Innovation Action

H2020-LC-SC3-SCC-1-2018

# D4.20 - Methodology and Guidelines for PED design - Initial Version

**WP4, Task 4.1**

Date [M12]

Author(s): Beril Alpagut (DEM), Cecilia Sanz Montalvillo (CAR), Jhon Fredy Vélez Jaramillo (CAR), Patxi Hernandez Iñarra (TEC), Jeroen Brouwer (TNO), Sari Hirvonen-Kantola (UOU), Hanna Kosunen (UOU), Nekane Hermoso Martinez (TEC), Petri Ahokangas (UOU), Samuli Rinne (UOU), Nicole de Koning (TNO), Joke Kort (TNO), Yueqiang Xu (UOU), Andrea Gabaldon Moreno (CAR), Enery Acevedo González (LEO), Mónica Prada Corral (LEO), Begoña Gonzalo Orden (LEO), Rachel Desmaris (R2M), Sophie Dourlens-Quaranta (R2M), Emilio Miguel Miter (GBCE), Paula Rivas Hesse (GBCE), Dolores Huerta (GBCE), Guillermo Fenández (GBCE), Daniela Gómez (GBCE), Oya Tabanoğlu (DEM), Gonca Akgül (DEM)

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*This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Grant Agreement n°824418.*

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# Document Information

| | |
|---|---|
| Grant agreement | 824418 |
| Project title | Energy efficient pathway for the city transformation: enabling a positive future |
| Project acronym | Making-City |
| Project coordinator | Cecilia Sanz-Montalvillo (CARTIF): cecsan@cartif.es |
| Project duration | 1st December 2018 – 30th November 2023 (60 Months) |
| Related work package | WP4 – Positive Energy Districts Concept Early Replication |
| Related task(s) | Task 4.1 – Methodology / guidelines for PED design |
| Lead organisation | DEM |
| Contributing partner(s) | CAR, TEC, GRO, TNO, RUG, HUAS, SEV, OUK, VTT, BAS, UNI, LEO, KM, POP, STU, VID, GSC, LUB, LPEC, R2M, GBCE, UOU |
| Due date | 30/11/2019 |
| Submission date | 30/11/2019 |
| Dissemination level | Confidential |

# History

| Date | Version | Submitted by | Reviewed by | Comments |
|---|---|---|---|---|
| 06/02/2019 | 0.1 | DEM | | Outline, TOC Preparation |
| 09/04/2019 | 0.2 | DEM | | TOC Update |
| 17/04/2019 | 0.3 | CAR | DEM | MC PED definition |
| 23/05/2019 | 0.4 | UOU | DEM | PED Replication Method |
| 03/06/2019 | 0.5 | DEM | | MethodDev.,Literature R. |
| 05/06/2019 | 0.6 | TNO | DEM | SPEC Cards |
| 07/06/2019 | 0.7 | UOU | DEM | Method Development |
| 20/06/2019 | 0.8 | GBCE | DEM | SPEC Cards |

| | | | | |
|---|---|---|---|---|
| 24/06/2019 | 0.9 | RUG | DEM | SPEC Cards |
| 04/07/2019 | 0.10 | DEM | | MethodDev.,Literature R. |
| 09/07/2019 | 0.11 | TNO | DEM | SPEC Cards |
| 18/07/2019 | 0.12 | TNO | DEM | Method Development |
| 26/08/2019 | 0.13 | GBCE | DEM | Reference PED Projects |
| 16/09/2019 | 0.14 | DEM | | Method Development |
| 23/09/2019 | 0.15 | R2M | DEM | Identification of Stakeho. |
| 04/10/2019 | 0.16 | CAR | DEM | PED Calculation |
| 10/10/2019 | 0.17 | DEM | | How to proceed with PED |
| 21/10/2019 | 0.18 | UOU | DEM | Method Dev., SPEC Cards |
| 22/10/2019 | 0.19 | TEC | DEM | Energy Demand Analysis |
| 23/10/2019 | 0.20 | TNO | DEM | Method Development |
| 12/11/2019 | 0.21 | OUK | DEM | SPEC Cards |
| 15/11/2019 | 0.22 | ALL FWC | DEM | Barriers and Enablers |
| 21/11/2019 | 0.23 | DEM | RUG, TNO, UOU | Cross-review of D4.20 |
| 27/11/2019 | 0.24 | DEM | CAR | Update of initial version. |
| 30/11/2019 | 1.0 | CAR | | Final version for submission |

# Table of content

*Highlighted SPEC cards will be finalized in final version of this deliverable.

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# Abbreviations and acronyms

| Acronym | Description |
|---|---|
| DER | Distributed Energy Resources |
| FWC | Follower City |
| GHG | Greenhouse gas |
| LHC | Lighthouse City |
| MC | MAKING-CITY |
| PEB | Positive Energy Block |
| PED | Positive Energy District |
| PEN | Positive Energy Neighbourhood |
| RES | Renewable energy sources |
| SEC | Smart Energy Cities |
| SET | Strategic Energy Technology |

# Executive Summary

This deliverable is consisting of an extensive description of a recently developed Positive Energy District planning and design methodology within WP4 "*POSITIVE ENERGY DISTRICTS CONCEPT EARLY REPLICATION*" of the MAKING-CITY Project. More specifically, it focuses on the activities carried out in Task 4.1 "*Methodology / guidelines for PED design*" which aims a comprehensive definition of PED including the definition of a rigorous procedure to evaluate the annual positive energy balance, according to technical, financial, social, legal and spatial constrains.

The main objective of MAKING-CITY is the development of new integrated strategies to address the urban energy system transformation towards low carbon cities, with the PED approach as the core of the urban energy transition pathway. Aligned with this aim, a harmonized energy and urban planning methodology is developed for PED design in cities. PED Methodology will be early adopted by FWCs (Task 4.2 Analysis of FWC candidate areas to become a PED) in the second year of the project to identify PED boundaries and select proper technologies collectively and co-design PED in their cities in the following year. This document will later be a basis for replication and upscaling plans of LHCs and FWCs in MAKING-CITY.

As indicated before, cities must have a holistic approach on harmonizing energy and urban planning for energy transitions. Urban developments must evolve from single, unintegrated, simple "building" based interventions into Positive Energy Districts and Neighbourhoods concepts in order to reach energy and climate targets which will lead to an integrated energy planning. Proposed PED Methodology in this report provides cities considerations and guidelines to plan and design PEDs not only technically but also socially, economically, politically and spatially aligned with sustainable urbanization domains. Phases of the proposed methodology analyses main characteristics and priorities of cities by evaluating city indicators, a deep research on existing national/regional/local level city plans and implementation areas of these plans, analysing city components (e.g. resources, urban macro-form, energy infrastructure and services, social aspects), and energy demand. Once PED concept boundary is defined by these analyses, cities start social, economic and technical processes for selection of solutions to achieve PEDs. The outcome of the PED methodology is the detail cards (SPECs) of all technical and non-technical solutions collected in solution catalogue (PEDBoard) The following figure describes in a schematic way the phases of the Methodology for PED Design.

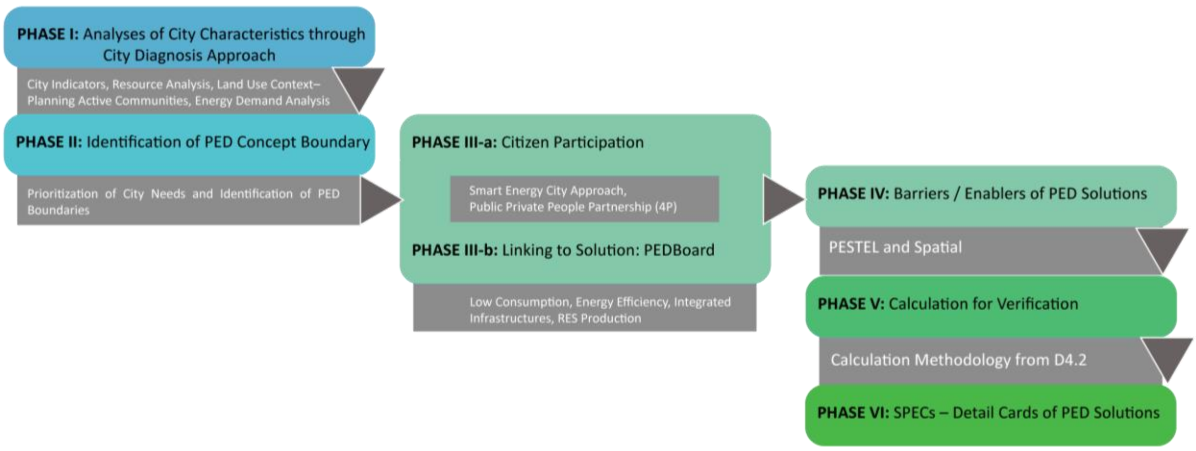


**Figure 1 Phases of the PED Methodology**

Thanks to proposed PED Methodology, aspects related with the specificities of the cities, regions and even countries, is considered, in order to have a standardized concept valid to be the core of specific urban energy transitions planning processes. As this incipient PED concept is a valid pathway towards an Energy transition, this must be aligned with the long-term and mid-term vision of the city plans (WP1). For the specific design of PED, technical and social barriers, and regulatory framework conditions will be identified for ensuring that technical and non-technical solutions are properly accompanied by a solid transferability perspective. In addition, in the demonstrations tested in Oulu (WP2) and Groningen (WP3), a set of solutions (can be considered as a 'catalogue') and their associated benefits to reach PEDs is carried out, establishing the basis to document any other suitable solution.

Furthermore, a set of guidelines according to the different application scenarios will be carried out to facilitate designers the identification and combination of the solutions to transform a district in positive energy in the final version of this deliverable.

# Keywords

Positive Energy Blocks, Positive Energy Districts, Positive Energy Neighbourhoods, Energy Transition, Harmonization of urban and energy planning, Participatory design, Public-private-people participation, local RES production, energy flexibility, energy efficiency, energy markets, replication

# 1 Introduction

This report constitutes Deliverable *"D4.20 Methodology and Guidelines for PED design (Initial Version)"* which is the based on the outcome of the *"Task 4.1: Methodology / guidelines for PED design*".

The objectives of the deliverable are:

- Definition of the PED methodology
- Establishing guidelines according to the different application of scenarios to facilitate designers the identification and combination of the solutions to transform a district in PED

The present deliverable is structured as follows:

Chapter 1 gives general information about the report and relation with MAKING-CITY.

Chapter 2 provides literature review on PED concept and different PED definitions and framework according to different initiatives, projects and network and reference PED projects. A study describing challenges for PED implementation in cities is also held for defining state of play in cities.

Chapter 3 identifies the definition of PED for MAKING-CITY and objectives of the proposed PED Methodology. A brief explanation for calculation methodology is presented and experience mapping of two LHCs is evaluated for introducing the phases LHCs went through during PED area selection.

Chapter 4 describes in detail the proposed PED Methodology by its phases to be pursued to implement Methodology for PED Planning and design

Chapter 5 discusses a reference method for citizen involvement strategies applied in Netherlands

Chapter 6 is focused on identification of stakeholders of each LHC and FWC.

Chapter 7 cites the activities performed during 1st year of MAKING-CITY, specifically GamePED Workshop that was held in project meetings, a section of brief lessons learnt from LHCs and how citizens will be involved in future cities for describing how to proceed with PEDs.

Finally, Annex I includes a barrier/enabler matrix that is contributed by all FWCs and their support partners which is mentioned in Phase IV of PED Methodology.

Annex II presents SPEC (Detail) Cards of technical and non-technical solutions of MAKING-CITY and other projects. The cards will be finalized in the final version of this deliverable.

## 1.1 Purpose and target group

The main purpose of Methodology and Guidelines for PED design is to provide an approach for planning and designing PEBs/PEDs in cities. Since PEDs play a key role on energy transition in cities, the aim of this report highlights the importance of citizen participation, economic, technical, political, regulatory and spatial issues for a sustainable urbanization. In line with this, definition of the methodology and establishing guidelines according to the different application of scenarios to facilitate designers the identification and combination of the solutions to transform a district into a PED, is pointed out. In this deliverable, the analyses and conceptions for defining PED boundaries in cities and selection of technologies in parallel with participative processes are intensely examined and presented.

The target group of the proposed PED method is mainly the municipalities, nonetheless the process defined in this report covers citizens, designers, planners, technology providers, energy utilities, grid operators, researches, energy real estate investors, energy generators, energy service providers and public transport operators and mobility planners.

## 1.2 Contribution partners

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

**Table 1 Contribution of Partners**

| Partner nº and short name | Contribution |
|---|---|
| 25-DEM | Main contributor for developing PED method, literature review and generator of PED Methodology Phases |
| 01-CAR | PED concept definition according to MAKING-CITY, identification of city level indicators and analyses of existing city plans, calculation of PEDs |
| 02-TEC | Energy demand analyses, summary of calculation of PEDs |
| 03-GRO | Discussions on PEDBoard and SPEC cards generation |
| 04-TNO | Citizen participation approach development, smart energy city methodology integration and citizen engagement strategies in Netherlands, SPEC cards |
| 11-RUG | Contribution to integrated energy planning approach |
| 13-OUK | Discussions on PEDBoard and SPEC cards generation |
| 14-UOU | Harmonization of urban and energy planning and design, contribution to phases and Public-Private-People Partnerships, SPEC cards generation |
| 20-VTT | SPEC cards generation, definition of city level indicators |
| 21-BAS | Contribution to Barriers and enablers of solutions, solution Index |
| 22-UNI | Contribution to Barriers and enablers of solutions, solution Index |
| 23-LEO | Contribution to Barriers and enablers of solutions, solution Index |
| 24-KM | Contribution to Barriers and enablers of solutions, solution Index |
| 28-VID | Contribution to Barriers and enablers of solutions, solution Index |
| 29-GSC | Contribution to Barriers and enablers of solutions, solution Index |
| 30-LUB | Contribution to Barriers and enablers of solutions, solution Index |
| 32-R2M | Identification of stakeholders, economic challenges against implementation of PEDs |
| 33-GBCE | Reference PED projects, SPEC Cards generation, contribution to phases of the methodology |

## 1.3 Relation to other activities in the project

The following table depicts the main relationship of this deliverable to other activities (mainly deliverables) developed within the MAKING-CITY Project and that should be considered along with this document for further understanding of its contents.

**Table 2 Relation of the report to other deliverables and activities**

| Deliverable / Task nº | Relation |
|---|---|
| T4.1/D4.15, D4.2 | PED Methodology Phase V adopts Guidelines to calculate the annual energy balance PED (demand, consumption, Energy flows, storage, RES) to verify if the selected boundary and solutions already provide surplus in energy balance. |
| T4.2/D4.16, D4.3 | This report will be a basis document for the analysis of districts in the FWC and selection of candidate areas to become a PED. |
| T2.1/D2.13 | Action Cards of Oulu PED (Kaukovaino) interventions detailed design report provide basis data for SPEC cards |
| T3.1/D3.13, D3.13 | Action cards of Groningen PEDs (North, Southeast) interventions detailed design report provide basis data for SPEC cards |
| T1.2/ D1.2 | *City diagnosis: analysis of existing city plans* mentioned in Phase I of the PED Methodology for identification of city needs and priorities |
| T1.3/ D1.22, D1.3 | *Tools for modelling energy demand, supply side, simulation of scenarios and estimation of impacts* mentioned in Phase I of the PED Methodology for identification of city needs and priorities |

# 2 Positive Energy Districts Concept

This section provides literature review on PED concept and different PED definitions and framework according to different initiatives, projects and network and reference PED projects for displaying the state of the art on complex structure of PEDs. A study describing challenges for PED implementation in cities is also held for defining state of play in cities.

One of the most important global trends is the dynamic growth of cities and the concentration of socio-economic functions in metropolitan areas. According to UN projections, world population will increase to 8.9 billion by the year 2050, two thirds of which will live in cities. The average population of the thirty most populous cities of the world will have tripled between 1965 and 2025.[1] The 2015 Paris Agreement has supported international efforts to reduce CO2 emissions, where urban areas with 70% share of emissions have a key role. **UN Sustainable Development Goal 11** is the goal of sustainable cities and communities with the aim of supporting the transition towards low-carbon cities. Thus, the development of cities in the following years, will determine progress on addressing the key environmental, economic and social challenges. Until now, **smart cities** have been evaluated within **energy, mobility and ICT domains**, while integrated ***sustainable urban planning, land use planning and urban design*** is also highly relevant for designing and implementing smart cities. Sustainable urbanisation is planned in a way that commuter towns are avoided, and the created districts provide as much services as possible with an integrated approach considering the environmental, social, economic, and spatial impacts. The challenge is that smart city aspects, such as **decentralization and digitalization of the energy sector**, have not previously been a part of integrated urban planning, land use planning and urban design. In this line, **Positive Energy Districts (PEDs)** can be seen as foundation of a highly efficient and sustainable route to progress beyond the current urban transformation roadmaps as PEDs **are integrated mixed-used districts** that have a positive impact within and beyond the limits of the district.

The Strategic Energy Technology (SET) Plan short definition is "Positive Energy Districts (PED) are energy efficient districts that have net zero carbon dioxide ($CO_2$) emissions and work towards an annual local surplus production of renewable energy (RES)." PED or Positive Energy Blocks[2] (PEB) are seen as "seeds" for an urban regeneration of all sizes, in fact, PEDs can raise the quality of life in European cities, contribute to achieving the COP21 targets and enhancing European capacities and knowledge to become a global role model. The TWG 3.2 "Smart Cities and Communities" has developed an integrative approach including technology, spatial, regulatory, legal, financial, environmental, social and economic perspectives, to support the planning, deployment and replication of PEDs for sustainable urbanisation[3].

SET Plan has been recognised as one of the major tools to deliver the Energy Union Strategy, by contributing to the cost reduction and improvement of the performance of low carbon energy technologies through impactful synergetic innovation actions.

The strategic target of the Implementation Plan was inspired by discussions in the European Innovation Partnership on Smart Cities and Communities, especially by the Initiative on PEBs and the "Zero Energy/Emission Districts" mentioned in the TWG 3.2 Declaration of Intent. The Programme on PEDs and Neighbourhoods (PED Programme) that was established in 2018 by the Action 3.2 on Smart Cities

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[1] Wołek, M., & Wyszomirski, O. (2013). The trolleybus as an urban means of transport in the light of the Trolley project. Gdańsk: Wydawnictwo Uniwersytetu Gdańskiego.

[2] A Positive Energy Block (PEB) is a group of at least three connected neighbouring buildings producing on a yearly basis more primary energy than what they use. These buildings must serve different purposes (housing, offices, commercial spaces...) to take advantage of complementary energy consumption curves and optimise local renewable energy production, consumption and storage. Another key advantage of the concept is that by creating a **functional and social mix**, they will contribute to **urban regeneration**. PEBs, mainly focussed on energy, can also help with taking-up bioclimatic architecture, advanced materials, Information and communication Technologies (ICT) with on-site renewable energy production. https://eu-smartcities.eu/initiatives/71/description

[3] Twg Action plan 3.2 Set Plan

and Communities of the European SET Plan, has the ambition to support the planning, deployment and replication of 100 'Positive Energy Districts' across Europe by 2025 for urban transition and sustainable urbanisation. PEDs will raise the quality of life in European cities, contribute to reaching the COP21 targets and enhancing European capacities and knowledge to become a global role model.

*PEB / PED = Circular Economy*

When considering the PEB/PED concept, a series of elements naturally come into place: the need for a smart grid; local renewable energy production; optimal use of elements such as advanced materials, or local storage; Information and Communication technologies (ICT); digital design; active management (demand-response, load shifting, peak shaving, optimisation, user interaction involvement and connection to electromobility solutions.[4]

The +CityxChange project considers that *Positive Energy Districts should also enable the trade of energy within the block and its surroundings utilising advanced Distributed Ledger Technology to create added value and incentives for the consumer to generate energy locally, provide flexibility and aggregate power generation in a system-wide cloud solution. The aggregation of these local energy, flexibility, power quality and balancing markets will lead the way towards maximum uptake of renewables and a near zero energy economy in the future.*

## 2.1 From smart cities towards Positive Energy Districts

PEDs are evolving from sustainable neighbourhoods, energy efficient districts and nearly zero energy districts concepts. Earlier concepts are with reference to Trias Energetica model that is developed by the Delft University of Technology and acts as a guide when pursuing energy sustainability in urban design. The Trias Energetica makes clear that energy savings have to come first on the path to environmental protection.[5] The method consists of three steps:

1. **Reduce the demand for energy through the rational use of energy:** There is substantial possibility for reducing energy demand in cities by an integrated approach to the design of buildings, building clusters, the transport system and district or micro- power generation, with novel technologies. Their effectiveness can be evaluated by and assist governments in writing their strict energy policies.
2. **Use sustainable sources of energy like renewable energy** to fulfil demands: Using natural resources wherever possible at any level, combined with reliable energy design choices. Using for instance the building facade and parking lots as solar collectors, and use that energy for heating and/or cooling also applying wind power, hydropower, geothermal power, biomass where possible.
3. **Use fossil fuels, if necessary, as efficiently and cleanly as possible**: (compensate) After having applied the first two steps to the maximum possible, the remaining energy need, if any, will be met by applying fossil fuels as efficiently as possible, by applying state-of-the-art techniques, such as: CHCP: combined heating, cooling, and power generation , use waste fuelled biogas generators.

Traditionally, energy has been centrally produced by big power plants, transmitted into cities and then distributed among the several consumers, such as: households, companies, or service providers. This corresponds to a linear progression from a centralized production (Figure 2) to a decentralized distribution. However, this landscape is quickly changing in all the steps of its supply chain. In the production process, we see a shift from centralized to decentralized generation.[6]

[4] EIP-SCC Webinar on Positive Energy Blocks for Small & Medium Sized Cities, 3rd November 2016.
5 Critical review of sustainable energy schemes of trias energetica
6 Smart cities MOOC prepared by IGLUS (innovative governance of large urban systems), EPFL – École polytechnique fédérale de Lausanne


**Figure 2 Centralized Generation - One-way power**

According to +CityxChange project, "recent technological developments have changed and reshaped the functioning scheme of different service sectors, including the energy markets. The consumption-production model is becoming more complex in terms of design, operation and maintenance. This is accompanied by the introduction of new key elements to the system, such as renewable source, energy storage, smart grids, data management and prosumers."

This relatively new, reshaped and derived concept emphasizes the so-called energy flexibility[7]/complexity which enables communication and trade between peers, all the while striving for a localized, flexible heat/power supply market, is defined as the modification of generation injection and/or consumption patterns in reaction to an external signal (price signal or activation) in order to provide a service within the energy system. Regarding this transformation in energy supply chain, the pricing of electricity has changed. Instead of fixed prices, consumers now find price signals, which change according to supply and demand. Individual electricity generators can choose to sell back to the grid when prices are high and buy from the grid when prices are low, for instance. This provides new generation of technologies that can automatically react to this shifting. The new concept towards PEDs for sustainable urbanization is schematized in Figure 3 From Trias Energetica Model to PED Concept.

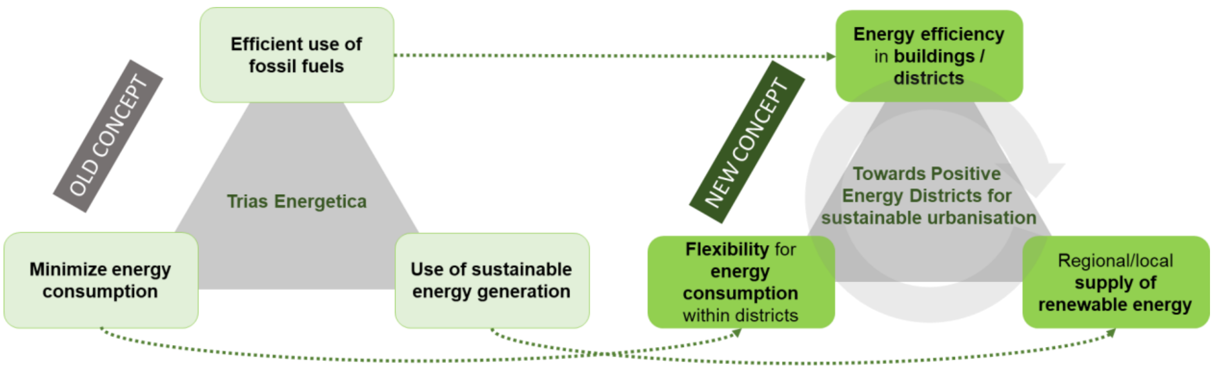


**Figure 3 From Trias Energetica Model to PED Concept**

Power demands are continuing to rise, and energy availability and reliability are becoming primary concerns for utilities, independent power producers, industrial manufacturers, and commercial campuses—all of which need solutions to help provide a reliable and cost-efficient electricity supply. At the same time, Distributed Energy Resources (DERs) such as renewable generation sources and energy storage are being added to the grid (Figure 4) , creating new operational challenges, while also bringing new business opportunities and revenue streams, resulting in decentralized systems also mentioned above.

[7] By flexiblity, we intend here the ability of a system to provide supply and demand balance over different time scales in an economic and reliable way, including response to unforseen events (N.Good, E.A. Martinez Cesena, P. Mancarella, 2017).

