project	Stor-Elvdal Municipality, NO	Implementation stage	https://fmezen.no/campus-evenstad/
30	Fornebu2, Bærum – ZEN Pilot Project	Bærum, NO	Implementation stage	https://www.baerum.kommune.no/politikk-og-samfunn/barum-2035/stedsutvikling-i-barum/nye-fornebu/
31	Furuset project	Oslo, NO	Planning stage	https://byplanoslo.no/content/furuset-skal-vise-vei-satser-stort-pa-klima
32	NTNU Campus within the Knowledge Axis, Trondheim – ZEN Pilot Project	Trondheim, NO	Implementation stage	https://www.ntnu.no/campusutvikling
33	Ydalir project- ZEN Pilot Project	Elverum, NO	Implementation stage	www.ydalirbydel.no
34	Zero Village Bergen	Bergen, NO	Planning stage	https://zerovillage.no/

No.	Name	Location, Country	Status	Further info
35	Ny by – ny flyplass	Bodø, NO	Planning stage	https://bodo.kommune.no/nyby-nyflyplass/
36	POCITYF	Évora, PT	Implementation stage	https://pocityf.eu
37	Laser Valley – Land of Lights (ELI-NP, Magurele)	Măgurele, RO	Implementation stage	http://landoflights.ro/
38	Hammarby Sjöstad 2.0	Hammarby Sjöstad, SE	Implemented/ In Operation	http://hammarbysjostad20.se//
39	Sege Park Malmö	Malmö, SE	Planning stage	https://www.eon.se/artiklar/sege-park-i-malmoe-blir-sjaelvfoersoerjande-pa-solel.html
40	Cityfied - Linero district energy-efficient retrofitting	Lund, SE	Implemented/ In Operation	http://www.cityfied.eu/Demo-Sites/Lund/Lund.kl
41	Hunziker Areal	Zürich, CH	Implemented/ In Operation	https://www.mehralswohnen.ch/
42	Making City – Follower City Kadıköy	Istanbul-Kadıköy, TR	Implementation stage	https://smartcities-infosystem.eu/sites-projects/projects/making-city