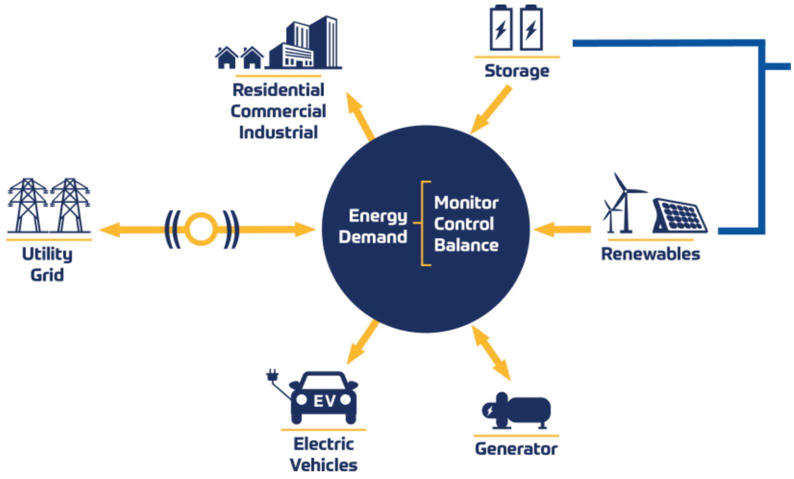


**Figure 4 Distributed Energy Resources in decentralized micro-grid systems**

There are several key factors driving the DER trend such as:

- Going Green (Many countries have made policy and regulatory changes, setting targets for the increase of green energy and reduction of GHGs),
- Security of Supply (As traditional fossil-fuelled generation plants are reaching end of life or being retired, new generation sources are needed to cover primary energy needs),
- New Revenue Streams (Power producers are starting to take advantage of new commercial models, including peer-to-peer energy transactions),
- DER Availability and affordability (As DERs become more cost effective, the rise of the "prosumer", the traditional energy consumer who is now also a producer.)

Prosumers are active energy users who both produce and consume energy from renewable sources (RES). Along with new PED concept, the framework of prosumers is developing into end users in energy flexibility approach. The development of micro-generation and storage in addition to consumption, empowers individual households and perhaps even more, those organized in cooperatives, neighbourhoods etc, to become pro-active actors and stakeholders that It is not just a matter of producing and consuming RES anymore, but also becoming actors who contribute to the resilience and balancing of the regional/local energy system by just-in-time communicating and trading between each other. If some amount of predictability can be imparted to micro-generation/storage in PED or even PEN districts via forecasts, end users and/or end user groups provide sufficient in energy flexibility in the local energy system architecture that could ease reinforce the shift from centralized to decentralized generation explained above to advantage from the service of pricing for optimal benefit. Demand side management, sector coupling (power-to-heat, heat-to-power) and storage are among the main instruments to achieve this goal. PED/PEN's as the nucleus of the urban energy transition require wholesale changes in the present energy supply and demand architectures. New market structures and players, local and/or independent multi-carrier micro grids, energy generation/storage at community level as mentioned above, drastically different end-user involvement and probably new technologies. Smart control of energy consumption inside (nanoGrid) and around buildings or group of buildings (microgrid) can provide a major contribution to address the imminent energy stability problems of the total energy infrastructure.

## 2.2 Definition and scope of PED

The Positive Energy Block concept is already integrated in the Action 3.2 Smart Cities and communities of the Energy Union and Set Plan that aims at net–zero-energy/emission districts (ZEED) that will strongly contribute to COP21 targets. A further step to this ZEED concept is the consideration of "positive energy districts (PED) or positive energy blocks (PEB)[8]".

There is not a standard definition for the PED concept. In fact, there are small differences between the definitions from the EIP-SCC[5], the EU definition[9], JPI Urban Europe[10] or within the the SET-Plan Implementation Working Group 3.2. They specially differ in qualitative characteristics of the PEDs such as "integrated buildings" within the city or that PED need to have a "positive impact" on the district/city energy system. All of the definitions agree that PEDs are consisting of delimited areas[11] of buildings and public spaces where the total annual energy balance (considering heating, cooling, air conditioning, lighting and domestic hot water) is positive, therefore the area will deliver, in average, an energy surplus to be shared with other urban or peri-urban zones. To that aim, these districts need to be designed with local RES generation systems in order to not only be able to cover its own needs but the needs of their surrounding limits.

Furthermore, several projects and cities are adopting the concept, with different particularities. The project *Hunziker Areal*, from Zürich (Switzerland) defined their newly built neighbourhoods as PEDs, integrating concepts such as affordable housing, jobs on-site, citizen participation, energy efficiency, RES production and sustainable materials. *+CityxChange* H2020 project defines a positive energy district in a similar way as the SET-Plan Implementation Working Group 3.2 on Smart Cities and Communities (IWG 3.2) emphasizing energy retrofitting, RES on-site, active management, mobility, social aspects, and energy flexibility, among others. *SPARCS* project defines a positive energy district with virtual boundaries, where the energy management, storage, e-mobility, RES production, NZEBs and retrofitted buildings concepts are integrated (among other characteristics). Even *COOPERaTE* project has developed an open, scalable neighbourhood service and management platform that provides services and energy management towards energy positive neighbourhoods and it was tested in two demo-sites. As a summary, the quantitative and qualitative characteristics of a PED observed in the state of the art are included in Table 3: Quantitative and Qualitative Characteristics of a PED.

**Table 3: Quantitative and Qualitative Characteristics of a PED**

| QUANTITATIVE CHARACTERISTICS | QUALITATIVE CHARACTERISTICS |
|---|---|
| Several buildings (New, retrofitted, combination of both, mixed-use)<br>Positive Energy Balance<br>Scalable<br>Optimal use of systems<br>Active management<br>Energy Efficiency<br>Net CO2 emissions<br>Surplus of RES | Integrated buildings<br>Positive impact<br>Interaction between buildings/users/systems<br>Synergically connected<br>Role model<br>Innovative<br>Sustainable urbanization<br>User added value<br>Affordable, high standard living<br>Sustainable Mobility, consumption and production |

The definition within MAKING-CITY project is explained in more detail in section 3.1.

On the other hand, discussions and studies on PED definitions and framework according to other projects, initiatives and organizations such as Strategic Energy Technology Plan of EC, European Energy Research Alliance – Joint Programme Smart Cities (EERA-JPSC), European Innovation Partnership on Smart Cities and Communities (EIP-SCC) and JPI Urban Europe, are still on-going. These discussions are summarized in following sections:

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[8] According to EIP-SCC, Positive Energy Block (PEB) is a group of at least three connected neighbouring buildings producing on a yearly basis more primary energy than what they use. https://eu-smartcities.eu/initiatives/71/description

[9] In the last tender of Smart Cities and Communities, LC-SC3-SCC-1-2018-2019-2020, the PED concept is defined https://cordis.europa.eu/programme/rcn/703271/en

[10] https://jpi-urbaneurope.eu/ped/

[11] The delimited area (the boundaries) has been discussed that can be functional boundaries (e.g. buildings connected through a district heating), geographical or even virtual boundaries (district contractually connected to an energy system outside the geographical limits).

### 2.2.1 Strategic Energy Technology (SET) Plan - ACTION n°3.2 Implementation Plan

The Positive Energy Districts in this work consists of several buildings (new, retro-fitted or a combination of both) that actively manage their energy consumption and the energy flow between them and the wider energy system. Positive Energy Blocks/Districts make optimal use of advanced materials, local RES, local storage, smart energy grids, demand-response, cutting edge energy management (electricity, heating and cooling), user interaction/involvement and ICT. Positive Energy Districts are designed to be integral part of the district/city energy system and have a positive impact on it. Their design is intrinsically scalable and they are well embedded in the spatial, economic, technical, environmental and social context of the project site. PEDs require interaction and integration between buildings, the users and the regional energy, mobility and ICT system, as well as an integrative approach including technology, spatial, regulatory, financial, legal, social and economic perspectives. Ideally, PEDs will be developed in an open innovation framework, driven by cities in cooperation with industry and investors, research and citizen organisations.

In this context, a PED is seen as a district with annual net zero energy import, and net zero CO2 emission working towards an annual local surplus production of renewable energy. The defining aspects, or "building blocks" of PEDs are:

- A PED is embedded in an urban and regional energy system, preferably driven by renewable energy, in order to provide optimised security and flexibility of supply.
- A PED is based on a high level of energy efficiency, in order to keep annual local energy consumption lower than the amount of locally produced renewable energy.
- Within the regional energy system, a PED enables the use of renewable energy by offering optimised flexibility and in managing consumption and storage capacities on demand. Active management will allow for balancing and optimisation, peak shaving, load shifting, demand response and reduced curtailment of RES, and district-level self-consumption of electricity and thermal energy
- A PED couples-built environment, sustainable production and consumption, and mobility to reduce energy use and greenhouse gas emissions and to create added value and incentives for the consumer. E.g., PEDs facilitate increased EV charging capability within the district and ensure that the impact of EVs on the distribution will be minimised by using local generation where possible.
- A PED makes optimal use of elements such as advanced materials, local RES and other low carbon energy sources (e.g. waste heat from industry and service sector, such as data centres), local storage, smart energy grids, demand-response, cutting edge energy management (electricity, heating and cooling), user interaction/involvement and ICT.
- PED should offer affordable living for the inhabitants.

PEDs will be implemented in newly built and retrofitted districts or districts with a mix of both.

Cities must have clear commitment to **sustainability, liveability and going beyond carbon neutrality** by becoming energy positive. Such "Positive Energy Districts/Neighbourhoods "(PED/PENs) could be new developments, but should also implement ambitious solutions for urban district renewal.

**PED Guides and Tools** will be developed to support replication and mainstreaming. This includes, e.g. PED definition, national PED certification, a process towards one standard in digital planning, construction, and building information management of PEDs, guides on funding and business models, guides for capacity building and PED planning tools. **PED Replication and Mainstreaming** will be driven by cities, including PED development in their city strategies, providing the necessary pre-conditions for PED deployment and the actual deployment and maintenance of PEDs.[12]

### 2.2.2 Energy Research Alliance-Joint Programme Smart Cities (EERA-JPSC)

SET-Plan Action 3.2 has the ambition to create a city driven network of municipalities and their stakeholders with ambition to develop PEDs. This PED City Panel will identify common dimensions of PEDs across Europe as a basis for national PED certifications, and aims to mutually learn from PED Labs.

To define the required RDI to move towards Positive Energy Districts, and from there to Positive Energy Cities, we have identified 4 lines of actions or conditions: Think big (system innovation), Start small (co create with citizens), Learn fast (and collaborate), Scale up (including design of strategy).

From a technical point of view, a PED is characterized by achieving a positive energy balance within a given boundary. Such boundary can be a

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

### 2.2.3 European Innovation Partnership on Smart Cities and Communities (EIP-SCC)

A Positive Energy Block (PEB) is a group of at least three connected neighboring buildings producing on a yearly basis more primary energy than what they use. These buildings must serve different purposes (housing, offices, commercial spaces...) to take advantage of complementary energy consumption curves and optimize local renewable energy production, consumption and storage. Another key advantage of the concept is that by creating a **functional and social mix**, they will contribute to **urban regeneration**. PEBs, mainly focused on energy, can also help with taking-up bioclimatic architecture, advanced materials, Information and communication Technologies (ICT) with on-site renewable energy production. The initiative links-in directly with the EU Strategic Implementation Plan's ambition to improve the energy efficiency of Europe's buildings and districts. 2016-PEB Initiative

First definition of Positive Energy Blocks, according to EIP-SCC was *"At least three connected neighbouring buildings producing on a yearly basis more primary energy than what they use (in terms of lighting, heating, cooling and ventilation)."*

The target was to launch by 2020 the construction of 100 PEBs throughout EU and neighbouring countries, with at least 1 PEB per EU Member State. Of this figure, 50% of the PEBs should be in cities with <100,000 inhabitants. These buildings must serve different purposes (housing, offices, commercial

[12] SET Plan – Declaration of Intent on Strategic Targets in the context of an Initiative for Smart Cities and Communities, https://setis.ec.europa.eu/system/files/integrated_set-plan/action3_2_scc_declaration_of_intent.pdf

spaces...) to take advantage of complementary energy consumption curves and optimise local renewable energy production, consumption and storage.

**Financing:** exploring Smart Specialisation Strategy (S3) (The Smart Specialisation Platform (S3 Platform) provides information, methodologies, expertise and advice to national and regional policy makers, as well as promoting mutual learning and trans-national cooperation, and contributing to academic debates around the concept of smart specialisation.) at regional level, EIB, Private investors…

**Location:** Identification specific to each city with preference given to central area for demonstration purposes

### 2.2.4 JPI Urban Europe and Positive Energy Neighbourhoods

According to PED Framework report prepared by JPI Urban Europe: *In honoring the economic, cultural and climate-related diversity of European countries and cities, a definition for such PED/PENs should not be just an algorithm for calculating the input and output of energy, but rather a framework, which outlines the three most important* ***functions of urban areas in the context of their urban and regional energy system****. The first obvious requirement is that PEDs should ultimately* ***rely on renewable energy only (energy production function)****, which is one of the main contributions towards climate neutrality. Secondly, they should make energy efficiency as one of their priorities in order to best* ***utilize the renewable energies available (energy efficiency function)****. Thirdly, the awareness that urban areas are bound to be among the largest consumers of energy, and therefore need to make sure that they act in a way which is* ***optimally beneficial for the energy system (energy flexibility function)****.*

There shall be enablers such as political vision and governance framework, active involvement of problem owners and citizens, integration of energy and urban planning, ICT and data management to reach PED/PENs target. These enablers pursue guides on their way towards climate neutrality and energy surplus taking into account the guiding principles such as quality of life, inclusiveness and sustainability. [13]

## 2.3 State of Play in Cities and Challenges for PED concept and implementation of PED

### 2.3.1 Legal and Institutional Challenges

Regulations are the most important instrument that serves for the improvement of technology ecosystems. During the transformation towards smarter cities, legal advisors play an important role as public authorities and investors. Smart city approach reveals a deep transformation of the relevant cities' infrastructure. Technological changes especially those that involve new information and communication technology (The Internet of Things (IoT) etc.) enable to infrastructure meets more efficiently the needs to which it responds. As another major transformation, the infrastructure's components are increasingly interconnected; they operate less and less in isolation. Finally, conventional urban infrastructure sits a digital meta-infrastructure made up of various public and private communication channels in which flow of data enabling smart cities to function.

From the legal perspective, smart city concept brings a variety of regulation areas in its wake as follows:

- Innovation and communication technologies (personal data and profiling, smart buildings, cyber security, cloud services etc.)

13 Norman Akhtar and Kevin Hasley, Smart cities face challenges and opportunities

- Energy regulation (internal market liberalisation rules, renewable energy support schemes, unbundling requirements, smart grids, energy efficiency, energy storage etc.)
- Environmental legislation (EIA, emission allowances, waste management)
- Procurement rules (public procurement rules, concessions and PPP projects)
- Banking/Finance (e.g., banking and public funding, capital markets (MIFID a MIFID II) regulation and project financing)
- IP regulation (Right of intellectual, industrial property and copyright)[14]

When preparing smart city strategies, public authorities may face conflict of competence with one another as well as legal restrictions in more strictly regulated areas, such as energy market, procurement, competition and state aid rules. Due to nature of smart city strategy in which runs the risk of amendments or even dismissal like any other such project, it passes through the standard and long-lasting bureaucratic process. During the process of strategy development, the basic plan to finance the respective projects has to be found in which includes a review of the possibilities for financing (i.e., private (e.g. bank financing, capital markets, PPP projects) and/or public (local/EU funds or cross-border financing)). Finding workable policies to regulate stakeholders, unleashing economic development, maintaining benefits for the citizens and permitting growth in research-and-development investment become important challenges for legislators. Public-private partnerships are one of the more popular investment types used to manage these financial challenges. Since interoperability and funding challenges faced by smart cities in every region of the world, lawmakers are trying to formulate common interest among project partners. Legislation can help local governments implement smart city technologies and overcome the various challenges. For example, the Smart Cities and Communities Act was introduced in the US Congress in February 2017. Although it has not received final Senate approval, the bill focuses on coordinating activities and funding from federal agencies among various smart cities-related municipal departments, by establishing an inter-agency council.

Aligning multiple city departments and stakeholders on common ground, and allowing interoperability and the sharing of data among them and with the potential regional and national platforms, helps in the allocation of the initial financial investment because, before implementing smart city initiatives, government departments and private partners have been working in their own silos. This silo mindset is one of the main problems governments and system integrators must overcome. A change in management style, which introduces open collaboration and data sharing among municipal bodies can help reduce the financial blockade, allowing smart cities to achieve their goals.

Getting participants to share their personal data, and balancing trade-offs, is also a challenge for many policymakers. Due to the fact that Smart Cities are investing more money and resources into security, while tech companies are creating solutions with new built-in mechanisms to protect against hacking and cyber-crimes. On the other hand, IP and ownership rights to the outcomes of smart solutions call for equal attention. Real estate issues, EU internal market regulation limitations, including security and reliability of the smart solutions and responsibility issues must also be taken into consideration.

Educating and engaging the community is another challenge area for smart cities. Smart city needs "smart" citizens who are engaged and actively taking advantage of new technologies. With any new city-wide tech project, part of the implementation process must involve educating the community on its benefits. City governments can communicate the intrinsic benefits of smart city projects more easily by making technology education programmes available. For instance, cities such as Singapore, Dubai,

[14] https://www.citiesdigest.com/2017/03/16/legal-aspects-smart-city-development-kamil-blazek-interview/

London and New York are among those that have moved forward with supporting policies, stronger digital and cyber security, improved connectivity and better education.

These partnerships demonstrate the growing readiness of city authorities and the project partners to work together to develop smart city projects. There are currently more than 450 cities that have adopted at least one smart city project, and project partners such as IBM, Cisco, Nokia and Huawei have introduced their platforms and are providing end-to-end solutions for the mentioned challenges. Also public, integrated open source platforms are being developed.

REMOURBAN project states that institutional challenges are often linked to tensions between top-down managerial approaches and bottom-up needs. It is widely accepted that democratic societies should adopt governance approaches that involve multiple stakeholders including residents and other civil communities-of-interest. However, there are often conflicts between what local communities want for their neighbourhoods and the plans coming from the city administrations. Additionally, financing schemes are often difficult to identify, also involving the right stakeholders and commercial developers.

The SCIS technology replication study already mentions a number of barriers city authorities, planners and developers face in the project preparation and implementations phases. Shifting cities to a low carbon future presents major technological, economic and social challenges, this includes reforming and adjusting policies at all levels. The framework conditions need to be created to facilitate the adoption of new solutions and promote innovation. This requires a flexible, but also a stable positive policy environment.[15]

At the local level the following aspects are key difficulties that can be addressed by policy actions:

- Insufficient level of local competences;
- Inappropriate level of local administrative capacity;
- High administrative burdens;
- Inappropriate procurement rules;
- Inappropriate Stakeholder involvement;
- Access to capital;
- Public Private Partnerships;
- Inappropriate Regulatory environment at national level.
- Urban planning regulations, energy market rules, DSO prescriptions, fiscal & financial regulations, public budget & tendering regulations (in particular the risk of 'prior knowledge') > need for sandboxes / regulation free zones and/or regulatory changes at the regional, MS or EU level – according to EIP-SCC.
- **Cross-sectoral & cross-silo collaboration** in order to acquire integrated solutions and maximizing secondary benefits. Effective guidance by proper urban strategies & governance. Cooperation with higher scale policy levels and between PED projects (peer-to-peer exchange).
- **Need for competent planners** (knowhow, tools, communication, talent, creativity) & proper capacity at all levels (local authorities, solutions providers, developers), 'planning for change', need for integrated planning (capacity)

[15] The making of a smart city: policy recommendations for decision makers at local regional, national and EU levels https://smartcities-infosystem.eu/

## 2.3.2 Economic Challenges

### 2.3.2.1 Economic challenges anticipated by the SET Plan

Key challenges and needs for planning, designing and deploying PEDs have been identified in the TWG 3.2 Implementation Plan (Figure 5). Most of these challenges are non-technological, business-related ones. They include for instance:

- The large-scale deployment of PEDs requires the development of **sustainable business models** that consider the whole process of building, operating and maintaining PEDs and engage all actors among **owners**, **city authorities**, **real estate developers** and **operators of the energy infrastructure**.
- **Strong leadership of public sector** is essential to lead the transformation process and respond to the emergence of PEDs besides stimulating innovative public procurement and its ability to push innovation to lead market strategy targeting the development of **investible PED projects**.
- The deployment of PEDs is expected to impact the whole energy market and its related technological, financial and regulatory aspects. Key aspects correspond to new innovative energy solutions and corresponding new roles such as **prosumers**, the complex regulatory framework and the resulting investment risks that require **credible and robust investment concepts** and **access to new financing schemes**.


**Figure 5. Key challenges and needs for planning, designing and deploying PEDs as identified by SET-Plan TWG 3.2**

#### 2.3.2.2 Economic challenges concretely encountered by existing projects

Even though the PED concept is quite recent and only a few projects are implemented or under implementation, experience sharing with regards PED implementation has already been carried out:

- The PED Programme Management of JPI Urban Europe published in March 2019 its "Booklet of Positive energy Districts in Europe – Preview: A compilation of projects towards sustainable urbanization and the energy transition".[16] Concrete economic challenges encountered by the PED projects listed in this booklet are explained.

- Economic challenges have also been discussed with MAKING-CITY partners active in Oulu and Groningen through interviews carried out in summer 2019 by R2M Solution (see chapter 6.1 of the present report).

The following economic challenges have been mentioned by projects:

- The main economic challenge is related to the **high investment costs for the transition from the previous (fossil-based) system to the new (carbon-neutral) system**. This is the case for instance in Groningen where all buildings are currently connected to the gas network, which is well-functioning and efficient, and where the project consists in (inter alia) switching from the gas to the heat network (heat being generated by renewable sources). Even though in the long run this should be financially efficient, there are high investment costs at the beginning.

- When applied to citizens, the challenge related to high investment costs is even harder. **The most energy-inefficient dwellings are often owned by families with modest revenues**, who cannot afford investing in energy-efficient technologies. They may also be owned by housing cooperatives with complex decision-making processes related to finance. That's why regulations pushing for energy-efficient refurbishments have to be accompanied by proper financial schemes.

- There is often a **lack of appropriate business models**, like for instance energy performance contracts (EPCs). Such contracts are widely spread for big energy consumers (like industrial or large commercial assets), but they are not tailored to smaller consumers. This is an issue since PEDs necessarily include residential buildings and other small energy consumers (for instance small shops). The situation might evolve positively thanks to the roll-out of smart meters and digital technologies which should facilitate the generalisation of EPCs to small energy consumers.

- The creation of a PED requires **optimising energy flows between different generation, storage and consumption assets**. This relies on optimisation algorithms and real-time data gathering, which represent a certain cost. It must be demonstrated that this cost does not exceed the savings and benefits brought by optimisation. Doing such demonstration might be challenging because of a lack of reliable historical data.

- The creation of PEDs generates **multiple benefits to multiple stakeholders**. Such benefits include for instance reduced costs for new energy infrastructures thanks to peak shaving, decreased health costs due to improved air quality, increased real-estate value thanks to PED branding, etc. The **identification and quantification of these benefits** is a difficult task. Therefore, it is challenging to make beneficiaries pay for the benefit they are receiving. For this, it's necessary

[16] https://jpi-urbaneurope.eu/app/uploads/2019/04/Booklet-of-Positive-Energy-Districts.pdf

to collect experience feedback in order to prove the benefits and facilitate the acceptance of (for instance) increased rents for tenants.

- The financial viability of PEDs will be ensured when the main PED building blocks (such as renovation packages for existing buildings and construction of passive or positive energy buildings) will be **mature enough to be scaled up** and become cheaper and less risky.
- Mixed funding models, role of public investment for realizing long-term infrastructures, identifying suitable business models. Ownership structures and financing beyond the common short & midterm horizons, sharing models for costs & benefits across actors/investors – According to EIP-SCC

### 2.3.3 Social Challenges

Sustainability is not just about solar panels, heat pumps and being energy neutral. Not the first user is important, but the second and the third, which means that the change should also become an inherited daily custom. That is why sustainable solutions should be economically cost-effective and have a long lifespan.[17]

Sustainability is about users' behavior and about users who make sustainable choices. How users make choices depends on many factors. To give a clear overview of these factors we use the Consumer Decisions Comprehended (CODEC) model (Brunsting, 2018) that has been developed by ECN part of TNO. This model has been developed to model, quantify and thereby calculate the market share of a specific innovation. Here we will use only the theoretical framework of the model. The model balances determinants stemming from several psychological models and theories, including habits, factual barriers, social processes, and irrationalities in the consumer decision processes.

This model has already been used to define the factors that play a role in the choice behavior of people towards fossil free living (see Figure 6) (Tigchelaar et al., 2019). The model consists of three elements:

1. attention, which is about whether people are engaging in decision making, or is there no trigger to provide attention? Do users consider buying/investing in sustainable alternatives?
2. enablers, which is about whether people are practically enabled to buy the sustainable alternative? Is it possible for them to take sustainable measurements?
3. intention, which is about whether consumers would like to buy the sustainable alternative? Does this provide them personal benefits, status and are there many other people who already have the sustainable alternative? Do sustainable alternatives offer people advantages?

Each of the underlying factors of the three elements – attention, enablers and intention - will be briefly explained at the same time indicating social challenges or barriers for the adoption of sustainable energy means by users/citizens:

**Attention**

- Presence of a trigger: at this moment there will be few natural moments when users consider fossil free alternatives, unless they are intrinsically motivated or there is a specific trigger (e.g., a central heating boiler that does not work anymore or a frontrunner neighbour).

[17] Ecovat.eu

- Breakthrough habits: when users have to make a choice there is a high chance of habitual behaviour if users have made the specific choice before. If for example the central heating boiler does not work anymore and the user is satisfied, the chance is high that s/he will buy a central heating boiler again.

Enablers

- Practically feasible: the solutions that are offered to users should be practically feasible.
- Acceptable investment: the investment for a fossil renovation should be feasible. What is an acceptable investment differing per user, the house s/he is living in and the fossil free alternative?
- Sufficient knowledge: many users have limited knowledge about the technical options of their houses. They do not know either what the fossil free alternatives are and whether these solutions are suitable for their houses.
- Certainty about regulation and policy: users are uncertain about policies for fossil free homes. They want to be sure that the rules do not change when they have just made investments in their houses.
- Option available on the market: options have to be available that are of high quality and that are affordable. Also, a qualified workforce has to be available to install the fossil free solutions.
- Intention
- Attractive investment costs and variable costs: users will have to make investment costs for fossil free solutions. Many users expect that they will get a compensation for the costs that they make.
- Personal benefits: for many user's sustainability is not their first priority. More important topics are for example family, work and health. People will come into action for topics that are related to their values. Some examples of values are autonomy, competence and relatedness (Sheldon, 2001).
- Attractive fossil free alternatives without hassle: many users are reluctant to the amount of work and all the choice they will have to make.
- Social comparison: the decision to invest in fossil free alternatives will be influenced by the (direct) context of the user. The more people will buy fossil free products and services, the higher the chance that others will also make these investments. Users are especially influenced by people that are like them.
- Social status: some users will be motivated to buy fossil free products if this improves their status.

| Attention | Enablers | Intention |
|---|---|---|
| Presence of a trigger | Practically feasible | Attractive investments costs and variable costs |
| Breakthrough habits | Acceptable investment | Personal benefits |
| | Sufficient knowledge | Attractive fossil free alternatives without hassle |
| | Certainty about regulation and policy | Social comparison |
| | Option available on the market | Social status |

**Figure 6: Overview of the factors that play a role in choice behaviour towards fossil free living (based on the CODEC model)**

## 2.3.4 Technical Challenges

From a technical point of view, the main challenge in PED concept is to optimize the building integration within the district and renewable energy sources (on/out site the district). Due to the variability in the RES generation, the needs for having flexibility options are higher. In order to decrease that reliability, Integrated and innovative technologies for PEDs could be a smart mix consisting of smart urban energy networks, energy storage, ICT's and e-mobility, among others.

According to Set Plan Working group, innovative solutions for realizing and deploying PEDs cover following domains[18]:

- Highest energy saving measures to reducing primary energy demand through a variety of energy conservation measures, highest energy efficiency and cutting-edge energy management systems comprising highly insulated building envelope and windows, integrated PV and solar-thermal façade, passive housing and efficient lighting, and smart metering.

- Maximize the use of renewable energy supply based on local distributed Renewable Energy Systems (RES) within the geographical boundary of the district as well as through local energy sources adjacent to the district. This covers PV, solar thermal, heat pumps, geothermal and waste-to-heat-and-power. Complementary to the local renewable energy supplies, the allocation of sites in adjacent urban areas or the surrounding regions should be considered for additional electricity generation from biomass, wind and solar parks, especially to ensure covering the peak demand. The generation of renewable energy sources in the local-regional energy partnership should be taken into account in the calculation of the net zero import definition of the PED.

- Integrated energy system design providing an efficient and flexible energy infrastructure (electrical, heating, cooling, gas grids, all components connected by an ICT platform, etc.), enabling the use of energy sector coupling (electricity, heating, cooling, energy for mobility), the exchange of energy between all consumers and producers in the PED. The energy system shall be designed to be robust and resilient to enable the adaptation to changing surrounding

[18] Set Plan Action Nº 3.2 Implementation plan, Annex 3, June 2018.

conditions. This includes technical (e.g. grid infrastructure), organizational and regulatory aspects.

- Flexibility options as well as optimized and smart energy management across the different building types within the district and in synchronisation with the wider energy system of the surrounding neighbourhood. This includes developing modular hybrid microgrids beside the opportunities of DC grids integration, optimizing control algorithms for real-time management of several energy vectors via ICT. In view of increased dependence on intermittent RES, active management will allow for balancing and optimisation of energy demand-supply, load shifting and reduced curtailment impact of RES.
- Energy storage presents one of the biggest gaps to realize PEDs. Finding ways to store energy all year long is not just a challenge when it comes to technology but also in terms of cost effectiveness. Technically feasible solutions for long-time storage of heat and electricity over days and weeks and even seasons must become cheaper in order to make PEDs cost-effective, so they can compete with conventional buildings and districts on the basis of a life-cycle, or total cost assessment.
- EV will be an integrative element of PEDs with an expected increased impact on the district energy system behaviour. Hence, EVs need to be considered already during the planning phase of PEDs. By planning and implementation of an optimized EV charging infrastructure and adequate management of charging as well as considering EV-to-grid, EV can have positive impact on the power load management charging capability within the district and make use of the ensure that the impact of EVs on the distribution will be minimised by using local generation where possible.
- Distributed ledger technology to manage power exchange at the local community level and create added value and incentives for the consumer to generate energy locally, provide flexibility and aggregate power generation in a system-wide cloud solution. Such innovative technologies are vital to maximize the uptake of renewables and manage the emerging local energy systems that couple the different energy demand and supply options in view of the changing role of consumer and producer to the role of prosumer.

### 2.3.5 Requirements for implementation of PED

1. Urban Planning, Land Use Planning and Urban Design

**Urban planning** can be defined as "the process of envisioning alternative futures for an urban area, setting goals and objectives, and formulating implementing strategies to reach the alternative future".[19] **Land use planning** is one element of urban planning.[20] Land use planning operates at a municipal level in order to regulate the conversion of land and property uses, with an aim of integrating social, economic and environmental issues, and reconciling competing interests.[21] **Urban design** addresses the scale between architecture and urban planning[22] and focuses on the physical and spatial features of the built environment. Urban design seeks to design a coherent whole out of the place-specific resources and qualities, within the wider regulatory systems and market conditions.[23]

[19] Caves, R. W. (2005). *Encyclopedia of the City*. London: Routledge.
[20] Caves, R. W. (2005). *Encyclopedia of the City*. London: Routledge.
[21] Commission of The European Communities. (1997). *The EU Compendium of Spatial Planning Systems and Policies*. Luxembourg: Regional Development Studies, Office for Official Publications of the European Communities.
[22] Caves, R. W. (2005). *Encyclopedia of the City*. London: Routledge.
[23] Carmona, M., Heath, T., Oc, T., & Tiesdell, S. (2012). *Public places — Urban spaces*. London: Routledge.

As the integration of various interests is the central aim of urban planning and land use planning, cities can utilize them to foster and enable energy actions. On the level of strategic master planning, municipalities may use land use plans to guide the development of urban structure in the long-term, and search locations for integrated urban functions, such as PEDs. Moreover, surveys and impact assessments produced during land use planning can be utilized to generate knowledge about energy opportunities. Land use planning can also be utilized to bridge energy targets with implementation: local detailed plans juridically enable implementation of building projects with energy actions, and the participatory land use planning processes can be utilized for energy-related participation.

There has to be a holistic approach towards sustainable, livable neighborhoods / Integrative perspective e.g. integrating technological, spatial, regulatory, financial, legal, economic, social, cultural and governance aspects. Synergetically connected to the wider energy/mobility/digital infrastructure. Sometimes the circular economy/sustainable urban metabolism is put forward.

One limitation for utilizing land use planning in fostering new PEDs is that the prerequisites of municipalities to practice land use planning vary depending on the spatial planning system in each country or region. Another limitation is that land use planning can be best utilized in contexts where new buildings are being built, that is, in PEDs based on new urban development or infill building. In PEDs that include existing buildings, other planning and policy tools, such as citizen engagement strategies, might be more applicable.

- **Context-sensitive,** urban structure – *'location, location, location'*

In the case of the City of Oulu PED, the existing central district heating network forms the framework for PED scale-up in the urban structure. This is because Kaukovainio PED uses excess heat from the district heating network as a heat source, which is possible only in selected locations within the city.

- **Mixed use & functions,** strong public spaces, integrating green and blue networks

implementation areas of PEDs are grouped as New Area Development, Infill Area and Retrofitting areas, to describe the nature of interaction processes with the stakeholders in PED development. Within this, according to the PED definition in MAKING-CITY project, a Positive Energy District (PED) is "an urban area with clear boundaries, consisting on buildings of different typologies that actively manage the energy flow between them and the larger energy system to reach an annual positive energy balance". We can estimate that diverse PED solutions match with different groups of buildings including different types of functions. In the case of City of Oulu PED, big public and private buildings in the neighbourhood are key factors in energy supply. Therefore, big public and private buildings' capacities are of interest. We may also expect that buildings fostering a diversity of energy actions in a PED, is capable of contributing to the energy system more flexibly.

2. Investment and Risk Models

   <u>This section will be finalized in final version of this deliverable. [M24]</u>

- **High and affordable quality of living** – environmental quality (air, noise, security) – architectural, urban & landscape quality – affordability
- In the context of the City of Oulu PED, real estate investors and construction companies have had challenges to explain new services' gains for future buyers, and to price new apartments to be sold. Place branding actions are taken by the City of Oulu to support the district's image and the implementability of the PED. In the nearby future, infill building can be expected to further enhance the value of the apartments in the district. However, to be socially sustainable, the affordability of the new and renovated apartments must be taken care of, which has outsourced some potential PED technologies..

3. Citizen Empowerment

    This section will be finalized in final version of this deliverable. [M24]

- **(Social) Inclusiveness** - accessibility, acceptability, diversity
- **Citizen centered - added value and incentives for the consumer** – interested and engaged users – citizen involvement from the outset, role of community ambassadors and emotional buy-in
- **Co-created** with local community, embedded in local community, culture & patrimony

4. *Collaborative Governance*
5. *Impact Assessment*
6. *Collaborative thinking on application faults, misconception, miscalculation)*

- **Exemplary & educational role** including up to eco-tourism; **scalable & replicable** character

## 2.4 Reference PED Projects

| PE - Positive Energy District (PED), Block (PEB), Zero Emission, Energy Neutral, Energy Efficient, Carbon-free, Climate Neutral | | | | | |
|---|---|---|---|---|---|
| Code | Project Name | City (Country) | Links and further information | Type | Phase |
| PE-1 | Åland Island | Åland Island (Finland) | •Booklet of PED - UrbanEurope: https://jpi-urbaneurope.eu/app/uploads/2019/04/Booklet-of-PEDs_JPI-UE_v6_NO-ADD.pdf<br>•https://sustainabledevelopment.un.org/content/documents/1523development_and_sustainability_agenda_for_aland.pdf<br>•https://www.barkraft.ax/english<br>•https://flexens.com/the-demo/<br>•https://smartenergy.ax/om-smart-energy-aland/<br>•Smart Islands Projects and Strategies (page39): https://library.fes.de/pdf-files/bueros/athen/12860.pdf<br>•https://www.euislands.eu/clean-energy-islands<br>•https://flexens.com/flexens-and-smart-energy-aland-joins-forces-with-kokar-island-in-the-clean-energy-for-eu-islands-project/D13 | PED -<br>Energy efficient<br>Carbon-free<br>Climate neutral | In operation: implemented |
| PE-2 | +CityxChange | Trondheim (Norway) | • Booklet of PED - UrbanEurope: https://jpi-urbaneurope.eu/app/uploads/2019/04/Booklet-of-PEDs_JPI-UE_v6_NO-ADD.pdf<br>• https://cityxchange.eu/our-cities/trondheim/<br>• https://smartcities-infosystem.eu/scis-projects/demo-sites/eco-city-site-trondheim | PED –<br>Energy efficient | In implementation stage |
| PE-3 | +CityxChange | Limerick (Ireland) | • Booklet of PED - UrbanEurope: https://jpi-urbaneurope.eu/app/uploads/2019/04/Booklet-of-PEDs_JPI-UE_v6_NO-ADD.pdf<br>• https://cityxchange.eu/our-cities/limerick/<br>• http://smartcitiesireland.org/wp-content/uploads/2018/10/1-2_M.Bilauca_LimerickLighthouseCity.pdf<br>• http://www.collaborativehousinglimerick.ie/wp-content/uploads/2019/01/6Webb_-Georgian-Neighborhood-Programmes-.pdf | PED | In implementation stage |

| | | | | | |
|---|---|---|---|---|---|
| PE-4 | +CityxChange | Võru (Estonia) | • Booklet of PED - UrbanEurope: https://jpi-urbaneurope.eu/app/uploads/2019/04/Booklet-of-PEDs_JPI-UE_v6_NO-ADD.pdf<br>• https://cityxchange.eu/our-cities/voru-estonian/ | PED<br>Zero-emission<br>Energy neutral<br>Energy efficient<br>Carbon-free<br>Climate neutral | In implementation stage |
| PE-5 | Laser Valley | Land of Lights, Măgurele (Romania) | • Booklet of PED - UrbanEurope: https://jpi-urbaneurope.eu/app/uploads/2019/04/Booklet-of-PEDs_JPI-UE_v6_NO-ADD.pdf<br>• https://ec.europa.eu/jrc/sites/jrcsh/files/20190618-bucharestconference-ss3_tt-curaj_en.pdf<br>•http://www.laservalley.ro/Home_files/BrosuraLV_EN_tipografie_compressed.pdf | PED<br>Energy efficient<br>Carbon-free | In implementation stage |
| Code | Project Name | City (Country) | Links and further information | Type | Phase |
| PE-6 | Edificio LUCÍA | Valladolid (Spain) | •https://www.construible.es/comunicaciones/edificio-energia-casi-nula-integracion-energias-renovables-generacion-energetica-autosuficiente-sector-terciario-edificio-lucia<br>•https://www.construction21.org/espana/data/sources/users/882/docs/b03-03-simulacion-equest-lucia.pdf<br>• http://aulagreencities.coamalaga.es/edificio-lucia-arquitectura-sostenible-y-consumo-nulo-de-energia/ | PEB<br>Energy efficient<br>Zero-emission | In operation: implemented |
| PE-7 | HIKARI | Lyon-Confluence (France) | • Positive Energy Blocks for Small and Medium Sized Cities: https://eu-smartcities.eu/sites/default/files/2017-09/1.%20Positive%20Energy%20Blocks%20for%20Small%20%26%20Medium%20Sized%20Cities_0.pdf<br>• HIKARI, a mix-use positive energy block: https://eu-smartcities.eu/sites/default/files/2017-09/3.%20HIKARI%2C%20a%20mix%E2%80%90use%20positive%20energy%20block.pdf<br>• Ichinomiya, Hiroki (Mitsubishi Research Institute, Inc.). Case Study: Smart Community Demonstration Project in Lyon, France. https://www.nedo.go.jp/content/100871965.pdf<br>• Lyon Smart Community: http://www.lyon-confluence.fr/ressources/flipbooks/LyonSmartCommunity/en/files/assets/common/downloads/publication.pdf<br>• Gaiddon, Bruno; Valentin, Maxime; Alfonsi, Laetitia; Laquerriere, Marie-Lyne; Gouranton, Germain; & Corgier, David. (2016). HIKARI: A POSITIVE ENERGY BUILDING WITH AN ARCHITECTURALLY INTEGRATED PV FACADE and a PV ROOFTOP SYSTEM (190 KWP). Zenodo. http://doi.org/10.5281/zenodo.834534<br>• https://www.construction21.org/espana/city/fr/hikari-1st-positive-energy-urban-islet.html | PEB - Positive Energy Block<br>Energy efficient | In operation: implemented |
| PE-8 | Hunziker Areal | Zurich (Switzerland) | • Booklet of PED - UrbanEurope: https://jpi-urbaneurope.eu/app/uploads/2019/04/Booklet-of-PEDs_JPI-UE_v6_NO-ADD.pdf<br>•ttps://www.mehralswohnen.ch/fileadmin/downloads/Publikationen/Broschuere_maw_engl_inhalt_def_181004.pdf<br>• https://tdlab.usys.ethz.ch/livlabs/hunziker.html<br>• https://issuu.com/ethel.baraona/docs/zurich_low<br>• Case Study 2019 - Sustain. practices: mobility: https://tdlab.usys.ethz.ch/teaching/tdcs/current.html<br>• Case Study 2017 - Suff. nutrition sector: https://tdlab.usys.ethz.ch/teaching/tdcs/former/cs2017.html | Climate neutral<br>Energy efficient | In operation: implemented |

| | | | | | |
|---|---|---|---|---|---|
| PE-9 | Fleuraye | Carquefou/Nantes (France) | • Booklet of PED - UrbanEurope: https://jpi-urbaneurope.eu/app/uploads/2019/04/Booklet-of-PEDs_JPI-UE_v6_NO-ADD.pdf<br>• https://www.construction21.org/france/city/fr/quartier-de-la-fleuriaye-a-carquefou.html<br>• https://www.nantesmetropole.fr/actualite/l-actualite-thematique/3-solutions-vertes-qui-font-de-la-fleuriaye-un-quartier-exemplaire-urbanisme-100458.kjsp<br>• http://www.quartierlafleuriaye.fr/ | | In operation: implemented |
| PE-10 | Hammarby Sjöstad 2.0 | Stockholm (Sweden) | • Booklet of PED - UrbanEurope: https://jpi-urbaneurope.eu/app/uploads/2019/04/Booklet-of-PEDs_JPI-UE_v6_NO-ADD.pdf<br>• https://hammarbysjostad20.se/?lang=en<br>•https://energiforskmedia.blob.core.windows.net/media/23661/14-pilotprojekt-hammarby-sjostad-sten-bergman.pdf<br>• https://www.nordregio.org/sustainable_cities/hammarby-sjostad/ | Carbon-free<br><br>Climate neutral | In operation: implemented |
| **Code** | **Project Name** | **City (Country)** | **Links and further information** | **Type** | **Phase** |
| PE-11 | Sharing Cities | Milano (Italy) | • Booklet of PED - UrbanEurope: https://jpi-urbaneurope.eu/app/uploads/2019/04/Booklet-of-PEDs_JPI-UE_v6_NO-ADD.pdf<br>• http://www.sharingcities.eu/sharingcities/city-profiles/milan<br>• https://sharingcities.wixsite.com/milano<br>• https://smartsustainablecities.uk/milan-sharing-cities/<br>• http://anyflip.com/zerr/kusu/basic | Energy efficient | In operation: implemented |
| PE-12 | Smart Otaniemi | Espoo (Finland) | • Booklet of PED - UrbanEurope: https://jpi-urbaneurope.eu/app/uploads/2019/04/Booklet-of-PEDs_JPI-UE_v6_NO-ADD.pdf<br>• https://smartotaniemi.fi/<br>• https://urbanmillblog.files.wordpress.com/2019/01/smart-otaniemi.pdf<br>• https://clicinnovation.fi/wp-content/uploads/2019/04/Smart-Otaniemi.pdf | Climate neutral | In operation: implemented |
| PE-13 | EnStadt:Pfaff | Kaiserslautern (Germany) | • Booklet of PED - UrbanEurope: https://jpi-urbaneurope.eu/app/uploads/2019/04/Booklet-of-PEDs_JPI-UE_v6_NO-ADD.pdf<br>• https://pfaff-reallabor.de/<br>• https://www.pfaff-quartier.de/ | Climate neutral | In implementation stage |
| PE-14 | mySMARTlife | Helsinki (Finland) | • Booklet of PED - UrbanEurope: https://jpi-urbaneurope.eu/app/uploads/2019/04/Booklet-of-PEDs_JPI-UE_v6_NO-ADD.pdf<br>• https://www.mysmartlife.eu/cities/helsinki/ | Climate neutral | In implementation stage |
| PE-15 | Sinfonia | Bolzano (Italy) | • Booklet of PED - UrbanEurope: https://jpi-urbaneurope.eu/app/uploads/2019/04/Booklet-of-PEDs_JPI-UE_v6_NO-ADD.pdf<br>• http://www.sinfonia-smartcities.eu/en/project | | In implementation stage |
| **EN - Eco-Neighborhood, Sustainable cities National Programs** | | | | | |
| **Code** | **Project Name** | **City (Country)** | **Links and further information** | **Type** | **Field of interest** |

| | | | | | |
|---|---|---|---|---|---|
| EN-1 | Écoquartier GINKO | Bordeaux (France) | • http://www.nouvelle-aquitaine.developpement-durable.gouv.fr/visite-de-l-ecoquartier-ginko-a-bordeaux-le-7-a479.html<br>• http://www.nouvelle-aquitaine.developpement-durable.gouv.fr/IMG/pdf/FP-Ginko-BordeauxV4_cle0f1996.pdf<br>• https://fr.calameo.com/read/00180283644f52af56df8 | Eco-neighbourhood | Sustainable neighbourhood Transport |
| EN-2 | Écoquartier ARAGO | Pessac (France) | • http://www.revelarchi.com/nos-projets/ecoquartier-arago-pessac/<br>• https://urbanisme-bati-biodiversite.fr/IMG/pdf/6-ecoquartier-arago-pessac.pdf<br>• https://www.construction21.org/france/case-studies/fr/eco-quartier-arago.html<br>• https://palmares.archi/2016/projets-candidats/smlxl/eco-quartier-arago/ | Eco-neighbourhood | Sustainable neighbourhood |
| EN-3 | Killesberghöhe | Stuttgart, Germany | • https://www.db-bauzeitung.de/db-themen/db-archiv/insel-in-weiss/<br>• https://www.world-architects.com/en/kcap-architectsandplanners-zurich/project/killesberghohe<br>• https://www.dbz.de/download/92553/2207-killesberg.pdf<br>• Park: http://www.landezine.com/index.php/2015/11/park-killesberg-development-towards-an-urban-environment/<br>• https://www.kcap.eu/en/projects/v/killesbergh_he/ | Eco-neighbourhood | Sustainable neighbourhood |
| Code | Project Name | City (Country) | Links and further information | Type | Phase |
| EN-4 | Oberbillwerder | Hamburg, Germany | • https://www.oberbillwerder-hamburg.de/<br>• https://transsolar.com/projects/hamburg-oberbillwerder-masterplan<br>• https://www.karresenbrands.com/project/the-connected-city<br>• https://www.pinarbalat.com/oberbillwerder-masterplan | Eco-neighbourhood | Sustainable neighbourhood |
| EN-5 | 2000 Watt Sites | (Switzerland) | • https://www.2000watt.swiss/ | Sustainable cities national program | Sustainable neighbourhood |
| EN-6 | ÉcoQuartier | (France) | • http://www.ecoquartiers.logement.gouv.fr/ | Sustainable cities national program | Sustainable neighbourhood |
| EN-7 | Viable Cities | (Sweden) | • http://viablecities.com/en/home/ | Sustainable cities national program | Sustainable neighbourhood |

# 3 MAKING-CITY PED Methodology

This chapter identifies the definition of PED for MAKING-CITY and objectives of the proposed PED Methodology. A brief explanation for calculation methodology is presented and experience mapping of two LHCs is evaluated for introducing the conditions that LHCs went through during PED area selection.

As the research for PED definitions was explained previously, a background of PED concept will be shown in this section. A homogenous definition about what we understand as a PED and the procedure to define Ped concept boundary and select proper technologies in cities and to measure how positive a district is, will be described below.

Different definitions and approaches can be found in the bibliography (See section 2.1), nevertheless we need a common starting point, in one hand, to be able to compare the results of each of the three demonstration PEDs that will be implemented in the MAKING-CITY project, and in the other, help other cities to replicate what we will do in lighthouse cities. Definition of MAKING-CITY is explained in section 3.1 of the present document and the calculation methodology (boundaries, energy balance calculation, etc.) is explained in D4.2.

For the demonstration that a district is positive and the evaluation of its energy surplus, the **annual energy balance** is a key aspect and for this calculation, the **primary energy factors** should be used to consider all possible energy carriers in the balance. This annual energy balance can be calculated assuming different rules, but in MAKING-CITY project, the standard that guides the calculations in terms of positive energy balance will be the "*Guidelines 2012/C 115/01 accompanying Commission Delegated Regulation (EU) 244/2012 supplementing Directive 2010/31/EU on the energy performance of buildings by establishing a comparative methodology framework for calculating cost-optimal levels of minimum energy performance requirements for buildings and building elements"*[24] *and ISO 52000*. D4.2 provides the guidelines for the calculation of a positive energy district, following the process that was performed during the initial state of MAKING-CITY project, and it completes the design of the PED by setting a robust methodology for replication of the PED concept.

## 3.1 What we understand as a PED

According to MAKING-CITY project, a **Positive Energy District (PED)** is **"an urban area with clear boundaries, consisting on buildings of different typologies that actively manage the energy flow between them and the larger energy system to reach an annual positive energy balance"**

PED is a relatively new concept, derived from the **Positive Energy Block (PEB)** concept. MAKING-CITY assumes that a single energy transition process can be accelerated if PEDs can be achieved and scaled up, due to the special features and ambitious of the approach. Reaching positive balance means a step forward regarding net zero energy districts but can obtain better impacts, since intensive use of RES and high efficiency can achieve very high reduction of $CO_2$ emissions. PEB is a group of at least three connected neighbouring buildings producing on a yearly basis more primary energy than what they use[25].

Speaking of neighbouring, **Positive Energy Neighbourhood (PEN)** is a system-level concept where the neighbourhood generates more energy than it consumes, with surplus energy being either stored locally or exported[26].

[24] https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A52012XC0419%2802%29

[25] https://eu-smartcities.eu/initiatives/71/description

[26] Antonello Monti Dirk Pesch Keith Ellis Pierluigi Mancarella. Energy Positive Neighborhoods and Smart Energy Districts. Methods, Tools, and Experiences from the Field. 1st Edition. Academic Press, September 2016

Before positive vision, Nearly Zero Energy Buildings (NZEB) and therefore Nearly Zero Energy Districts (NZED) were the tractors for helping the energy transition the cities. NZEB as a building that has a very high energy performance with the nearly zero or very low amount of energy required covered to a very significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby[27] forms the NZED.

In fact, other definitions of PED, quite similar and not contradictory to the MAKING-CITY one, is defined by the SET-Plan as a district with annual net zero energy and net zero $CO_2$ emission working towards an annual local surplus production of renewable energy (the comparative. **PED Labs** has appeared also as a pilot action that provide opportunities to experiment with planning and deployment of PEDs, as well as provide seeding ground for new ideas, solutions and services to develop[28].

Nevertheless, in terms of SET-Plan definitions, it is necessary to take into account that although the PED concept is complementary to the MAKING-CITY one, the assumptions for the annual energy balance are less restrictive in terms of the electricity generated from Renewable Energy Sources (RES) than the MAKING-CITY procedures is. The EU Guidelines[29] considers that the primary energy factor should be applied to all energy (RES or non-RES) imported to the PED; the SET-Plan assumes that the electricity generated by dedicated renewable energy systems in the region outside the PED and supplied to it, is not necessarily regarded as import into the PED[28]. Therefore, bioenergy production outside the PED would affect in different way depending on the procedure followed to calculate the annual energy balance.

## 3.2 Objective of the PED Methodology

The objective of the MAKING-CITY PED Methodology is to empower replicability, scalability, and sustainability of PEDs, taking into account the city needs and priorities, on-site resource availability, urban planning, land use planning and urban design situation, MAKING-CITY PED solutions (demand side solutions as low consumption in buildings, improving energy efficiency by energy management in buildings and districts, supply side solutions as alternative energy resources and integrated infrastructures as large storage, heat pumps, district heating, ICT platforms, etc..) and their business models through a decision-making journey emphasizing citizen engagement. Since scaling up heavily depends on city size, geography, demographics, climate, infrastructures and economic and planning context, MAKING-CITY project works on identifying a method that firmly pursues this ambition.

PED Methodology focuses on the procedure considering the identification process of the PED concept boundary and selection of proper PED solutions peculiar to the cities. It is composed of the phases encompassing a decision-making route that underlines citizen engagement throughout this process. The procedure aims to understand what the city is looking for, described as state of play in cities (city characterization) for figuring out the priorities, objectives and needs of the cities. Therefore, the main goal is the creation of a specific plan/design/guideline for each city that may reach, understand and try to follow the phases of the methodology and find out its needs, vision and objectives.

Aligned with JPI Urban Ped framework studies, PED Methodology strongly builds upon wide stakeholder consultations and dialogues; connects to ongoing policy and strategy debates, in particular the implementation of Agenda 2030 SDGs, the Urban Agenda for the EU or the National / Regional and Local Energy and Climate and Urban Plans and strategies. In addition to citizen empowerment, urban

[27] D'Agostino et al., Synthesis Report on the National Plans for NZEBs; EUR 27804 EN; doi 10.2790/659611

[28] SET-Plan ACTION n°3.2 Implementation Plan. Europe to become a global role model in integrated, innovative solutions for the planning, deployment, and replication of Positive Energy Districts. June 2018.

[29] https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A52012XC0419%2802%29

planning, land use planning, urban design, investments and business models, collaborative governance and impact assessment have fundamental requirements to implement PED in any other places.

## 3.3 Calculation of PEDs

The basis for the energy calculation in MAKING-CITY PEDs is the Primary Energy Balance (annual base). If this average value is positive our district will be a PED, if not our district will only be nearly zero, not positive. The basis for the energy calculation in MAKING-CITY PEDs is the Total Primary Energy Balance (annual base – following ISO 52000). It is also important to calculate the Non-Renewable Primary Energy Balance, as it is another important indicator when aiming to PEDs. Indeed, many districts could have a difficulty achieving a zero-energy balance in terms of Total Primary Energy if there are not enough renewable resources within the district boundaries, and in these cases a zero-energy balance in terms of Non-Renewable Primary Energy could be a compromise, accepting renewable energies coming from outside the district boundaries.

A very detailed procedure for PEDs calculation is included in the deliverable D4.2 “Guidelines to calculate the annual energy balance PED”, nevertheless the main aspects will be here summarized for helping the understanding of this guidelines.

The methodology explained in D4.2, goes step by step from explaining the district boundaries to the primary energy balance calculation (Figure 7). The first step of the procedure will be to define the boundaries of the PED, in order to set the limits of the calculation (what is the energy produce within the district, what is the energy exported and imported, etc.). PEDs can be delimited by spatial-physical limits including delineated buildings, sites and infrastructures (Geographical boundaries). Furthermore, it might be possible that the district has several buildings within a district or city interconnected with each other in terms of energy grids (functional boundary). Besides that, the case of a community that has the resources to own a windmill which are not usually located close to the city, could be considered a PED with “virtual boundaries” as the district is managing this energy facility.

Secondly, the standards and different calculation methodologies to calculate the energy needs are described. Later by identifying the on-site systems (as reported in the deliverable D4.2.), the next step is to calculate the on-site production. Once the energy outputs and inputs of each system have been identified, the different connections between the systems and the energy flows need to be linked. By doing an energy balance, the energy that should be imported into the district can be estimated. Finally, primary energy factors to be used are explained and the primary energy (total and non-renewable) associated with the delivered and exported energy of the district is calculated. The difference between them is the “Primary Energy Balance” of a PED.

Calculation goes from net energy needs to primary energy use and different steps have been identified for making easier the following of the energy calculations.

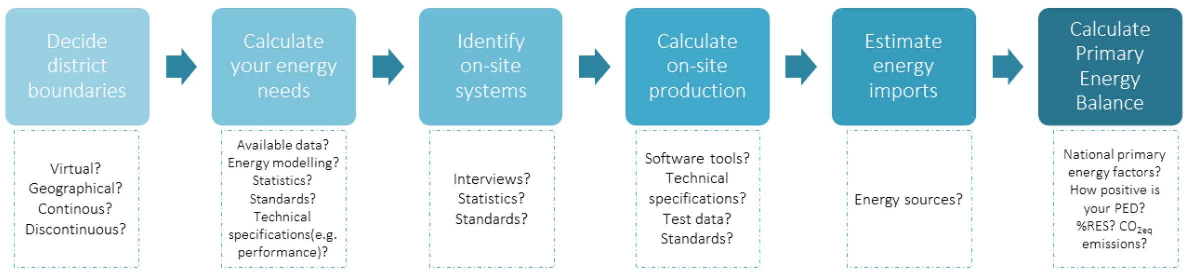



**Figure 7: Steps of the calculation procedure**

At the end, the overall Sankey diagram can be performed. For the energy flows (Figure 8), energy is separated by energy use (heating, cooling, DHW, appliances, etc.) and energy carriers (delivered energy: fuel energy, electric energy coming from RES, electric energy coming from grid, etc.). The difference between energy needs and energy use is the efficiency in the distribution system (if there is any).

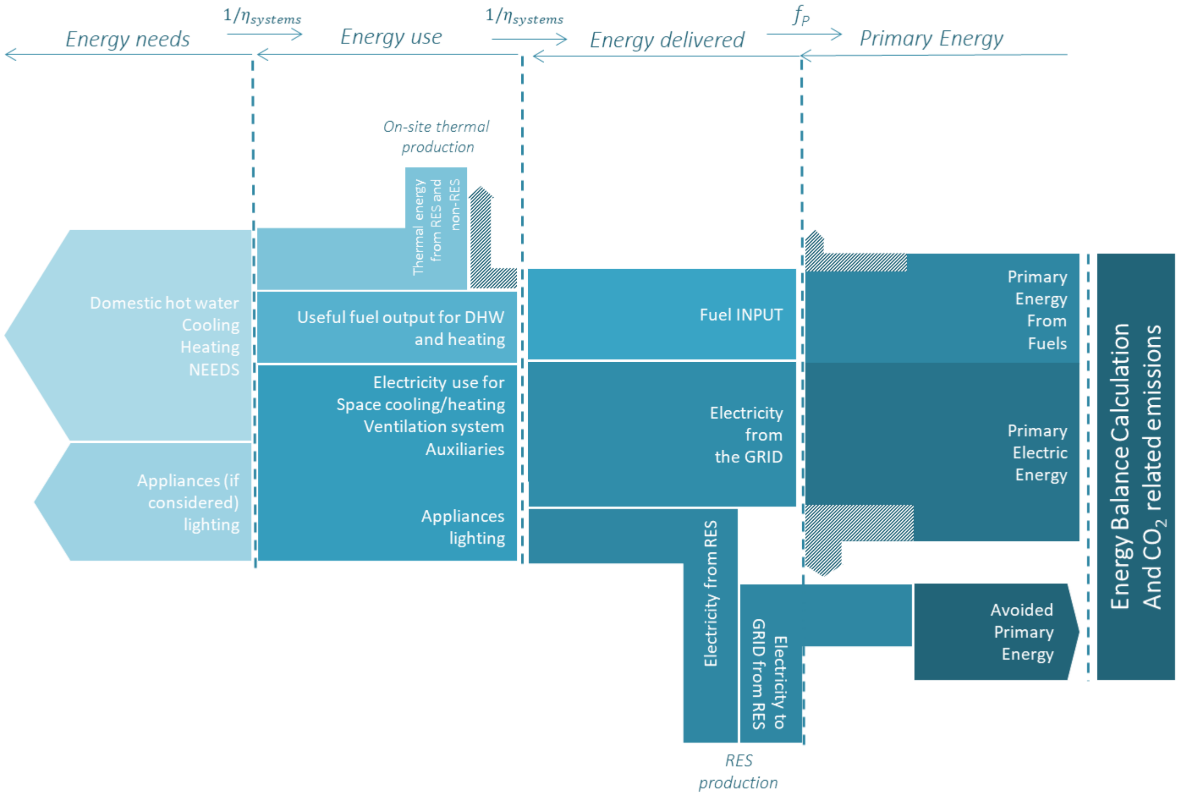
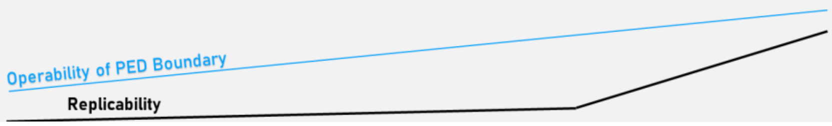



**Figure 8: Sankey Diagram of the energy flows in a PED**

## 3.4 PED Experiences in Lighthouse Cities: Oulu & Groningen

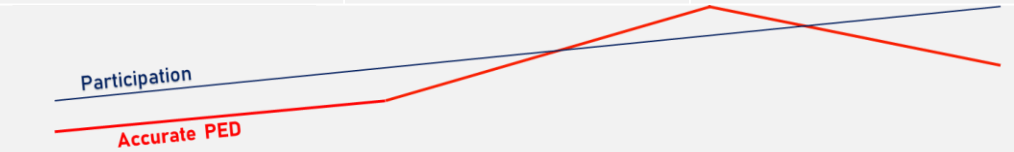
Methodology for PED design aims to find solutions for identifying PED concept boundary and proper technical and non-technical actions for cities in their pathway to energy transition. Oulu, Finland and Groningen, Netherlands which are two Lighthouse Cities of MAKING-CITY, already identified PED concept boundaries and designed solutions at the proposal stage of the project. Interviews have been held with city representatives in April 2019 before Project Meeting in May (in Groningen) in order to figure out the experienced cities' approach on PED planning and design. Main conditions on the process for selecting PED area and defining PED boundary and priorities of these cities while selecting PED areas are discussed within these interviews and knowledge share from LHCs to FWCs is expected as a result of this study. The conditions and priorities are summarized in Experience Mapping Tables of Oulu and Groningen (Table 4 and Table 5).

**Table 4 Experience Mapping of Oulu**

| PED Area Selection | PHASE 1<br>1st Condition | PHASE 2<br>2nd Condition | PHASE 3<br>3rd Condition |
|---|---|---|---|
| ACTIONS | City Planning / Development Area | Maintaining network stability | Buildings / RES |
| Questions / Thoughts | How can we place PED on the urban development plans of the city? | How can we identify the stakeholders in the area? | Which solutions can we use? How do we improve technologies to go for (+)? |
| Happy Moments | Urban Development Area / including Arina Shopping Mall<br>Urban Planning Department Approval | They are willing to collaborate and willing to implement PED in this time schedule | High COP Heat pumps integrated to return pipelines of district heating<br>Waste heat from AC systems<br>Geothermal Heat Well for SM |
| Pain Points | | Part of the buildings are being held up until certain percentage of apartments are preserved. Development company asks the city of Oulu to be marketed for future residence. | Too long pay-back times for some investors.<br>Technological uncertainties, especially concerning the most ambitious solutions. |
| OPPORTUNITY |  | | |

Experience Mapping of Oulu: Oulu City together with technical partners considered potential PED areas in relation to the urban development plans of the city. They specified KAUKOVAINIO district after a set of analyses since this is an urban development area with a shopping mall and regeneration plans. Secondly, the team analysed the stakeholders in the area in terms of their land use agreements and investment plans for the near future. And finally, they considered which energy solutions could be implemented in the area. The PED boundary was identified by addressing both technical and non-technical solutions. All of the happy and pain points of the conditions are summarized in Table 4. The opportunities are illustrated in the same table regarding the conditions in Oulu's process.

**Table 5 Experience Mapping of Groningen**

| PED Area Selection | PHASE 1<br>1st Condition | PHASE 2<br>2nd Condition | PHASE 3<br>3rd Condition |
|---|---|---|---|
| ACTIONS | Heat Grid | Active Community | Buildings / RES |
| Questions / Thoughts | Most of the city is upon gas grid, since resource has to be within boundaries, what chances do I have? | How can we foster the transition process from citizen perspective? | Which buildings already have plans & processes? |
| Happy Moments | Resource Availability within city | Paddepoel Energiek (PE) is the local foundation that has the goal to foster the transition in Paddepoel (part of the North district). Grunneger Power has hired two people that are active in PE to represent the local community | Apts belong to housing association. Tenants willing to collaborate<br><br>TNO worked on probable tech & calculations |
| Pain Points | Gasgrid is socialised, heatgrids are not | Everyone needs to be connected in order to remove gas grid | To get enough buildings connected to make a business case work |
| OPPORTUNITY |   | | |

<u>Experience Mapping of Groningen:</u> Groningen City together with technical partners first considered the resources and heat grids in the city boundaries. Since most of the city is upon gas network, they searched for geothermal based district heating area in order to benefit from renewable energy production. The infrastructure of heat grid is being built and therefore, second consideration was to involve active communities in the area to arrange a full commitment on investment and implementation of PED in this area. Finally, city plans were analysed in order to define buildings listed for retrofitting targets. All of the happy and pain points of the conditions are summarized in Table 5. The opportunities are illustrated in the same table regarding the conditions in Groningen's process.

# 4 The Phases of the MAKING-CITY PED Methodology

The next sections explain the general context, introduction, identified phases for planning and deployment of PED, stakeholders involved and citizen engagement strategies in the MAKING-CTY Methodology. Regarding planning of PED areas, identification of PED concept boundary and identification of technical and non-technical solutions are considered. On the other hand, for deployment of PED areas, verification of PED calculation, identification urban/land use planning support, stakeholders, financial schemes and citizen engagement are evaluated. PED Methodology also highlights replication view by standardization and workshop activities that will be held in Follower Cities and other potential cities.

MAKING-CITY Methodology pursues six phases of which the first is related to analyses of city characteristics through city diagnosis approach. Phase II considers all of the analyses regarding city needs and identifies a prioritization study on defining the PED framework within PED concept boundaries in the city. Phase III and IV focuses on the set of solutions proposed from the experiences of Oulu and Groningen and potential barriers and enablers that the Follower Cities or other cities may face during designing and implementing PED. Phase V offers an annual energy balance calculation relying on the method defined in D4.2 and monitors if the area is absolutely surplus building upon the applied earlier phases. Finally, Phase VI is an outcome of solution catalogue and barriers/enablers study and covers all detailed information regarding PED solutions. The phases are illustrated in Figure 9.

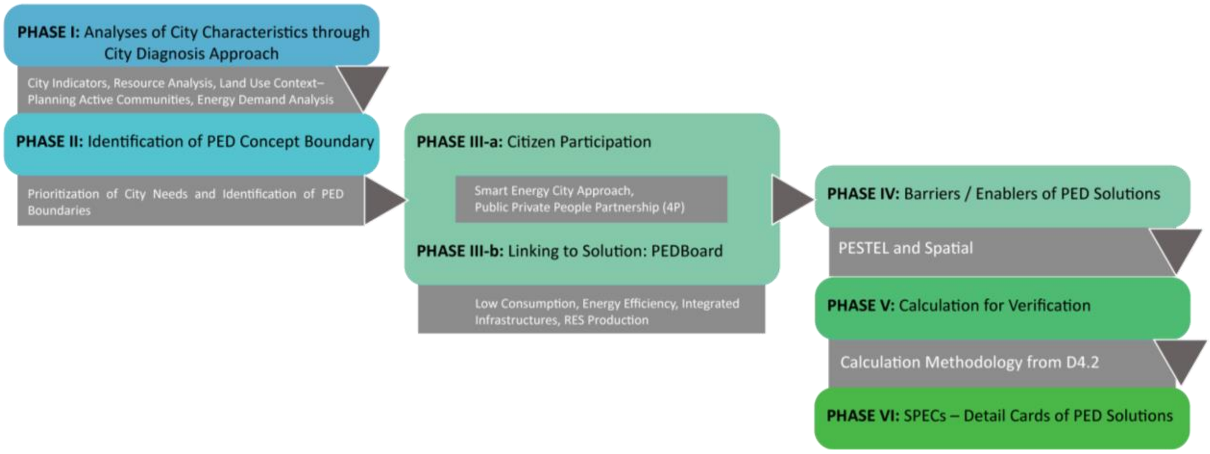



**Figure 9 Phases of MAKING-CITY PED Methodology**

## 4.1 Phase I: Analyses of City Characteristics through City Diagnosis Approach

Phase I addresses main city needs in terms of energy aligned with integrated urban planning, land-use planning and urban design. This phase includes robustly local authorities, citizens, researchers, planners and designers in the process. In doing so, city characteristics and priorities are analysed under four steps (Figure 10):

1. Analysis of the main city characteristics: Calculation of City Level Indicators
2. Analyses of existing City Plans and identification of implementation areas in these plans
3. Analyses of City Components
4. Energy Demand Analyses

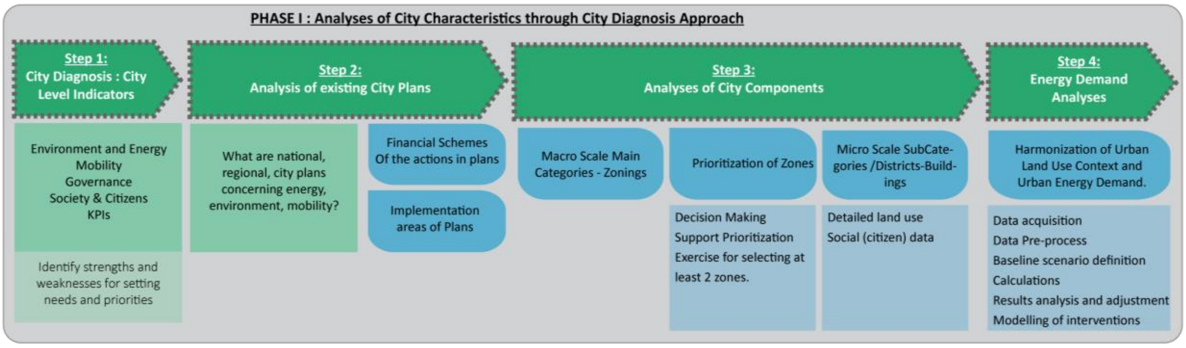



**Figure 10 Four Steps of Phase I**

### 4.1.1 Step 1: City Diagnosis: City Level Indicators

The city level indicators are used to show to what extent overall policy goals have been reached. In the process to become a smart city, establishing a reliable metric is a key point to support cities to identify strengths and weaknesses and consequently set priorities for action. For this reason, a set of city level indicators are established for the city diagnosis and for the identification of their needs and priorities. The indicators are defined within WP5 and used in WP1 in the city diagnosis framework. These indicators are grouped under Energy & Environment, Mobility, Governance and Society & Citizens categories. Within the four categories, application fields are found in which the indicators are included.

Thanks to the calculation of these indicators (D5.1), in D1.2 a process is carried out for the calculation of some city indexes with respect to the four categories. Through this process, the different indicators are scored according to the criteria of a previous normalisation based on a ranking of these indicators across European countries (literature analysis). A prioritisation is also carried out by the cities, in a way that reflects their priorities and needs regarding the different categories, application fields and indicators, since the intention is not to base the diagnosis only on the objective values, but also in the concerns and interests of the cities. This is done using an Excel Tool for pair-wise comparisons of the elements (Analytic Hierarchy Process, AHP).

Through the prioritisation, weights are obtained for the indicators of each city, which are aggregated with their scored to reach the city indexes (4 indexes, one per category). The method of aggregation of these two elements varies according to the city and its results, so that the parts in which the city have a good score are differentiated (either because it is very important for the city and many measures have been taken in this regard, or because there have never been any problems regarding that issue), from the parties in those the city is not well punctuated (and that score is attenuated because the city is aware of its problems and is on the way to improve it, or the low score is marked to highlight a problem that the city was not aware of).

This whole process and its results are reported in D1.2.

### 4.1.2 Step 2: Analyses of existing City Plans and identification of implementation areas in these plans

After city diagnosis research for defining the state of play in cities, a comprehensive study on analysis of existing city plans and the targets defined in these plans is carried out. The relationship between Step 1 and Step 2 is illustrated in Figure 11.

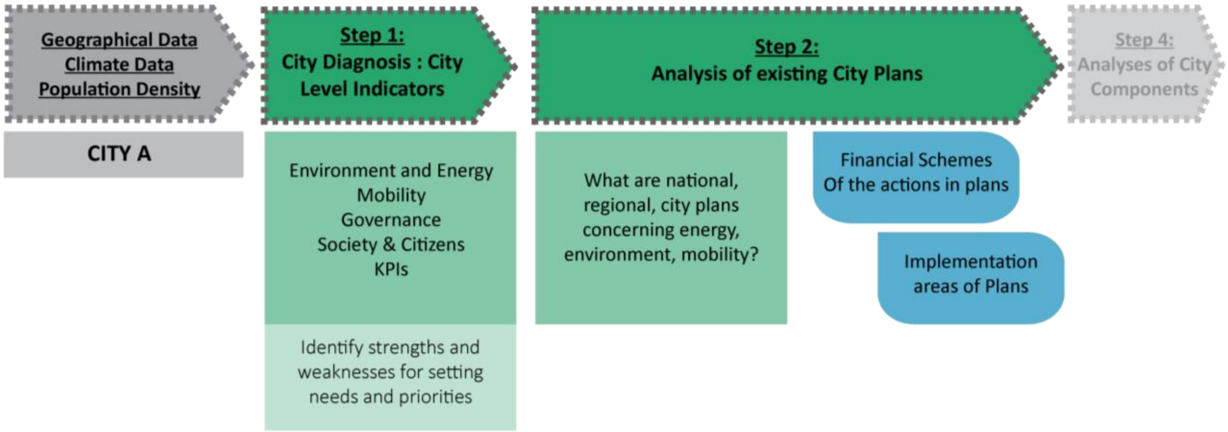



**Figure 11 Step 1 and Step 2 of Phase I**

To analyse the plans of the cities (explained and reported in D1.2) a table template of information gathering was made, so that all the plans were comparable to each other, both those of the city itself and those of some cities with others. Within this template, it is collected in a first approach the description of the plan, the implementation period, the scope of the plan, and the topics covered (energy, mobility, ICT, social). With this key information, it can already be made analysis about the plans of the city, the issues addressed in them, their scope or term of implementation. It also allows classifying the plans according these characteristics: their short, medium- or long-term planning, and their local, regional or national scope. At this phase, cities can also utilize their strategic land use plans to explore opportunities for PED implementation, by taking into account the aims of the city, the energy network operators, private sector and citizens. For instance, areas with both strategic importance for the city and energy network operators, and on-going or anticipated development activities by private sector or citizen initiatives could be prioritized.

Then, cities can profile areas suitable for implementing PEDs. At this phase, more specific information is collected on the main targets of the plans, and within these targets, the actions defined to achieve this goal, if there are actuation areas identified to implement the previous actions, the current status of the implementation of the actions (finalised, just getting started, on-going, cancelled due to lack of budget, cancelled due to technical issues), the execution period of the action, and the financial scheme that is or will be applied for the deployment of the actions. Once, the implementation area is selected, financial schemes or innovative business models for the deployment of the actions are analysed. To enhance implementation, cities may utilize detailed land use planning and land policy tools, as well as citizen and stakeholder engagement strategies. For instance, in some spatial planning systems, local detailed plans juridically enable implementation of building projects, and their participatory planning processes can be utilized for energy planning-related participation.

For the regional and national plans, the second approach of information collection has been simplified so that the actions are not repeated and taking into account that the measures or targets defined in these broader plans serve as the basis for the drafting of the local plans, in which the specific measures and areas of the city are already defined. Therefore, these plans only collect information about the targets and their related actions (or measures).

### 4.1.3 Step 3: Analyses of City Components

Analyses of City components play a key role for identification of peculiar and efficient PED concept boundary in cities. Until today, smart cities were particularly evaluated with energy, mobility and ICT (rarely with waste, water, too) domains. In fact, the challenge is that local energy production and distribution, connected with digitalization, have not previously been a part of the integrated urban planning and design approaches, while they have included many other environmental and social topics.

MAKING-CITY PED Methodology underlines **energy sustainability in urban planning, land use planning and urban design** and therefore repeats deep analysis in macro/micro scale in the city/neighbourhood/district/building level. A harmonization of these diverse modes of spatial planning with energy planning is the main aspect of PED Methodology for pointing out city characterization.

Likewise, MAKING-CITY PED Methodology indicates that inclusiveness, co-creation and participatory planning shall rule the energy transition since an inclusive city is a city in which the processes of development include a wide variety of citizens and activities. These cities maintain their wealth and creative power by avoiding marginalization, which compromises the richness of interaction upon which cities depend.[30]

The main analyses of integrated energy planning, spatial planning and data is divided into two categories, comparatively **macro and micro scale** main categories. Macro scale main categories involve GIS based spatial data as zonings. Cities start to assess zones of efficiency for PED areas peculiar to their characteristics, climate, demography, geography in different macro scale categories listed below (Figure 12)

1. Resource Analysis
2. Urban Macro-form Analysis
3. Land-use Context
4. Energy Infrastructure Analysis
5. Social Aspects

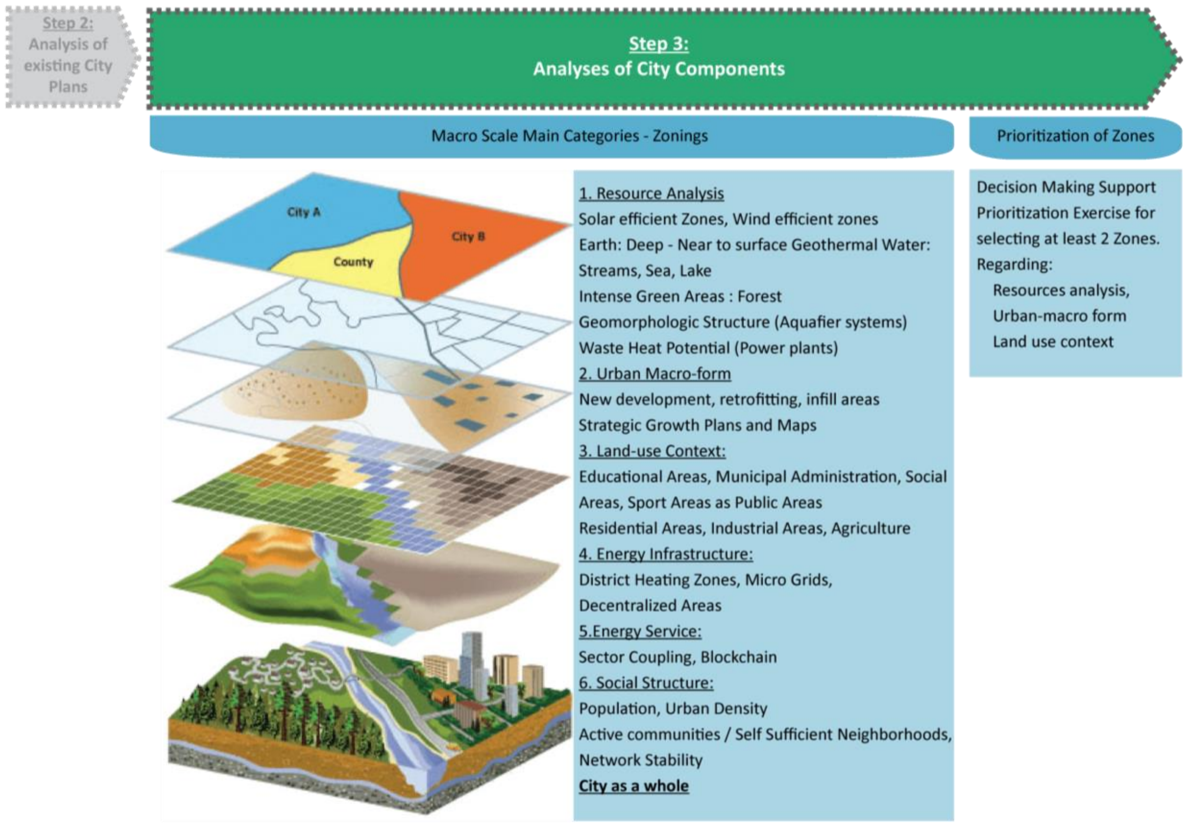



**Figure 12 Step 3 of Phase I**

30 http://www.inclusiveurbanism.org/

Macro scale main categories are explained in detail as follow:

Resource Analysis: This category comprises recognition of solar efficient zones, wind efficient zones, earth resources (e.g. deep-near to surface geothermal), water resources (e.g. streams, sea, lake) or intense green areas (reduce urban heat island effect) and other available resources in the city boundaries. Existing power plants, RES plants & facilities may also be evaluated for waste heat potential, thus their locations shall be identified for potential renewable energy sources. Municipalities specify the relevant zones for aforementioned resources as in spatial data.

Urban Macro-form Analysis: The macro-morphological zones of the city are drawn for this analysis depending specifically on the implementation areas of strategic plans that are already examined in Phase I Step 2. Suggested implementation areas are grouped as New Area Development, Infill Area and Retrofitting areas. In these areas, the form of property ownership and participation needs in urban planning, land use planning and urban design processes are different, which also affects PED implementation. New development areas are new urban areas where there are no existing buildings. There, land use planning has good prerequisites to steer PED implementation, because PED can be planned to integrate with the other development interests of the area, prior to the implementation of the buildings and infrastructure. This is especially the case when the local spatial planning system allows public officials to have regulatory powers over private developers' investments, or when PED is developed on publicly owned land. Whereas, Infill Areas are redevelopment or land recycling that occurs on previously developed land. Infill buildings are constructed on vacant or underused property or between existing buildings. In infill areas, there are certain possibilities for spatial planning to enhance PED replication. As infill projects take place in existing urban environments, there is often a vast number of stakeholders. Thereafter, PED replication depends on the capacity of public officers to cooperate with stakeholders: energy network operators, real estate investors, development companies and citizens. Lastly, Retrofitting Areas are development or upgrading of buildings or technology within existing infrastructure. In retrofitting areas, some spatial planning tools, such as citizen and stakeholder engagement plans, are available to enhance PED implementation. PED implementation is dependent on citizens and property-owners, as well as on the prerequisites of the existing energy network. Municipalities should identify the relevant zones for these strategic areas in spatial data format.

Land-use Context: Since PEDs are consisting of different building typologies or functions, a broad analysis on the macro-scale of land-use is very important for identifying PED concept boundaries. At this stage, zoning of educational, municipal administration, social, sport areas as public areas, residential, industrial, agricultural areas are mapped in spatial data in order to prioritize proper zones for PED boundaries. Municipalities probably have land-use maps and they may be integrated into GIS platform preferably aligned with the INSPIRE model.

Energy Infrastructure Analysis: The analysis of energy infrastructure in the city is a perquisite for defining PED boundary since the existing infrastructure may help demand side management scenarios, energy in and out the district/neighbourhood etc.

Energy Service Analysis: sector coupling applications for energy efficiency for the calculation of surplus. (i.e. district heating/cooling facilities, P2H – Power to heat, H2P – heat to power, P2V – power to vehicle, V2P – vehicle to power…)

Social Structure Aspects: There are **groups or cooperatives** of citizens working on **renewable energy**, energy efficiency and **e-mobility** for integration of citizen involvement for the energy transition and for inspiring others to take action, as well. These active communities are added as a layer (in spatial data) to macro-scale analysis to obtain an image of the city in social characterization. Urban density and population data also affect the Ped boundaries in decision making processes.

After all of macro-scale analysis have been realized and zones have been determined regarding resources, implementation areas of strategic plans, land-use context, energy infrastructures and social aspects (and embedded in GIS based maps as spatial data), cities and relevant stakeholders are encouraged to construct a prioritization study to specify **at least 2 most proper zones** for implementing PED according to the most prioritized zones by **overlay mapping.** Since these zones will cover large areas**,** next step is going through micro-scale analysis and identifying PED areas in the city. Cities will develop micro-scale analysis in the following subcategories (Figure 13):

1. Land-use Detail Maps
2. Social (citizen) Data Maps
3. Energy Demand Analysis

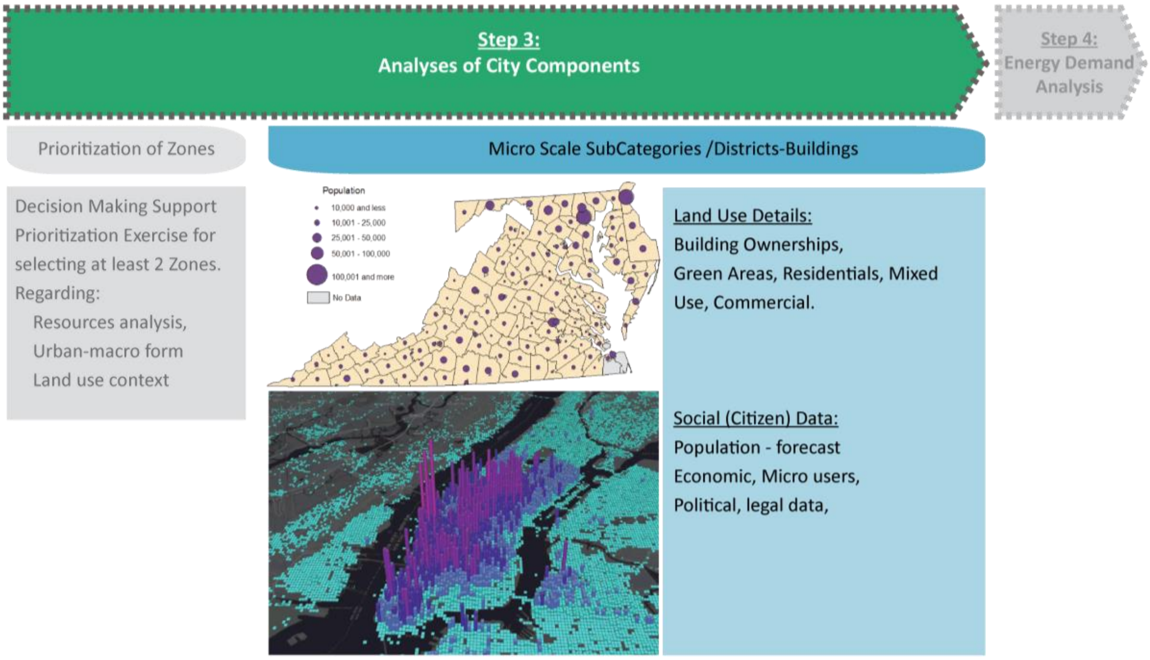



**Figure 13 Step 3 of Phase I**

<u>Micro-scale subcategories for detailed analysis in the prioritized zones</u> are examined as follow:

<u>Detailed Land-use Analysis:</u> Within the selected zones from macro-scale analysis, a detailed micro-scale analysis will be generated. Residential, mixed-use, commercial or all other tertiary buildings are identified in GIS cadastral environment, to find out whether there is a suitable mix of building typologies for PED development. Property ownership (e.g. public, private, semi-public) plays a key role in PED areas as well, and therefore the property ownership data of all the properties in the prioritized zone is defined. The state of existing land use plans in the area is analysed, to find out if the existing local plans already allow for PED development, or whether amendments have to be made for the plan. Based on these analyses and depending on the land use context of the area (new area development/infill development/retrofitting area, relevant stakeholders are then scanned, to find out whether the other property development needs can be integrated to PED development, and whether they are willing to implement PED in the agreed schedule.

<u>Social (Citizen) Data:</u> Citizens must be included from the early stages of PED planning and design in order to raise acceptability and potential for private investment on energy transition. The citizen data, such as, economic welfare level, capacities, legal data on incentives, population

forecast etc., (as layer in GIS system) will be integrated in the prioritized zones in order to view the potential of the districts to become PED area.

### 4.1.4 Step 4: Energy Demand Analyses

There are several bottom up methodologies and techniques for making building stock energy models to analyse energy demand, and they can be applied at any level, local (district, municipal) or national level.

This section, presents a bottom up methodology for modelling the building stock of urban districts based on publicly available data and describes the workflow from the collection of the data to the adjustment, calibration and visualization of the simulation results.

The workflow is divided into the following process steps (Figure 14):

1. Data acquisition
2. Data Pre-process
3. Baseline scenario definition
4. Calculations
5. Results analysis and adjustment
6. Modelling of selected interventions.

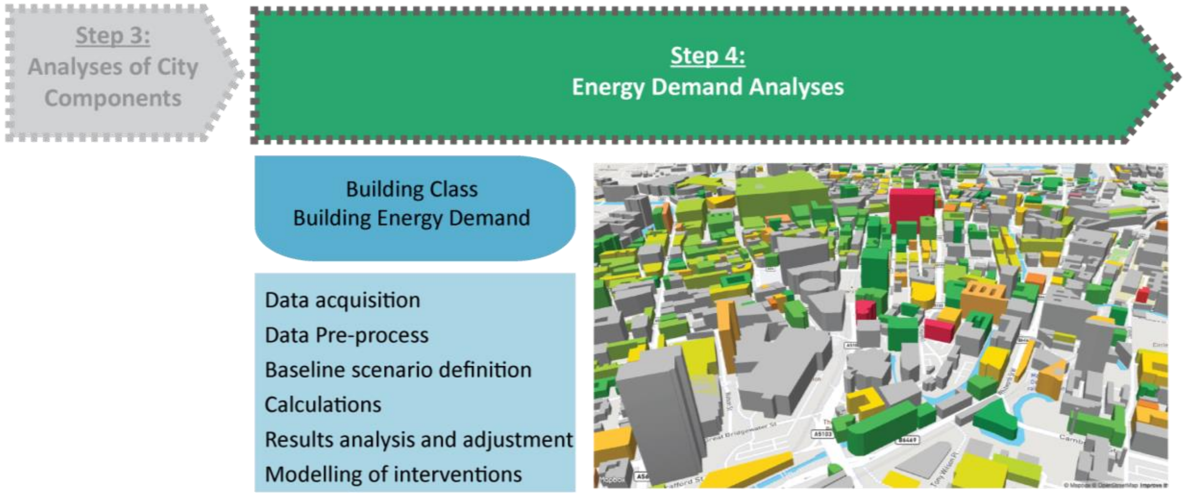



**Figure 14 Step 4 of Phase I**

The data gathering process is necessary to collect buildings' characteristics, regardless of the technique used to generate the model. This information can be obtained from public sources such as the cadastre, municipal datasets, statistical sources or European databases like the EU Building stock or the TABULA Web tool. The type of information and the disaggregation of the data required will depend in each case on the technique used. All this information must be processed and adapted to meet the requirements of the tool used in each case.

In order to obtain a realistic model, the particularities of the study area are defined in the best possible way to represent the current circumstances. These include the representation in a GIS tool of the different buildings with basic information regarding their year of construction, floors, area, use type, etc. With this basic information, the energy demand for heating, cooling, DHW, lighting and appliances can be obtained. If additional information is provided, the energy use for the different services, the emissions and the primary energy demand for each building within the district can also be calculated.

Finally, the results are validated against real data from billing or other sources such as energy performance certificates and the model is adjusted if necessary. The calibration of the energy models with actual consumption data is crucial to quantify current energy consumption correctly and not to overestimate the reduction potential of the measures applied in future scenarios.

These calculations would be a preliminary assessment of the baseline situation, which can also be compared with the analysis of the city indicators in Step 1 of this diagnosis Phase I. In Phase V, more detailed calculations with different solutions for PED design could be modelled, as future scenarios so that the impact on the energy demand, the $CO_2$ emissions and the primary energy demand can be analysed.

For all this process, the use of GIS software facilitates the representation of results, so that it is possible to analyse the actual state of energy demand in the study area in a visual way and identify the areas with the greatest potential for savings or implementation of interventions in the baseline scenario and the comparison with the results of the modelled PED scenarios. For the generation of the energy demand models within the Making City project, the use of ENERKAD® tool is proposed. ENERKAD® is a plugin for QGIS which evaluates urban energy scenarios at building, district and city scale and calculates the energy needs and energy use per hour for each building in a district, departing from generally available cadastral data, basic cartography and climatic information of the study area.

The application of this methodology is detailed in D4.15 section 7.

## 4.2 Phase II: Identification of PED Concept Boundary

Once the city needs and priorities are identified, land use context of the city is clarified and resources are listed, the boundary for the PED concept may be formed. This phase is connected with city and district scale and accommodates the participation of the local authorities, all relevant stakeholders and citizens. In advance of Phase II, what does the city analyse so far?

- City Level KPIs and preliminary outcomes
- Existing city Plans and implementation areas in these plans
- Macro Scale Urban GIS Zone Maps – covering resources, urban macro-form, land-use, energy infrastructure and social structure.
- Micro Scale Neighbourhood GIS Maps - covering land-use in detail, social (citizen data)
- Energy Demand Maps – analysis of heating/cooling demand, building energy properties/class

Phase II is illustrated in Figure 15.

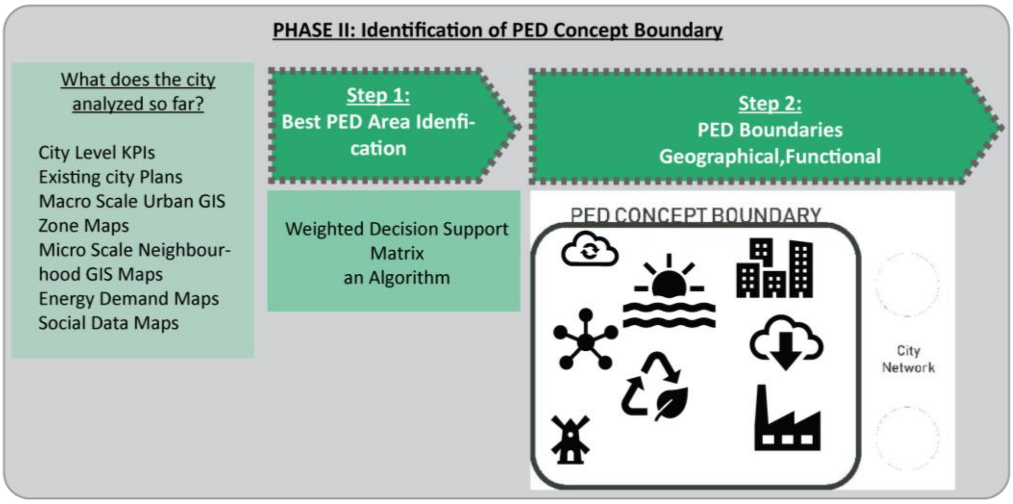



**Figure 15 Phase II Illustration**

### 4.2.1 Step 1: Best PED Area Idenfication

Following the first phase, Step 1 of Phase II focuses on results of the analysis. Within Macro-scale analyses, at least two zones were selected in order to further examine them in detail with micro-scale analyses and energy demand analyses. Phase I deals with city characteristics and needs, introduction to neighbourhood and district scale and prioritization of potential PED zones. In Phase II -Step 1, a decision-making support mechanism / an algorithm is designed to identify PED concept boundary within the prioritized zones. Such a decision-making matrix refers to a harmonization (Synthesis) of Urban Land Use Context and Urban Energy Demand. More detail regarding decision making support matrix will be developed and shared in the final version of this deliverable.

### 4.2.2 Step 2: PED Boundaries

PED framework is still under discussion that PEDs can be delimited by spatial-physical limits including delineated buildings, sites and infrastructures. Therefore, the PED will be characterized by geographical boundaries. Furthermore, it might be possible that the district has several buildings within a district or city interconnected with each other in terms of energy grids. This is the case of a district with a district heating or cooling system. A definition of a PED with a "functional boundary" can be taken from this as the buildings are interconnected by means of the pipes, and buildings are supplied by the same service. A gas network grid or an electric grid will follow the same approach, as an electricity/gas grid behind a substation can be considered as an independent functional entity serving the PED, even if the mentioned service areas are substantially larger than the energy sector of the PED in question. But, what if an energy generation infrastructure own by the community is outside the geographical boundaries of the district? Then, a virtual boundary could be defined, where the momentary energy produced and consumed is compared guaranteeing that, when a district demands, that RES energy is purchased to the grid. This is the case of a community that has the resources to own a windmill which are not usually located close to the city.

More info may be found within D4.15 Guidelines to calculate the annual energy balance of a PED, Section 4.1 decide the boundaries.

## 4.3 Phase III-a: Citizen Participation - Smart Energy City Approach

As explained by the Covenant of Mayors of the EU, "*all members of society have a key role in addressing the energy and climate challenge with their local authorities*". Public participation is useful to determine needs, desires and requirements and to increase transparency. Their implication is also useful to increase citizens' engagement with the environmental challenge.

Essential part in understanding the wider context of an existing urban district, identifying priorities and most urgent needs to address in designing and planning of a sustainable Positive Energy District, is to include the perspective of citizens and end users of the district itself. One of the methods to include the citizens in the process of involvement, being part of planning and prioritizing, is potentially the approach of Smart Energy Cities (Figure 16).

The lessons provided in the five steps to actively involvement citizen in the transitions are discussed in detail below.

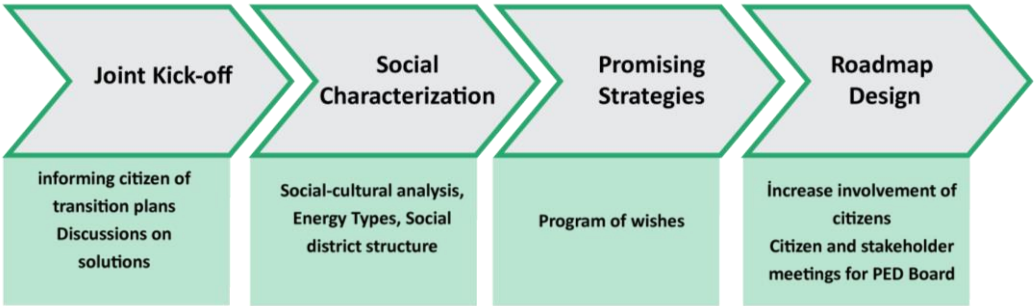



**Figure 16 Smart Energy City Approach Integration**

## 4.3.1 Step 1: Joint Kick-Off

A joint start of the transition process is required in order to create a joint ownership, broad support and participation of all stakeholders relevant to the transition. This should also include citizen.

*"Include the residents as early as possible by informing them and including them in the process"*.

By including citizen, they get the change to organize and join the process as a ***collective***. When residents are not included in the process, they might oppose the eventual outcome of the process. The transition solutions will most likely require investments by the residents. Involving residents includes, first of all, informing citizen of transition plans and second of all, including them in the deliberation process for possible solutions in the district – (a toolbox for participation with suggestions may be developed at this stage).

## 4.3.2 Step 2: Social Characterization

Step two includes the characterization of the district in order to explore the possibilities, challenges and chances of the district, both technical and social. Technically, the buildings, energy infrastructure and heath sources in the district are mapped. In addition, it is vital to map the social character of the district to be able to construct an adequate district transition approach. The social characterization entails different activities:

a) Social-cultural analysis

A social analysis of the district starts with the social data (income, education, age, etc.) which is necessary to create the appropriate approach and communication process for every group of citizens. However, these numbers alone are not enough as these do not tell anything about the level of knowledge, activity or motivation to investment of the citizen in the district. As a policy maker or project manager, it is necessary to really explore and indulge in the district in order to understand social and cultural characteristics of the district.

b) "Explore the wishes, demands and needs of citizen in the district"

Start a conversation in and with the district in order to gain insights in the attitude of citizen towards the energy transition. The SEC recommends to select a diverse group of at least 12 to 15 citizen which represent the citizens in the district. The interaction with the citizens can take place in informal settings such as the supermarket or on the street or during formally organized individual or group meetings. Explore the district as the context in which the citizens are situated. Explore their current attitude towards the district and subsequently their wishes, demands and needs for change. Determine to what extent sustainability is already part of their context and attitude. It is important to capture and secure the outcome of the conversations in order to take it into account in the preparation and implementation phase of the transition not only in energy domain but also in quality of life, spatial quality, liveability etc aspects that affect directly or indirectly energy in cities.

c) Energy Types

Divide the citizens in energy types based on the outcome of the conversations conducted in the district. Not every citizen holds the same motivation or attitude or has equal knowledge or capacities to contribute to the transition. As a result, citizens require an approach to involve them in the transition congruent to their characters. A division in energy types creates a foundation for the development of customized communication, products and services. The energy types can be elaborated into energy personas which are fictional descriptions of fictional citizens. This further increases the understanding of the social characterization of the district and enhances the communication and intervention strategies used. The energy types and energy personas answer the following questions

- What is the knowledge, attitude and behaviour towards sustainability and energy use?
- What is important in sense of housing and residential environment?
- What is the most effective strategy to reach and involve this type in the energy transition?
- What does this type need in order to act and invest in the adaptation of their residence? Knowledge, facilitation, money or something else?

d) Social district structure

It is important to know the social structure of the district in order to understand where and how to entre and start the transition in the district. A **social opportunity map of the district** outlines the social structure of the district. In the social opportunity map marks **the initiatives, pioneering residents and organisations, collaborations and communication networks** between the citizen and **promising locations** of the district. The social structure should be used to build on and connect the transition of the district to.

### 4.3.3 Step 3: Weighing Promising Strategies

The third step is to combine the technical and social character discovered in the previous step in order to determine promising strategies. The technical and social possibilities and requirements in the district need to be in harmony. The goal is to formulate the criteria and conditions for the design of a promising strategy to realize a sustainable district. This includes the input provided by the citizen.

e) Program of wishes

A program of wishes is based on the outcome of the social characterization in step two. The program includes the broad wishes, concerns and needs of the citizen. For example, **fundamental living conditions, public spatial planning or personal sustainability challenges.** A program of wishes provides a starting point and guide for the development of promising, efficient and effective transition strategies and approaches to engage citizen in the process. This document contains the above-mentioned information of the locals and the environment and the linkages to energy aspects.

### 4.3.4 Step 4: Design Roadmap

The next step is to design an adaptive roadmap to realize a sustainable district based on the social and technical data collected in the previous steps. According to the SEC, this roadmap includes three aligned approaches: **to increase the involvement of citizens, to realize sustainable heating in the buildings and to invest in the necessary infrastructure** (Technical solutions of PEDBoard – explained in section Phase III-b). In Phase III-b, solution catalogue (PEdBoard and Solution Index) involves all stakeholders for selecting peculiar solutions for the city by Public-Private-People Partnerships framework (detailed between in section 4.3.5). The focus in this section is on the first approach: involvement of citizens. The SEC approach includes several activities to achieve involvement of citizen.

f) Start with promising groups

In an early stage it is not yet efficient or effective to engage everyone in the district. Based on the social characterization of the district in step 2 and 3, select the groups in the district which have the knowledge, opportunity and capacity to contribute to the transition process. These are promising groups which already have plans to develop, reconstruct or renovate or which are already involved in sustainable development.

g) Make residents aware and include them

Besides actively working with the promising groups of the district, the remaining citizens should be kept informed and engaged. Keep all citizens informed of the transition plans in the district and make them aware of their position, role and the possibilities to contribute.

h) Communication and trust

In order to engage citizen and keep them engaged proper communication is required throughout the transition process. This includes communication between the stakeholders in the district and between the stakeholders and the citizen. In order to guarantee proper communication with the citizen the stakeholders in the district should:

- Collectively decide on a message to communication;
- Determine who communicates on the integrated transition process;
- Determine who communicates with whom;
- Create one main information platform for the citizens;
- Use different communication tools to reach all citizens;
- Create formal service points for the citizens;
- Organize informal citizen activities (such as sustainable festivals in the districts);
- Evaluate the response to the communication;
- Communicate on natural moments.

i) Ambassador

Collaborate with pioneering citizen, businesses or organizations in the district. Experience shows citizens are more eager to listen to and trust their neighbours then an organization which they believe have more or different interests. The pioneers can act as ambassador for the transition. They can share their experiences and lessons learned and increase awareness and enthusiasm in the district.

### 4.3.5 Public-Private-People Partnerships as a tool for collaboration

Alongside with citizen involvement, the objective of PEDs to integrate smart city objectives with sustainable urban transformation calls for collaborative innovation, which can be obtained in public-private-people partnerships (4P). Here, the 4P denotes collaboration between the city, energy network operators, private property developers and citizens in the context of PEDs. Innovative collaboration that is generated by the 4P can simultaneously improve everyday activities and life conditions in cities, create economic opportunities, and enable experimentation and implementation of new technologies.[31] In the 4P, cities have a crucial role as facilitators and orchestrators of this collaboration.

In the context of PEDs, cities can utilize urban planning, land use planning and urban design to initiate 4Ps. This is the case especially when PED is developed in the context of new urban areas or infill areas, where new buildings are built, and urban planning thus takes place. One potential approach is Integrative Urban Development, which considers urban design and planning as a capacity to establish social relationships that integrate the aims of the city, private actors and citizens.[32] This is remarkably a different perspective focused on the implement ability, from regarding urban planning merely as a regulative framework. The Integrative Urban Development approach takes the development aspirations of all the PED stakeholders as a starting point of development, and proactively and creatively develops them further to discover mutual gains.

In the Integrative Urban Development, the principle is to produce value for all PED stakeholders. Noteworthy is that the concept of value is subjective. For instance, the city might value generation of public good, citizens might value generation of pleasant living environment, and private developers might value economic viability. For the city, the ability to create public value can be ensured by clarifying its strategic priorities in urban development, for example via strategic urban planning. However, the priorities should be set flexibly enough, so that they allow value creation also for other interested parties, such as, citizens and private developers. The value creation can be further facilitated in the negotiations and participatory processes related to urban planning, considered as a learning process where value creation requires continuous interaction between interested parties.[33]

Two parallel phases of social and technical dimensions may be unified and merged at the end of Phase III activities from an economic point of view by involving Public-Private-People partnership (4P) as a tool. PEDs must be planned and designed not only technically but also economically and socially aligned with a participative perspective. Thus, proposed PED Methodology encourages a holistic approach by integrating socio-technological dimensions with 4P tools in order to guarantee successful PED designs

[31] Leminen, S., & Westerlund, M. (2015). Cities as labs. Towards collaborative innovation in cities. In P. Lappalainen, M. Markkula & H. Kune (2015). Orchestrating regional innovation ecosystems – Espoo Innovation Garden (pp. 167-175). Helsinki: Aalto University, Laurea University of Applied Sciences and Built Environment Innovations RYM Ltd.
[32] Ahlava, A., & Edelman, H. (Eds.) (2009). *UDM: Urban Design Management: a guide to good practice*. Abingdon: Taylor and Francis.
[33] Ahlava, A., & Edelman, H. (Eds.) (2009). *UDM: Urban Design Management: a guide to good practice*. Abingdon: Taylor and Francis.

and implementations in cities. The relation of mentioned cross-sectoral integration is illustrated in Figure 17.

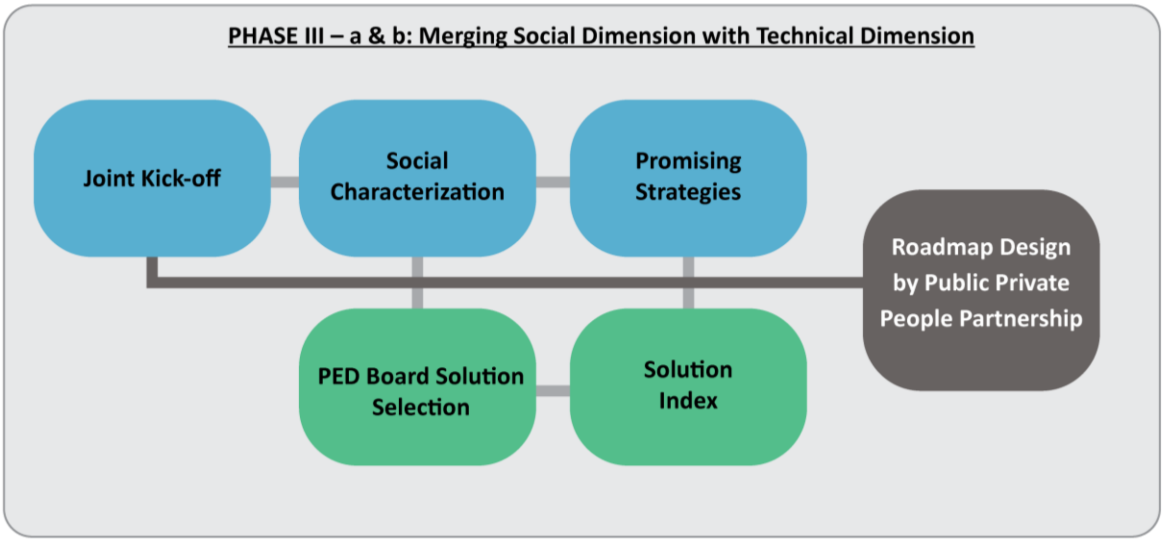



**Figure 17 Phase III-a and Phase III-b merged by 4P tools or shared vision document**

## 4.4 Phase III-b: Linking to Solution: PEDBoard

In parallel with Phase III-a Citizen Involvement, a technical study on PED technologies is realized (Figure 17 – Section 4.4.1). Within this phase, the inputs of Phase I and Phase II are evaluated by a decision-making mechanism and the particular technical and non-technical solutions are linked to the according to the data obtained from Phase I and Phase II. The solutions are classified under main solution categories of demand side, supply side and integrated infrastructures. The concept will enable the delivery of energy services, allow the management and trading of locally generated energy and grid-based energy supplies, and potentially link with other local and cloud-based services such as security/safety and e-mobility in order to progress towards energy positive districts.

Each PED solution is characterized in a solution index table (Figure 17 – Section 4.4.2), including short description, intervention scale, risk factors, benefits and initial budget information. All of the main and subcategories and index of each solution is presented on a panel, named "PEDBoard". While selecting peculiar solutions for a city, the stakeholders may go one step back and feed the PED boundary with the new results / actions. This phase is concerned with district scale and includes municipal departments, researches, technical designers and citizens.

Technical and economic aspects are braced with a social approach in order to implement the required transition innovations in a district. Citizen involvement, collaboration between stakeholders, and selection of technologies are moving on in parallel and learning activities from stakeholders to citizens and citizen to stakeholders in the local are taking place.

PEDBOard (PED Solution Catalogue) will be flourished with other technical and non-technical solutions apart from MAKING-CITY in the final version of this deliverable. Likewise, PED Solutions Index will be finalized in the final version of this deliverable until M24 of MAKING-CITY project.

### 4.4.1 PEDBoard (PED Solution Catalogue)

**PEDBOARD (PED SOLUTIONS)**

**DEMAND SIDE SOLUTIONS**

| Category 1: LOW ENERGY DEMAND Technologies for reducing the energy demand -passive measures or building insulations *Building/District Level* | |
|---|---|
| Solution 0.1 District level strategies according to local environmental conditions | S0.1a Wind strategies |
| | S0.1b Solar orientation strategies |
| | S0.1c Water resources strategies |
| | S0.1d Ground coupling strategies |
| Solution 0.2 Climate change adapt. District Strategies | S0.2a Cooling of surfaces |
| | S0.2b Evaporative cooling |
| Solution 0.3 Mobility (emissions) | S0.3a Foster clean mobility |
| Solution 1 Building Envelope Retrofitting in Residential b. | S1a Residential Building (High Rise) retrofitting |
| | S1b Residential Building (Private House) retrofitting |
| Solution 2 New High-perfor. residential buildings | S2a New High-Performance Building (residential) |
| Solution 3 Building Envelope Retrofitting in Tertiary b. | S3a Retrofitting of the office building |
| Solution 4 New high performance tertiary buildings | S4a New High Performance Building (Shopping Mall) |
| | S4b New High Performance Building (Academy Building) |
| | S4c New High Performance Building |

| Category 2: ENERGY MANAGEMENT all interventions related to monitoring, control, smart readiness, (Improve Energy Efficiency) *Building/District Level* | |
|---|---|
| Solution 5 Smart Building / Home energy controllers | S5a Smart Control / Advanced Metering / Wireless Advanced Control in Buildings |
| | S5b Visulation Units to study human behaviour regarding the energy consumption |
| | S5c Demand Response/Smart Grid |
| | S5d Heat Matcher |
| Solution 6 IoT Monitoring | S6a Smart Lighting, power LED |
| | S6b LoRa (Long Range) wireless network and activity sensors to optimize the lighting level |
| | S6c Energy data monitoring of PED |
| | S6d Integration of new services to the data platform |
| | S6e Installation of IoT infra |
| Solution 7 ICT Urban Platform | S7a Open Urban Platform adaptation |
| Solution 8 High Speed data transfer network | S8a High Speed data transfer network |

**SYSTEM INTEGRATION**

| Category 3: INTEGRATED INFRSTRUCTURES Storage as energy exchange facilitator, pipelines & heat exchangers... etc | |
|---|---|
| Solution 9 Power storage | S9a Neighbourhood electro storage facility (power storage) |
| Solution 10 Thermal Storage | S10a Phase transfer Liquid tank |
| | S10b Seasonal storage |
| | S10c Thermal Storage |
| Solution 11 District Heating & Cooling Facilities | S11a Low Temp regional transfer pipeline |
| | S11b Adjust geothermal district heating for using low temperature |
| | S11c Connection to the low temperature district heat |
| Solution 12 Building energy connectivity for energy sharing | S12a Building energy connectivity for energy sharing |
| Solution 13 Heat Pumps | $CO_2$ based heat pump |
| | Advanced Heat Pump (high COP) |
| | Acoustic Air Heat Pump |
| | Acoustic Hybrid heat pump |
| | Geothermal Heat Pump |

**SUPPLY SIDE SOLUTIONS**

| Category 4: RENEWABLE ENERGY SYSTEMS ALTERNATIVE URBAN ENERGY SOURCES *Building/District Level* | |
|---|---|
| Solution 14 Solar PV Panels | S14a PV in roofs and parking lot |
| | S14b Building Integrated PV (on the façade) |
| | S14c Floating Solar pontoons |
| | S14d Solaroad |
| Solution 15 Solar Thermal Panels | S15a Hybrid Heat collector (high preassurised $CO_2$) |
| | S15b PVT Panels |
| Solution 16 Geothermal energy | S16a Geothermal energy |
| Solution 17 Waste Heat Recovery | S17a Heat recovery system from AC and sewage water |
| | S17b Heat recovery system from return pipeline to DHW |
| Solution 19 Wind turbine | S19a RES from Wind turbines |

**NON-TECHNICAL SOLUTIONS**

| Category 5: POLITICAL, SOCIAL, ECONOMICAL INTERVENTIONS | |
|---|---|
| Solution 18 Policy Innovation | S18a Integrated Sustainable Energy Planning |
| | S18b Land use planning fostering energy actions |

### 4.4.2 PED Solutions Index

| PED SOLUTIONS INDEX | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Name of the Solution** | **Short Description** | **Intervention Scale** | **Risk Factor** | **Benefits** | **Initial Budget** | **CATGEORY** | **Solution Type** |
| **Solution 0.1 District level strategies according to local environmental conditions** | · **Wind strategies** to take advantage of urban ventilation corridors<br>· **Solar orientation strategies** to exploit solar potential or mitigate its effects<br>· **Water resources strategies** in order to optimize water management<br>· **Ground coupling strategies:** Ground adequation for future ground-source heat exploitation | District | The studies themselves are not a solution. Adequate design solutions must be developed in relation to those studies. | Potentially high impact on mitigation of the urban Heat Island Effect. All studies combined lead through design strategies that favor evapotranspiration and temperature moderation | | **Category 1:** LOW ENERGY CONSUMPTION | **DEMAND SIDE SOLUTIONS** |
| **Solution 0.2 Urban Cooling Strategies** | · **Cooling of surfaces**<br>Shading through native adequate vegetation and other human-made shading elements<br>Cool pavements (high albedo materials - vegetated and non vegetated permeable surfaces)<br><br>· **Evaporative cooling**<br>Introducing vegetation for evaporative cooling as well as water bodies. | District | *pay attention to accesibility<br><br>Water management: potable water consumption may increase if recovered water reuse is not ensured | Potentially high impact on mitigation of the urban heat island effect.<br>Vegetation increases humidity level. Shading and proper pavements help to reduce temperature.<br>Combined with natural ventilation, it favors evapotranspiration. It increases humidity level. The need of water for irrigation and water elements shoud be supplied by non-potable water sources (building's depurated greywater as well as rain water collected) | xxx | | |
| **Solution 0.3 Mobility (eliminate vehicles emissions)** | Foster clean mobility (public transport, cycling, walking) through the adequation of roads, pedestrian sidewalks, bike lanes, etc. In order to reduce emmisions | District | XXX | potentially high impact on mitigation of the urban heat island effect. Adequate and alternative clean public mobility supports private mobility abandonment | xxx | | |
| **Solution 1 Building Envelope Retrofitting in Residential buildings** | Deep Insulation (wall, roof, windows.. Building envelope), Daylighting, Natural Ventilation | Building | lack of coordination between stakeholders | potentially high impact on lowering energy demand increased indoor environment quality / comfort | | | |
| **Solution 2 New High performance residential buildings** | | | | | | | |
| **Solution 3 Building Envelope Retrofitting in Tertiary buildings** | | | | | | | |
| **Solution 4 New high performance tertiary buildings** | | | | | | | |
| **Solution 5 Smart Building / Home energy controllers** | | | | | | **Category 2:** IMPROVE ENERGY EFFICIENCY | |
| **Solution 6 IoT Monitoring** | | | | | | | |
| **Solution 7 ICT Urban Platform** | | | | | | | |
| **Solution 8 High Speed data transfer network** | | | | | | | |
| **Solution 9 Power storage** | | | | | | **Category 3:** INTEGRATED INFRSTRUCTURES | **SYSTEM INTEGRATION** |
| **Solution 10 Thermal Storage** | | | | | | | |
| **Solution 11 District Heating & Cooling Facilities** | | | | | | | |
| **Solution 12 Building energy connectivity for energy sharing** | | | | | | | |
| **Solution 13 Heat Pumps** | | | | | | | |
| **Solution 14 Solar PV Panels** | | | | | | **Category 4:** RENEWABLE ENERGY SYSTEMS | **SUPPLY SIDE SOLUTIONS** |
| **Solution 15 Solar Thermal Panels** | | | | | | | |
| **Solution 16 Geothermal energy** | | | | | | | |
| **Solution 17 Waste Heat Recovery** | | | | | | | |
| **Solution 18 Policy Innovation** | | | | | | **Category 5:** POLITICAL, SOCIAL, ECONOMICAL INTERVENTIONS | **NON-TECHNICAL SOLUTIONS** |
| **Solution 19 Business Model** | | | | | | | |
| **Solution 20 Social Awareness** | | | | | | | |

## 4.5 Phase IV: Barriers / Enablers of PED Solutions

In this phase, impact-based evaluation is integrated in selection of solutions process and political, economic, social, technical, environmental, legal and spatial barriers, constraints, supporting factors are recognized for each selected solution. A brainstorming on how to overcome the barriers is encouraged and if the results are negative to continue to the next phase, Feedback loop (a system for improving a product, process, etc. by collecting and reacting to users' comments) mechanism starts to find another particular solution for the PED area. The discussion is expected to be developed by an open dialogue and consensus between technical designers, citizens and local authorities. In this report, barriers/enablers analyses are performed and the matrix is filled by FWCs and their support partners to figure out political, economic, social, technical, environmental, legal and spatial aspects in other geographies in EU. Unexperienced cities are encouraged to provide their concerns, thoughts and advantages on solutions of LHC that are being implemented in MAKING-CITY lifetime. Barriers/Enablers matrix may be reviewed in ANNEX I BARRIERS / ENABLERS OF THE SOLUTIONS by FWCs.

## 4.6 Phase V: Calculation

As explained in Section the basis for the energy calculation in MAKING-CITY PEDs is the Primary Energy Balance (annual base). If this average value is positive our district will be a PED, if not our district will only be nearly zero, not positive.

A very detailed procedure for PEDs calculation is included in the deliverable D4.2 "Guidelines to calculate the annual energy balance PED", nevertheless a calculation of the PED will be evaluated in this phase for the verification of surplus in annual energy balance. If the PED calculation is not surplus regarding energy demand, energy use, energy distributed and primary energy balance, new selections from PEDBoard must be assessed in order to provide PED.

## 4.7 Phase VI: SPECs

This Phase presents the detail cards of each solution categorised in PEDBoard. The solution cards, named SPECs, involve general data, technical and graphical details, implementation time, initial investment and financial models, stakeholder mapping, integration with other smart solutions, potential for replication, expected impacts of all of the solutions. This is the main output of proposed PED Methodology, guiding cities with a detailed information on the technical and non-technical issues of solutions presented in PEDBoard (Section 4.4.1)

The cards may be reviewed in ANNEX II SPEC CARDS of SOLUTIONS.

# 5 Citizen Engagement Strategies / Smart Energy City Approach in Netherlands

### Citizen engagement in prioritizing city needs / characteristics

Essential part in understanding the wider context of an existing urban district, identifying priorities and most urgent needs to address in designing and planning of a sustainable Positive Energy District, is to include the perspective of citizens and end users of the district itself. One of the methods to include the citizens in the process of involvement, being part of planning and prioritizing, is potentially the approach of Smart Energy Cities. The Smart Energy City (SEC) approach Figure 18 is the result of a private-public collaboration between the ministries of economic affairs, interior affairs, the national grid operators, the TKI Urban Energy and the TKI ClickNL.

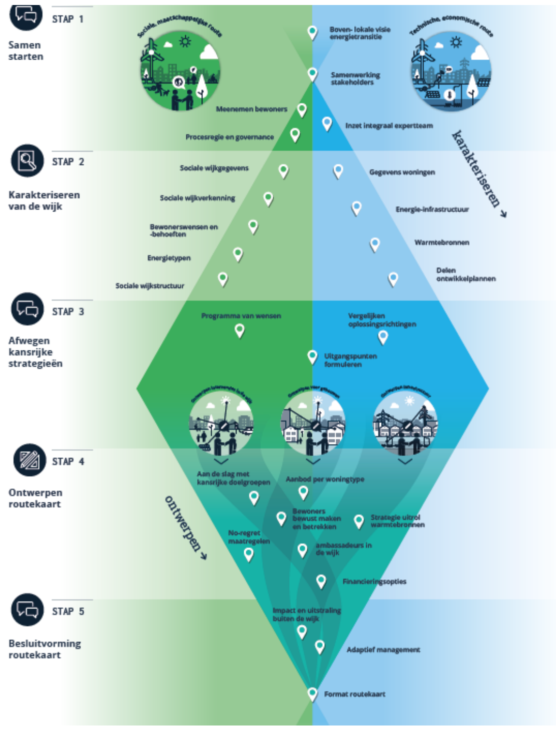



**Figure 18 llustration of SEC Approach in Netherlands**

These parties collaborated in order to develop a national-wide applicable approach to facilitate the energy transition of districts in the Netherlands. The approach is the synthesis of the lessons learned in 16 case studies in which municipalities, grid operators, residents and other local organizations collaborated in a district transition approach. SEC offers an integrative model (Figure 19) with a congruent approach to shape and accelerate the transition process in districts with a sustainability ambition. Technical and economic aspects are braced with a social approach in order to implement the required transition innovations in a district. In the model the converging and diverging blue and green tracks visualize the transition process. The **blue track** outlines the **technical-economic** transition process and the **green track** outlines the accompanying **social transition** process.

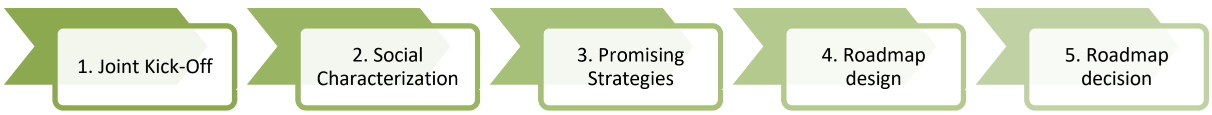



**Figure 19 Smart Energy City Approach**

The two tracks develop individually however simultaneous and aligned. Both the blue and the green track follow the same five process steps:

1. **Step 1:** A joint kick-off
2. **Step 2:** Characterize the district
    - 2.1 Social characterization
    - 2.2 Technical and economic characterization
3. **Step 3:** Weighing promising strategies
4. **Step 4:** Design a roadmap
5. **Step 5:** Decide on a roadmap

These five steps contain multiple technical (blue) and social (green) transition activities which are deemed essential in the transition of a district. As of the last two steps the social and technical tracks converge and are increasingly integrating into the roadmap. After fulfilling the five steps of the SEC approach, a district is able to formulate an adaptive and integrated transition roadmap for the following (depends on the city characteristics) years. In general, a roadmap includes specific technical solutions for the constructions in the district, specific steps for the development of the energy system, an integrated intervention and communication strategy and a concrete investment program for the first period (1 -2 years).

The SEC approach also includes specific guidance on the involvement of citizen. The involvement of citizen is part of the green, social track of the SEC approach. In order to use sustainable energy sources in the district; the houses of the residents, both house-owners and renters, require adaptation. The activities within the five steps of the approach which are relevant for the active involvement of citizens are outlined in the Figure 19.

Though citizen engagement has its place in the SEC approach it is not described in great detail and the means and tools available for citizen engagement are limited. When designing a citizen engagement strategy, it is important to use the perspective of the citizen; what are the steps that the user is going through? And what are his/her experiences? In order to focus on the users' perspective, the customer journey method could be used. The customer journey describes all the steps a user is going through from the perspective of the user. Figure 20 shows the steps a Dutch user is going through in order to make his home fossil free (Tigchelaar et al., 2019). The steps will be briefly described:

**Step 1 –** Awareness of fossil free at a national level: the user has to become aware of the plans of the government to make all homes fossil free by 2050. Users will hear about it from (social) media or other sources.

**Step 2 -** "tam-tam" phase: in this step people will form their opinion about fossil free living via different sources like (social) media and their network. The information that they get can be incomplete or incorrect.

**Step 3 –** awareness of personal situation: at a certain moment it will become clear which solutions will be chosen by the municipality for a certain neighbourhood. This will provide users with somewhat more information about what fossil free living will mean for their own situation.

**Step 4 –** choice for orientating, waiting or resistance: at this point in the journey people will consciously or subconsciously make a decision to start orienting for specific solutions in their house, to wait or to actively resist fossil free living.

**Step 5 –** Orienting: users will look for information to the channels that are at their disposal. They will go to the next phase once they think they are well informed or they have use a specific decision aid (e.g., what choices have others made or what is advised by an expert).

**Step 6 –** choice for a specific solution: users will choose the solution that they find most attractive.

**Step 7 –** living in a house that is being renovated:  users might experience disturbance when their house is being renovated.

**Step 8 –** living in a (partly) fossil free house: users live is a house where the renovation operations have been (temporarily) finished. They experience fossil fee living.

**Step 9 –** being an ambassador: users will share their positive or negative experiences about the process they have gone through. This is important information for other people in their social network. The CODEC model, described in 2.3.3. underlies many of these steps in the journey.

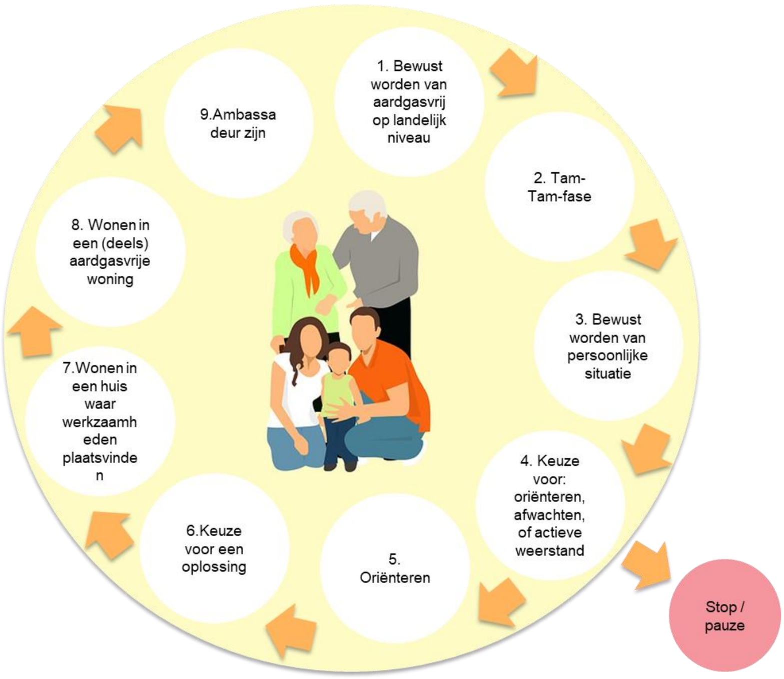



**Figure 20: Fossil free living: customer journey**

Other approaches such as those followed by the municipality of Groningen and Grunnuger Power put (slightly) more emphasis on a more rigorous inventory of the social structure of a neighbourhood and the role of citizen collectives in realizing energy transition means. In short, they put citizens and citizen collectives even more central the vision formulation, decision and implementation/adoption process.

# 6 Identification of Stakeholders

A specific stakeholder mapping for PEDs has been developed in the project deliverable D6.1 "Ecosystem Analysis for Positive Energy Districts". It is represented on **Figure 21** and further described here after.

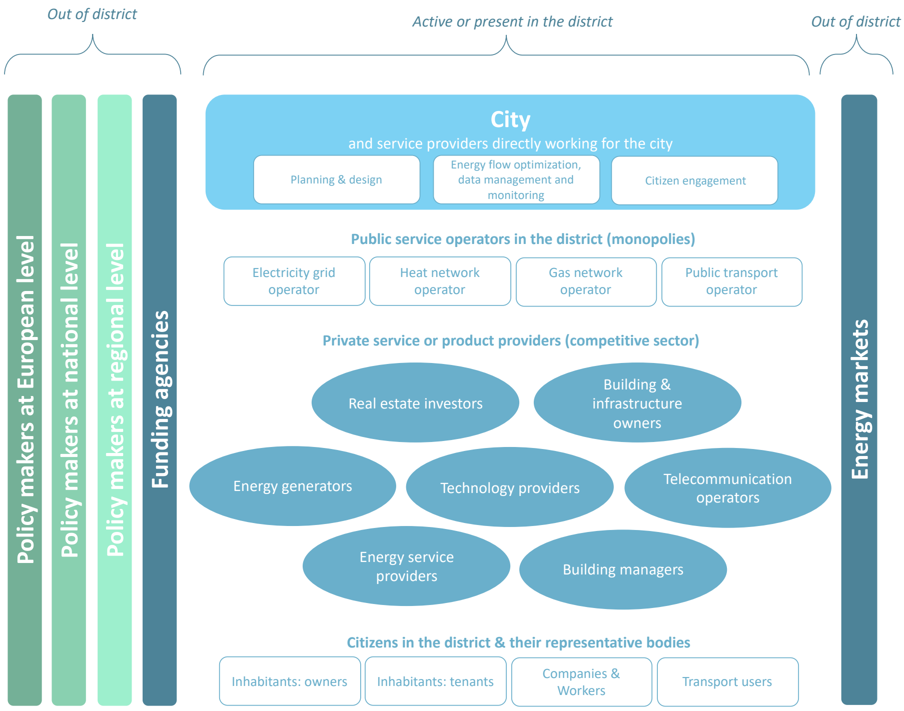



**Figure 21. Stakeholder mapping in PEDs**

This representation is made of four layers regarding the stakeholders active or present in the district, plus some stakeholders not necessarily present or active within the district's boundaries:

- Stakeholders active or present in the district:
  - Layer 1: The City itself is represented at the top of the mapping, as the main body in decision-making and implementation processes of PEDs. The City performs, in general in cooperation with contractors:
    - The planning and the design of PEDs,
    - The optimisation and monitoring of energy flows, and corresponding data management,
    - Citizen and other stakeholder engagement actions.
  - Layer 2: Public service operators are key players in PEDs. Not necessarily all of them are involved: their participation depends on the technological choices and available energy sources within the PED:
    - *Electricity grid operator:* The electrification of many energy usages, the hosting of distributed electricity generation capacities and the growing involvement of consumers in power markets make the electricity grid operator a pivotal player in the design and implementation of PEDs.

    - *Heat network operator:* If heat network exists in the district, or if there is a potential for such network, then the heat network operator is likely to be a central player in the PED design and implementation.
    - *Gas network operator:* If gas network exists in the district, then the gas network operator might be involved in the PED design and implementation. Existing gas networks have more and more available capacity, freed up by the decrease in conventional gas consumption. These networks are likely to take a growing role in energy transition projects by hosting and distributing gas from renewable sources (syngas, biogas or hydrogen).
    - *Public transport operator:* Since the transport sector represents a major share in energy consumption, the public transport operator(s) active in the district is likely to be involved in the PED design and implementation.
- Layer 3: The following service or product providers, in general from the private sector, have a strong role in PEDs:
    - *Real estate investors:* Especially for new districts, but also possibly in existing districts, real estate investors have a crucial role to play in the implementation of a PED. They will often bear extra costs at the development stage of the buildings, in order to implement energy-efficient technologies contributing to the positive energy balance of the district, for which they would be paid back during the exploitation phase of the buildings.
    - *Building and infrastructure owners:* Similarly, with a stronger focus on existing districts in which they would retrofit the buildings or infrastructures they are owners of, they would make energy choices and bear the corresponding costs during the renovation phase.
    - *Building and infrastructure managers:* This role may be played by the same entity owning the building or infrastructure, but it can also be played by a different entity. Building and infrastructure managers are those who are exploiting and operating the energy-efficient technologies implemented at their premises.
    - *Energy service providers:* They are in general providing energy from outside the district's boundaries and have customers inside. Therefore, the implementation of PEDs might have a negative impact on them, since they will be selling less energy to their customers. They have therefore a strong interest to diversify the services they are offering and to find new business models related to the development of PEDs.
    - *Energy generators:* This role may be played by entities playing other roles in the district such as the inhabitants or the building managers, or it may be played by specific entities. Anyway, this role is crucial since the positive energy balance of the district depends on the energy generation which can be done within its boundaries.
    - *Technology providers:* This category includes the providers of different technologies which can be installed at building or district level, such as energy

generation, conversion and storage technologies (heat pumps, batteries, BIPV, etc.).

        - *Telecommunication operators:* They might be involved in the concept of Positive Energy Districts especially regarding the IT infrastructure necessary to implement energy data exchanges.

    - Layer 4: Citizens, either individually or through representative bodies, are players in the PED, being them active or passive:

        - *Inhabitants / owners:* Inhabitants are energy consumers, and may be energy producers (for instance, if their house is equipped with solar panels). Especially when they are owning their house or apartment, they are the ones choosing the energy technologies to implement in the case of a renovation for instance. When buying an apartment or a house, they also consider the energy performance of the dwelling. Furthermore, depending on cultural aspects, they are more or less involved in the district-related decisions.

        - *Inhabitants / tenants:* Even though not owning the dwellings they are living in, tenants are concerned by energy technologies since they are in general paying the energy bills. They may be keen paying more for the dwelling if it is energy efficient.

        - *Companies and workers:* A district include in general not only inhabitants but also businesses (like shops or offices) involving workers. Workers might not be interested in energy bills, but certainly appreciate a comfortable working space. Companies are interested in energy bills and are increasingly interested in actions enhancing their reputation regarding climate issues.

        - *Transport users:* They might also be impacted by the development of PEDs. For instance, development of e-mobility might be incentivised in order to use the excess energy generated by the buildings in the district and/or to provide flexibility services when charging.

- Stakeholders not necessarily present in the district:

    - *Policy makers at European, national and regional levels:* Those policy makers, above the level of the city, might be involved in regulatory or economic incentives for PEDs.

    - *Funding agencies:* They might be involved in finance services for the development of PEDs.

    - *Energy market:* By definition, the PED delivers surpluses of energy (in general in the form of electricity, and possibly in the form of gas or heat). These energy surpluses have to be sold to consumers or to resellers, out of the district's boundaries. This can be done through organised markets (for instance power exchanges) or through bilateral contracts with specific stakeholders.

## 6.1 Experience feedback from Lighthouse cities

Detailed stakeholder mapping in Groningen and Oulu has been conducted in the deliverable D6.1 "Ecosystem Analysis for Positive Energy Districts". In this framework, Groningen's and Oulu's stakeholders have been interviewed by phone. The list of interviewees is presented in Table 6.

| Partners | Role in the project | Persons interviewed | Date of the interview |
|---|---|---|---|
| Partners in Groningen | | | |
| 3-GRO | Municipal regulatory authority | Jasper Tonen | 20/08/2019 |
| 3a-WAR | Heat network operator | Joep de Boer | 13/06/209 |
| 4-TNO | Support to PEDs' planning and design, citizen engagement activities, optimisation of heat consumption and production at building level | Joram Nauta, Marc Hamburg | 20/08/2019 |
| 5-GPO | Community-owned energy cooperative, in charge of citizen engagement actions | Joep Broekhuis | 19/06/2019 |
| 6-SEV | Responsible of the workstream "Business Models and Financing" | Mark de la Vieter | 17/06/2019 |
| 7-WAM | Owner of part of the real estate in the MAKING-CITY project | Bart Jager | 08/07/2019 |
| 8-NIJ | Housing corporation in the city of Groningen | Han Folkerts, Henrik Prosman | 21/08/2019 |
| 9-CGI | Provision of energy platform | Gerard van de Kamp | 26/06/2019 |
| 10-SB | Provision of monitoring technologies and services | Tuan Anh Nguyen | 26/06/2019 |
| 12- HUAS | New approaches and inclusive business models | Rob Roggema, Cyril Tjahja | 21/06/2019 |
| Partners in Oulu | | | |
| 13-OUK | Municipal regulatory authority | Samuli Rinne | 08/07/2019 |
| 14-UOU | Long-term urban planning methodology fostering PED replication and stakeholder salience analysis | Sari Hirvonen-Kantola | 17/06/2019 |
| 15-OEN | Leading energy company, in charge of district heating network in Oulu | Reijo Pantsar, Mikko Ojala | 20/06/2019 |
| 16-SIV | Housing company owned by the municipality of Oulu | Heikki Pohjola, Raimo Hätälä, Kari Puotiniemi | 27/06/2019 |
| 17-YIT | Construction company building two new private houses in Kaukovainio | Kristina Vähäkuopus | 09/08/2019 |

**Table 6: List of Groningen and Oulu partners interviewed**

Some analytics have been calculated based on the mapping (Section 6.2.1); prominent elements from a replication perspective have been identified for Groningen (Section 6.2.2) and Oulu (Section 6.2.3).

### 6.1.1 Analytics about the type of actions conducted

Within the project's Lighthouse cities, Groningen and Oulu, a series of actions are implemented in order to create the PEDs. Those actions range from technical actions (implementation of energy technologies such as photovoltaics, district heating, energy storage, etc.) to non-technical actions (policy innovation, citizen social research, capacity building, etc.).

An analytic study of the distribution of actions among the partners in Groningen and Oulu shows that the proportion of non-technical actions is significant to structure the project, as illustrated by Figure 22

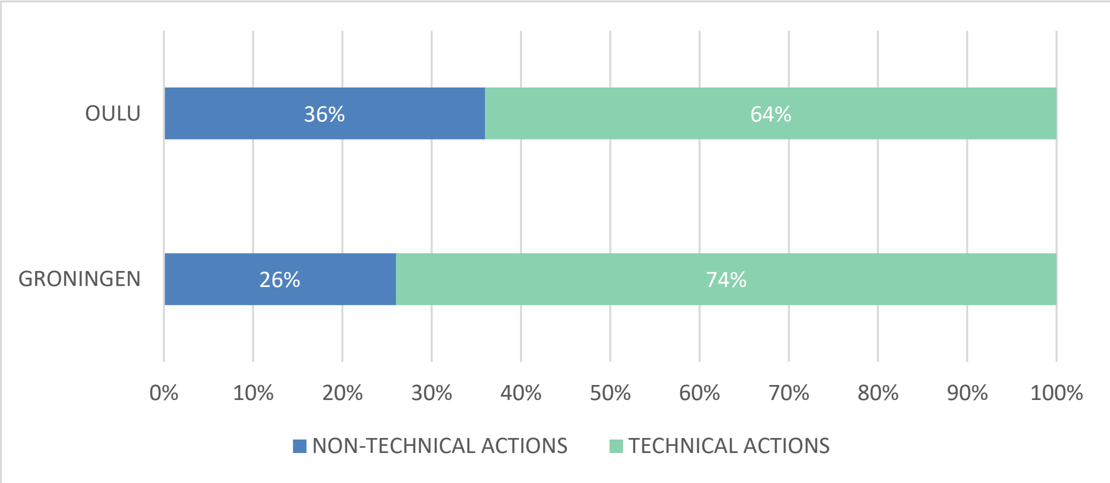



**Figure 22. Distribution of technical and non-technical actions for PED implementation in Oulu and Groningen**

In Groningen, the design and implementation of two PEDs simultaneously result in a lower proportion of non-technical actions than in Oulu (where only one PED is implemented). Furthermore, some savings are made because some actions (including technical actions) are conducted jointly for the PED North (N) and the PED South-East (SE), such as the deployment of smart charging stations for electric vehicles in both PEDs.

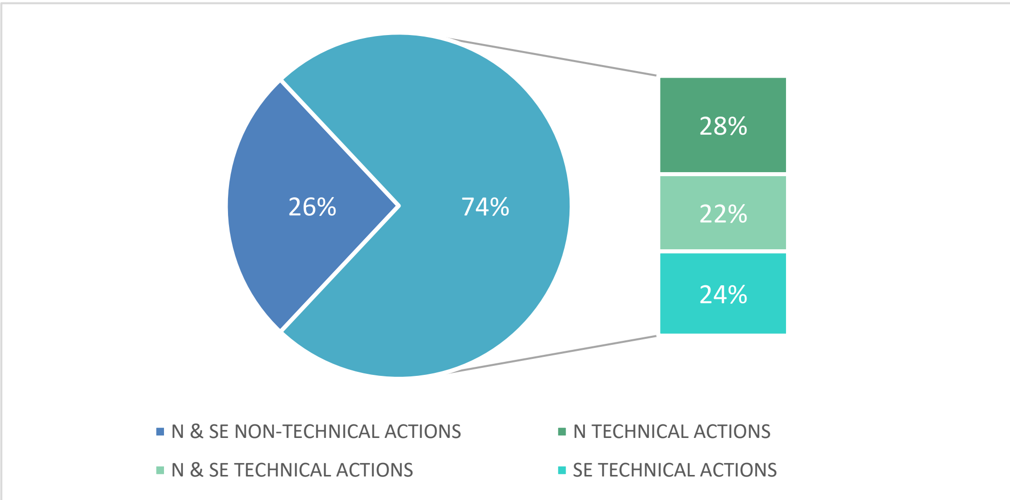



**Figure 23. Distribution of actions by type in GRONINGEN PEDs North and South-East**

A comparison of Groningen and Oulu Municipalities' involvement in the project shows that the City council of Groningen has proportionally more technical actions than the City council of Oulu (see Figure 24 and Figure 25). Indeed, the City council of Groningen owns one of the buildings built in the PED South-East (Sport Complex Europahal), in which several technical actions are conducted. The Municipality of Groningen also leads the implementation of RES technologies in public spaces (SolaRoad, Solar Pontoons, etc.). In terms of technical actions, the Municipality of Oulu focuses mainly on public lighting.

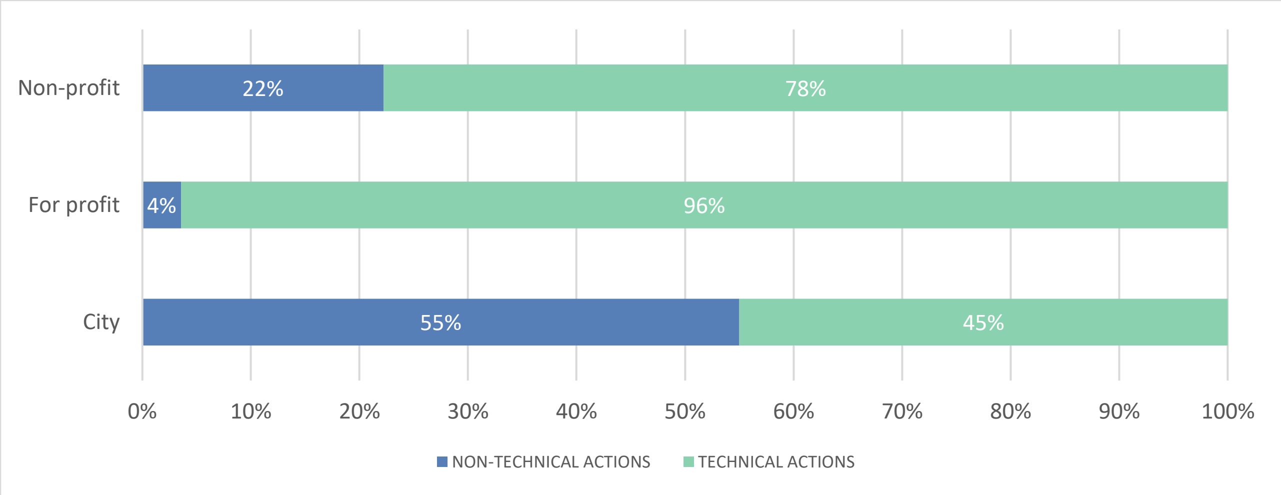



**Figure 24. Distribution of technical and non-technical actions by type of leading stakeholders in Groningen PEDs**

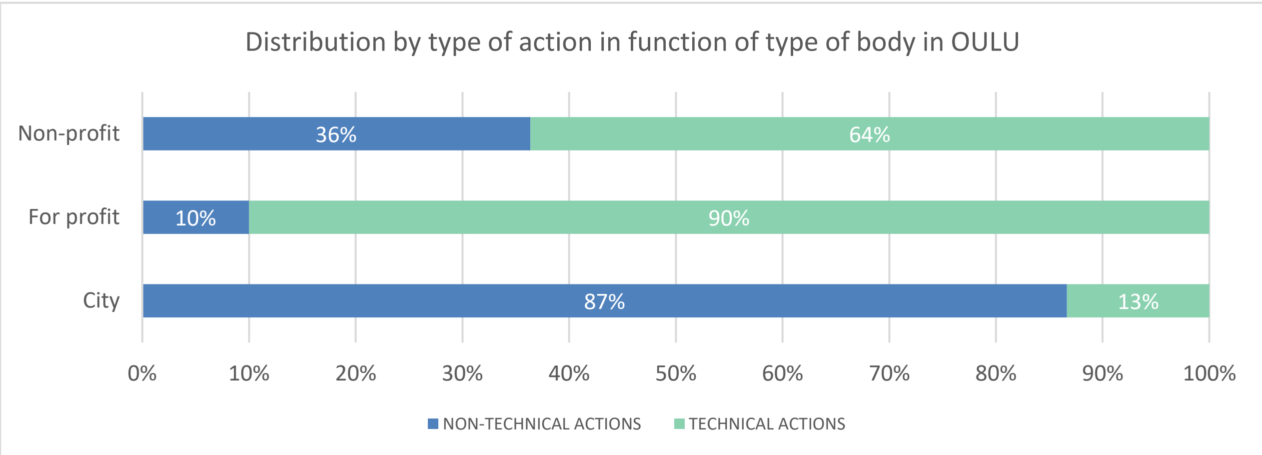



**Figure 25. Distribution of technical and non-technical actions by type of leading stakeholders in Oulu PED**

### 6.1.2 Prominent elements from stakeholder mapping in Groningen

#### 6.1.2.1 Context

Groningen was chosen as one of the two Lighthouse cities involved in MAKING-CITY due to its current urban energy transformation strategy. In the Netherlands, natural gas remained for decades the main energy source to respond to the national energy demand. However, reiterated earthquakes caused by the gas exploitation activities seriously damaged houses and revealed a need for sustainable alternatives. In Groningen almost every citizen wants to stop using ‘Groningen’ gas that is extracted from the nearby gas fields and is causing local earthquakes.

#### 6.1.2.2 The City council has set clear goals and KPIs

Targeted goal of Groningen is **clearly identified and quantified**: it is to become $CO_2$-neutral by 2035 and to reduce the use of natural gas. Those goals can be monitored to follow the success of the PED project.

The Municipality of Groningen has already implemented strong policies in favour of the energy transition. For instance, they have set as Energy-Efficiency standards as a strict obligation for obtaining building permits for new buildings. The City council has also decided to build a very ambitious energy performing building, the Sport Complex Europahal, which has involved different departments at City level playing various functional roles, for instance about permits, design requirements, greenery, real estate (since the building is owned by the City), etc.

#### 6.1.2.3 Project team has a dynamic organization

The following features appear to be crucial success factors for the project in Groningen:

- **Scheduled meetings:** On a scheduled basis the Municipality staff meets with the partners to discuss the progress in the project.
- **Flexibility in the actions to reach the objectives**: When it happens that some actions are no longer feasible, the project team talks about suitable alternatives.
- **Market-oriented:** The actions selected have to be profitable. For example, Action 31a consisted in implementing a high-pressure waste-water digester, to collect and digest waste from toilets and canteen. Eventually, it is being redesigned since it would need to change the collection system in the buildings, which is too much efforts and spending and not worth it given the modest contribution of this action to the City objectives. Therefore, only waste from canteens would be collected.
- **Impact on the inhabitants' life:** This PED project enhances the link with the citizens. Citizens are the most important stakeholders targeted by the City. On one hand, the inhabitants are involved in the decision-making, so the City council better understands their needs and wishes. On the other hand, to be able to reach the $CO_2$ neutrality by 2035, the City council has to put more constraints one the citizens' life. In Groningen, the loss of connecting to a heat grid is that customers can no longer choose the energy company for their heating solution whereas in the common situation with natural gas they can.

#### 6.1.2.4 The project is supported by facilitators

In Groningen's PED project, several partners are acting has facilitators.

A facilitator[34] is someone who engages in facilitation—any activity that makes a social process easy or easier. A facilitator often helps a group of people to understand their common objectives and assists them to plan how to achieve these objectives; in doing so, the facilitator remains "neutral", meaning he/she does not take a particular position in the discussion. Some facilitator tools will try to assist the group in achieving a consensus on any disagreements that pre-exist or emerge in the meeting so that it has a strong basis for future action.

Those partners bring their own experience, network and energy needed to reach the City's goals:

- TNO has been supporting the City from the design phase of the project to its implementation. Furthermore, TNO supports **citizen engagement** activities thanks to a participation tool for social innovation. It facilitates citizen engagement, participation and formulation and adoption of sustainable solutions (e.g. by individual citizens and local initiatives) and seeks **alignment with all public and private partners** active in the project to realize community benefits, leading to a sustainable eco-system in collaborations, solutions/value(s), investments and costs. TNO has also developed a Urban Financial Model (UFM) intending to support policy makers and private

[34] Definition of facilitator – source wikipedia

partners in aligning their activities within a neighborhood an seek for **mutual benefits**, thanks to quantitative insight in cash flows.

- Grunneger Power (GPO) is a non-profit organization launched 7 years ago. The cooperation of GPO represents all citizens of Groningen. Currently GPO has more than 2,000 members. GPO started with advising citizens in having rooftop solar panels, who united into a small clean energy company to which people could buy 100% sustainable energy. It then grew based on rewards to members inviting new members to join. Benefits are invested into new local green energy projects for the benefit of the quality of life in the neighbourhoods and of the circular economy. Within MAKING-CITY, GPO is mainly in charge of **citizen engagement** activities, to **empower the people in Groningen** to be in charge of their own energy future. GPO is working hand in hand with the Municipality.

- Stichting Energy Valley (SEV) is supporting the Groningen ecosystem in a transversal manner. Actions in Groningen have been grouped into workstreams; SEV will be responsible of the first workstream, namely "Business Models and Financing". This includes early replication, business concepts, **citizen engagement**, optimizing business models & **acceptability by all stakeholders**, etc.; in short, it is linked with the in-between work needed to come up with replication plans. SEV is also involved in actions involving local dissemination, communication and **capacity building**.

- Hanze University of Applied Sciences (HUAS) is focusing on how innovation is handled in the neighbourhood. HUAS investigates **how people respond to take those measures in their direct environment.** HUAS implements **co-creation & co-ownership** approaches, **social acceptance**, inhabitants' behaviour. HUAS contributes to the "Business Models and Financing' workstream.

#### 6.1.2.5 Data monitoring is conducted

The MAKING-CITY project is developing a procedure for modelling the energy demand side. Data collected from PEDs will be aggregated for monitoring and data analysis. Data monitoring and data management is a very important topic because it allows the project team to be informed to choose the most suitable technical solutions. Three main actors are working on it at different scale:

- Within the project, CGI Nederland **collects the data, process it and enable others to use** it. To be able to do so, they use their Urban Data Platform.

- Sustainable Building (SB) is responsible for collecting the consumption and production data. Based on the data needed, SB will specify the most **suitable hardware solutions (meters, sensors)** and will select hardware providers. SB will ensure the hardware devices installed provide the required data, all in the same way. SB provides the software tool to collect the data, and performs, to some extent, data analysis.

- The municipality of Groningen is connected to the Civity Data platform which is a widely used **open data platform in the Netherlands**. The most important goal of this platform is to share and use the potential of (open) data by governmental, commercial and knowledge institutes.

#### 6.1.2.6 The City council has strong link with energy infrastructures

The City of Groningen has a special role in relation to the heat grids. Some years ago, the City and the local water company founded the company WarmteStad, from which both parties have a 50 percent share. WarmteStad is the local heat grid operator and owns the system that is connected to the Sport Complex and other buildings in the PED South-East. Also, the heat grid in the PED North will be owned by WarmteStad.

#### 6.1.2.7 Technologies are chosen in a flexible way

The choice of technology providers is a key aspect of the project. Some of the technologies were listed at first. But as the City council is flexible some of them might change to reach a better cost and energy efficiency.

### 6.1.3 Mapping in Oulu

#### 6.1.3.1 Context

Oulu was chosen as one of the two Lighthouse cities involved in MAKING-CITY due to its current urban energy transformation strategy. Today, Oulu is one of the fastest growing regions within European high North. The population of Oulu is one of the youngest in Europe with an average age of about 38 years. Every third resident has a university degree. According to a EU's study from 2015, inhabitants of Oulu are the most satisfied with their quality of life in the whole Nordic region. It is also considered as one of Europe's "living labs", where residents experiment with new technology (such as NFC tags and ubi-screens) at a community-wide scale.

The strong expertise in ICT has created a unique base for innovations and new business in Oulu. During 2014-16 over 500 start-ups started operating, and the amount of rented offices has over doubled within the last years. In recent years, the business activities of many enterprises have been made difficult by the long global recession. In addition, Oulu has suffered from high unemployment rates, especially among the young. In 2016, however, unemployment levels began to fall.

In the Kaukovainio PED area the housing stock is old and outdated (no lifts in many of the residential buildings for example), so new buildings are needed.

#### 6.1.3.2 The City council has set clear goals and KPIs

The City council of Oulu adopted in 2012 the Sustainable Energy and Climate Action Plan (SECAP) targeting a 20% reduction of Oulu's carbon gas emissions by 2020. Actions such as improving public water management, increasing renewables as energy sources, or developing biogas plants, are expected to achieve this objective. More recently, the 2018 "Light of the North" strategy was adopted, reinforcing the willingness of the city to act for sustainable urban energy transformation.

#### 6.1.3.3 The project is supported by facilitators

To enable the replication and scale-up of the Positive Energy Blocks and Districts, the University of Oulu (UOULU) works on the alignment of the urban plans with the energy strategies and ecosystemic business models, and proposes a Simple Rules toolkit regarding the urban planning activities.

UOULU will also conduct a stakeholder salience analysis, where governmental actors, public organisations, companies and other related associations are surveyed and categorized depending on the stakeholders' ability and interest in influencing the project. The end goal is to have a clear understanding of who the stakeholders are, what their stake is, what their influence will be and how likely they are to use their influence.

UOULU has already identified following difficulties that Cities are likely to experience before, during and after the implementation of a PED:

- Before: the integration of all the stakeholders needed to develop and implement the PED,
- Before: finance of the investments on infrastructure,
- During: place branding, to create the prerequisites for the building project to get going,

- After: leadership for the scale up and replication of PEDs.

#### 6.1.3.4 Data monitoring is conducted

VTT has tailored the Oulu ICT Platform infrastructure to high-performance buildings in the PED area, and it will be used for real-time energy monitoring and management services. UOULU will use smart home data-based feedback platform to pilots and assess the impacts of environmental and social awareness on energy consumption.

#### 6.1.3.5 Impact on the value of the district is created

Real estate investors have difficulties to explain new services' gains for future buyers. When they build apartments, it is difficult for them to price new apartments to be sold. Being in PED, it should be easier, thanks to branding of Kaukovainio (the city tries to help the area to have a positive image). They will get new opportunities to brand their premises.

Also, in Kaukovainio PED's case one of the gains can be the knowledge of being a part of the more energy-efficient future. Still, this is not enough to justify higher prices for the apartments. At the moment, quite low prices are proposed in Kaukovainio in order to attract customers to this area in which no new buildings have been built for years. More buildings should be built soon in the area; prices might then go up.

### 6.1.4 Conclusions

Oulu and Groningen develop their PEDs with clear goals and flexible ways to reach them. The selection of technologies is made according to the calculation of annual energy balance. As the Municipalities constantly reassess the relevance of the different technologies, and take into account the various legal, economic or technical constraints arising, the technology portfolio can evolve. This is also why energy data monitoring is an important element of the project. Facilitators are helping City councils to manage all the stakeholders of the project, with the citizens at its heart .

This type of project management is similar to the Agile project management.

Agile[35] is an approach described by a set of principles and practices for delivering projects, which promotes an iterative approach, collaboration of self-organized teams, and process adaptability throughout the lifecycle of the project.

The key characteristics of Agile projects are:

- Focus on delivering value on time and to budget.
- A collaborative approach between all parties, including external suppliers.
- High level plans created based on outline requirements.
- Detailed plans created with the involvement of core project team members.
- Scope management by prioritisation of features.
- Continuous stakeholder involvement at all levels.
- Iterative development with short increments and frequent delivery.

[35] Source : Service@EC: https://webgate.ec.europa.eu/fpfis/wikis/pages/viewpage.action?pageId=192092335

- Embracing change, learning and improvement.
- Sufficient but not excessive documentation and control.
- Facilitative leadership and empowerment.

## 6.2 Application in follower cities

Representative of follower cities have been interviewed as presented in Table 7 in order to assess the ecosystem in each follower city.

| Partners | Description | Persons interviewed | Date of the interview |
|---|---|---|---|
| 21-BAS | Municipality of Bassano del Grappa | Giorgio Strappazzon | 12/06/2019 |
| 23-LEO, 01-CAR, 02-TEC | Municipality of Leon and supporting partners (Cartif, Tecnalia) | Monica Prada, Enery Acevedo, Cecilia Sanz Montalvillo, Nora Fernandez | 27/06/2019, 08/07/2019 |
| 24-KM, 25-DEM | Municipality of Kadikoy and supporting partner (Demir Enerji) | Burcu Sari, Beril Alpagut | 08/07/2019 |
| 28-VID, 29-GSC | Municipality of Vidin and supporting partner (Green Synergy Cluster) | Siyana Asenova, Ina Karova, Daniela Kostova | 04/07/2019 |
| 30-LUB | Municipality of Lublin | Dorota Wolinska | 13/08/2019 |

**Table 7: List of follower cities and supporting partners interviewed**

### 6.2.1 Bassano del Grappa

#### 6.2.1.1 Context

Bassano del Grappa (BdG) is located in the North East of Italy in the Veneto region. In the city, very few buildings are owned by the municipality or by other public entities. Most are owned by citizens or private companies.

Bassano has participated in other collaborative EU projects, in particular in the field of smart public lighting. The SUNSHINE project has been started within the context of SMART ENERGY with the objective of supplying intelligent services for the improvement of energy efficiency. Another European-funded project is called ENIGMA. The goal of ENIGMA, involving 5 European cities, is to foster the next generation of public lighting systems developing breakthrough solutions in the field of smart ICT-based lighting through the joint transnational Pre-Commercial Procurement (PCP) procedure.

#### 6.2.1.2 City council’s goals

Mid and long-term goals aim at a reduction of non-renewable energy sources in these sectors with a target of a 20% reduction of $CO_2$ emission by 2020. These reductions are the result of careful planning, incentives and monitoring through the implementation of residential energy efficiency, industrial energy efficiency, energy efficiency within the public administration, sustainable mobility, communication, information, education and training.

#### 6.2.1.3 Technology provider first mapping

At the moment, within the project contacts have been established with the local industrial association (which is influential in the city). The full value chain for heating buildings is present in the area and interested in participating in the development of the PED concept: BAXI is one of the main stakeholders. The start-up WindCity which is developing micro wind turbines has also been approached, as well as a company active in energy accumulation (Westrafo). In addition, building developers have been approached.

The grid operator has not been approached so far, but this is planned soon. Furthermore, ENEL-X, subsidiary of ENEL active in the field of EV charging, might be interested to take part in the project.

### 6.2.2 Leon

#### 6.2.2.1 Context

Leon is one of the main provincial capitals in Castilla y León in Spain. Potential districts to become a PED are within the area of Entrevías, in the northern part of the city. This is a group of isolated neighbourhoods without synergies with others next and well-developed areas due to topographic and accessibility constraints. Population amounts to 27,000 inhabitants, representing 21% of the population of León. Population density is high. Population consists mainly of working class with modest revenues and there are problems of physical and social segregation. Most of the housing stock consists in low-quality, energy-inefficient buildings built in the 40s and 50s.

Historically, León has had coal mines. Many people are still using coal for heating their dwellings, which is very cheap. It is forbidden to use coal in new buildings, but the use of old coal boilers is allowed until their end of life.

#### 6.2.2.2 Citizen mindset

Awareness for energy issues is not well developed. There are however some people concerned about energy consumption and generation. They might be the basis for the creation of an energy cooperative and to support involving other citizens.

In general, people are not ready to invest in energy retrofitting. We need to demonstrate that in the long-term retrofitting is beneficial.

#### 6.2.2.3 The project is not yet supported by facilitators

There is a university, but scientists are mainly active in the food sector, not in the energy sector.

There are some IT companies, but they do not form an ecosystem yet.

The levers to create an ecosystem have to be identified.

#### 6.2.2.4 Technology provider first mapping

Public lighting operators are important stakeholders. In Leon, a 10-year contract with a private company to operate public lighting is going to be signed by the municipality. The company will have some targets for the retrofit of energy-inefficient lamps.

Solar potential is high in Leon. Some houses already have solar panels because there is a legal obligation to have a solar panel, but not all of them are working. There are important regulatory changes at the moment, so there might be some opportunities to develop solar further so as to create a PED.

Bike-sharing and car-sharing systems should be considered besides public transport.

## 6.2.3 Kadikoy

### 6.2.3.1 Context

Kadıköy is one of the central districts of the metropolitan city of Istanbul. Located on the Southwest of Anatolian part of the city, it is surrounded by Marmara Sea on the West and South. Kadıköy Municipality's approach to local public administration has been that of participatory local democracy all the way down to neighbourhood level and a very high degree of citizen empowerment leading to transparent administrative processes and decision-making. Sharing information with citizens is therefore a priority for Kadıköy Municipality which has tried to establish wide open channels of communication, maximizing inclusivity and building on principles of trust and transparency in all functions.

### 6.2.3.2 The City council has set clear goals

As signatory of Covenant of Mayors since 2012, Kadıköy Municipality, in collaboration with Boğaziçi University, prepared a SEAP aiming at a 20% reduction in carbon emission and energy consumption by 2020. Kadıköy was the fourth city in Turkey signing up to the initiative but was the first metropolis in the country (it is the considered under this term those cities with more than 500,000 inhabitants). The Plan calculated ~ 1.7 million tons of carbon emissions in 2010 for the district, and through energy efficiency and renewable projects in the built environment, lighting sector, transport and via social awareness, targeted 348,000 tCO2eq reduction in total by 2020. Kadıköy Municipality has recently signed a grant contract with Central Finance and Contract Unit with its project of "Integrated and Participatory Climate Action".

### 6.2.3.3 Stakeholder mapping

Most of the stakeholders on the map haven't been informed yet. Kadikoy Municipality is a local municipality under Istanbul Metropolitan Municipality (IBB). The public service operators are public for Gas and transport network but is private for electricity. The elections in IBB were in a problematic situation for a few months, but now solved and the Mayor of Istanbul or the related departments should be contacted for MAKING-CITY in order to define the PED area.

## 6.2.4 Vidin

### 6.2.4.1 Context

Vidin is a port town on the southern bank of the Danube in North-Western Bulgaria. It is the $20^{th}$ town by population in Bulgaria. It has serious demographic problems (decrease of population).

### 6.2.4.2 City council sets clear goals and KPI

The city has an EE and RES Strategy and Action Plan. In 2016, the total energy consumption of the city was 297 GWh of which 75% were due to residential sector, 17% to industry and 8% to the public buildings and facilities.

Major target for the city is to reduce the energy demand in the public buildings through energy renovation and RES integration – most buildings need in-depth renovation, self-sufficient production capacities or prosuming capacities, intelligent energy monitoring and management.

### 6.2.4.3 The project is not yet supported by facilitators

The city is open to suggestions about how to implement smart energy management solutions.

The city has strong expectations about what the lighthouse cities are doing, and about what can be replicated and what can't.

#### 6.2.4.4 Technology provider first mapping

The heat network of the city is non-operational, but its revitalisation is under consideration in order to connect several municipal buildings (schools, kindergartens, etc.) to a single heat source. Time horizon is approx. 5 years.

Solar panels represent the main potential for local energy production. Biomass-based boilers have potential for local heating and domestic hot water production.

Energy cooperatives are not very popular in Bulgaria. By law, they have to feed all energy generated into the grid. They can't use the energy (being from any source: PV, biogas, etc.) for the community. An energy community would need to be part of a balancing group or stand-alone provider and to satisfy a production schedule, with important financial penalties in case of deviation.

### 6.2.5 Lublin

#### 6.2.5.1 Context

Lublin is the biggest city in Eastern Poland with a population of 340,466 (2016). Lublin benefits from high standards of living, good economic situation, ambitious sustainability objectives and has 9 universities.

#### 6.2.5.2 Citizen mindset

Citizens have to be involved to push for energy transition. At the moment they are quite passive. This is also related to the cost of new technologies (for instance to change boilers). The city is supporting citizens in changing supplier to switch from coal to PV (50% of cost is subsidized), but this is not enough.

Energy cost has just raised at national level; therefore, citizens are complaining about that.

There are also complains because of bad air quality.

No local energy communities have been active so far.

#### 6.2.5.3 Technology provider first mapping

Regarding solar photovoltaic, an analysis has been done and there is a big potential in Lublin. At the moment, few buildings in the city have PV panels. Development of PV in Poland should be a political decision at national level. At the moment the energy system is mainly based on coal.

Heat network exists in the city; it actually covers the whole city. Heat is generated from coal. Lublin owns the heat network operator LPEC which is Lublin's linked third party in the MAKING-CITY project.

Up to 50-60% of citizens in Lublin are connected to the gas network. Around Lublin there are agriculture areas so there might be some potential for biogas – but this is not a priority now.

With regards to energy-efficiency retrofits, a renovation plan covering 2013-2023 exists; it will be updated soon for 2024. There is an ongoing renovation in one building owned by the city.

There is a strong focus on urban mobility. There are ambitious objectives at national level in terms of development of electric vehicles. Lublin is applying these objectives by developing EV charging stations and developing EVs within its own fleet. Unfortunately, electricity is based on coal at national level and there is no plan to move away from coal in the short term.

Lublin University of Technology is working on energy technologies and is developing a new energy measurement method, which might be used in future PEDs.

## 6.3 Conclusion and next steps

As observed in Lighthouse cities and anticipated in Follower cities, each district has its own constraints and barriers, leading to different priorities regarding the stakeholders to be involved in the design and implementation of a PED. Though, some structural point of the stakeholders mapping can be considered as essential:

- The PED project should include non-technical actors who will act as facilitators to manage the team, , stakeholders and the citizen involvement,
- The PED project should include data monitoring,
- The PED project should be based on sustainable, tailor-made business models adapted to the local financial situation.

The MAKING-CITY project will help the Lighthouse and Follower cities to simulate their annual energy balance. The data monitoring is a key element to establish those energy simulations. The annual energy balance is the starting point of the reflection to establish the technology-mix and the interaction in-between the technologic actors.

# 7 How to proceed with PED Design

In previous chapters all the analyses that should be taken into account, have been described. Regarding the process to be a guideline, this chapter could have an organigram of the different steps, identifying each of them and describing in detail linking with the previous chapters. This section will be a base for replication potential of PED concept and how knowledge transfer could be performed via innovative tools or learning methods. Since citizens are in the "core" of this transition process towards PED/PEN and more ambitiously towards Positive Energy Cities, citizens gain innovative roles and undertake different interactions regarding power/heat energy markets, Public Private People Partnerships models, participatory design approaches for participative decision-making. This study is summarized in section 7.1.3 to support the replication and upscaling potential of PEDs.

### 7.1.1 A new Workshop "GamePED"

After studies have been started on Methodology for PED design (in the first year of MAKING-CITY), Fellow cities are introduced to be on board for early adoption of methodology for PED design for selection of areas to be PED in their cities. In order to involve fellow cities intensely in this methodology development procedure, first project meeting in Groningen (May 2019) was selected to be the first interaction space for Lighthouse and Fellow cities to work collaboratively. As being WP4 (Positive Energy District Methodology and Early Replication) Leader, Demir Energy designed and developed a workshop structure, namely GamePED, in order to share knowledge and experience from LHCs to FWCs. GamePED layout is illustrated in Figure 26. It presents the phases of the proposed PED Methodology for identifying city needs of each FWC, then defining the PED Concept boundary depending on resource availability, selection of technical solutions (that are being implemented in LHCs) and finally, a section to be considered for analysing barriers and enablers of these solutions. There are six tables (six different layouts) regarding six fellow cities and partners of LHCs are divided into these six tables in order to help FWCs for determining the above explained phases.

GamePED will be flourished and refined for the second project meeting, for instance PED methodology has been analysed and advanced in the first year. Probably, tools like GIS based layouts in relation with Phase I – section 4.1.3-Step 3: Analyses of City Components of proposed methodology. This advanced version will also support interaction of FWCs and LHCs in a more digitalized way. GamePED design and description will be updated in the final version of this deliverable.

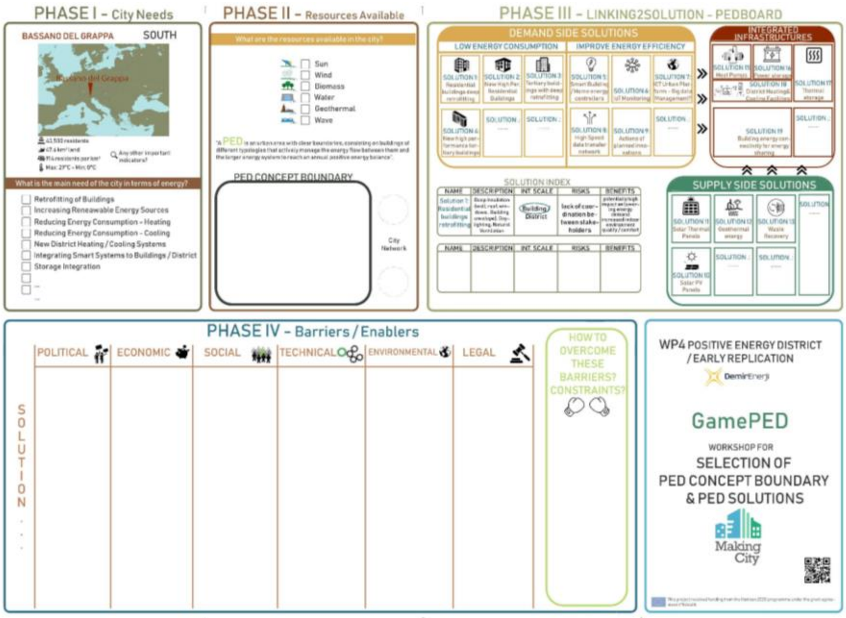



**Figure 26 GamePED Layout**

### 7.1.2 Lessons Learnt from the methodology development perspective

The PED development in Oulu illustrates the central role of the city in PED selection. Aligned with the PED selection actions in Oulu, described in Table 2 in section 3.4, the first condition is the examination of the potential PED area in relation to the strategic urban plans and land use plans of the city, to fit in the planned overall future and infrastructure development in the city area. Another condition for the existence of a new PED is the identification of the investors in the potential PED area, and their planned schedules for infrastructure and building implementation. In some spatial planning systems' contexts, cities can use urban planning, land use planning and urban design tools and approaches, such as Public-Private-People-Partnerships, to enhance these two prerequisites for PED implementation, scale up and replication.

PED experience of the first year in Groningen will be mentioned in the final version of this deliverable in M24.

### 7.1.3 Citizens in Future of PEDs / PENs/ Positive Energy Cities

Due to environmental and resiliency benefits, distributed energy resources (DER) are a potential solution for meeting future electricity demand, but their integration into centralized power markets on the large scale is challenging. Many practitioners argue that blockchain technology can create new market structures for DER like peer-to-peer (P2P) markets, community-based market, hybrid P2P market, and aggregators which foster renewable generation. As explained in Chapter 2.2 From smart cities to Positive Energy Districts, DERs have become key levers for transforming the electricity market from a vertical structure into a decentralized, bottom-up landscape and for providing a reliable and sustainable energy supply despite shrinking natural resources[36].

Incorporating DER in the market thus increases the complexity of the optimization problem for utility providers and challenges their distribution networks that are not built for bi-directional electricity and information flow. These developments have led to a paradigm shift toward a more decentralized market and spurred ambitions to build peer-to-peer markets (P2P) in which owners of solar panels can sell their production to other consumers on the local low-voltage distribution system. This puts small generation system operators in the focus and creates a competitive environment for distributed generation.

[36] Green J, Newman P (2017) Citizen utilities: The emerging power paradigm. Energy Policy 105:283–293

Mengelkamp[37] also states that on a blockchain-based market, transactions can be settled without the mediation of a utility company or a financial institution.

Local electricity markets are defined as the exchange between prosumers and consumers to balance locally and to trade energy surplus (e.g. excess wind or solar), manage load peaks, optimize the use of RES, and maximize the use of flexibility asset.[38] In such a system, citizens gain new and innovative roles than just being consumers. Within the traditional system, citizens were trying to be involved in energy production without sharing mechanisms, therefore investing in for their own benefit. **(Citizen as an Investor)**. Intense participation and collaborative innovation by the new flexible mechanisms provides new roles, such as **Citizen as a Trader, Citizen as a Prosumer** and citizens begin to share with neighbours (P2P) and provide congestion management for the local grid, facilitate Local RES integration, preserve power quality, energy savings because of short distances in distribution and citizen participation.

Meanwhile, citizen as an individual may participate to this new and innovative market, whereas **Citizen as an Organization Member** would have more power and pressure on decision policies and mechanisms. Citizen becomes one of the main stakeholders (apart from city authorities, energy utilities, research institutes, NGOs etc.) and Public-Private-People Partnership model can simultaneously improve everyday activities and life conditions in cities, create economic opportunities, and enable experimentation and implementation of new technologies. The main objective of PEDs/PENs/Positive Energy Cities is to integrate smart city objectives with sustainable urban transformation calls for collaborative innovation.

Besides, citizen knowledge (living knowledge) develops effective citizenship and democracy building through participation. Today, necessities and priorities of smart citizens should be considered in inclusive cities. Citizens uses know-how, saves knowledge and saves time with regards to participative science by their own platforms for planning and designing the cities. As a result of this, new roles are identified as: **Citizen as a Scientist, Citizen as a Participatory Designer** and they demand more information social and economic benefits and technological assets as they participate actively to management and the living of their cities.

[37] Designing microgrid energy markets: https://ideas.repec.org/a/eee/appene/v210y2018icp870-880.html

[38] Backe, S., del Granado, P. C., Kara, G., & Tomasgard, A. (2019, August). Local Flexibility Markets in Smart Cities: Interactions Between Positive Energy Blocks. In Energy Challenges for the Next Decade, 16th IAEE European Conference, August 25-28, 2019. International Association for Energy Economics.

# Conclusions

Conclusion section will be detailed and finalized in the final version of this deliverable in M24 when impacts of the methodology is clearer after early adoption by FWCs to select their areas to be PED.

As mentioned, and extensively described in this deliverable, PEDs are complex structures regarding unclear definitions, framework and boundary issues and lacking of real integration between urban and land-use planning to energy planning in cities. Since the main objective of MAKING-CITY is the development of new integrated strategies to address the urban energy system transformation towards low carbon cities, (with the PED approach as the core of the urban energy transition pathway) this methodology will serve as a basis document for cities for identifying their PED boundaries, selection of technologies, managing a citizen -community led participative governance and co-creation activities for energy transition. Innovative and social business schemes will be indicated and referred in this deliverable later in the final version.

The impact of this methodology is expected to be high and may be replicated in different geographies / demographies / urban economies / socio-cultural structures since it considers parameters through smart and sustainable urbanization.

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Yonas, A. Critical review of sustainable energy schemes of trias energetica

# ANNEX I BARRIERS / ENABLERS OF THE SOLUTIONS by FWCs

| Name of the Solution | City Cont | POLITICAL | ECONOMIC | SOCIAL | TECHNICAL | ENVIRONMENTAL | LEGAL | SPATIAL |
|---|---|---|---|---|---|---|---|---|
| S1a Residential (High Rise) retrofitting | Kadikoy | (-) inadequacy of promotional campaign<br>(-) inadequacy of sustainable and integrated policies<br>(+) Commitments/ agreements | (-) High costs<br>(+) incentives and funds<br>(+) financial savings of customers in mid or long-term (from bills, invoice of heating-cooling) | (+) raising of ecological trends<br>(+) prestige for companies<br>(+) raising of wondering new and smart technologies | (-) difficulties of implementations<br>(-) Time and labor constraint<br>(-) Inadequacy of Turkish Standards on building materials | (+) reduction of CO2 emissions<br>(+) raising of use of eco and recyclable materials | (-) Inadequacy of law and regulations<br>(+) Gaps in law and regulations<br>(-) Lack of incents<br>(-) Lack of inspections | (+) Set an example for neighborhood<br>(-) Rebuilding is more popular |
| | Vidin | (+) Existing and updated Residential buildings strategy at national level<br>(+) Existing financial mechanism for renovation: National program for renovation of Bulgarian homes<br>(+) Increasing responsibility from the institutions related to the building renovation<br>(+) Decentralized management - local responsibilities from the municipalities<br>(-) Slowly and hard administrative procedures<br>(-) Lack of trust in the authorities | (+) Existing financial mechanism for 100% funding of the residential buildings renovation<br>(+) Financial savings realized by energy costs reduction - reduction of household heating costs<br>(+) profits both in the construction sector and in building materials<br>(-) Relatively high price of the EE services | (+) Improved living environment<br>(+) Energy poverty decreasing<br>(+)Improving healthy living conditions - thermal and hygienic comfort in buildings is greatly increased<br>(+) More aesthetic appearance of the renovated residential buildings is achieved<br>(+) Increased market value of the property<br>(-) Lack of trust in the energy service providers<br>(-) Lack of interest in issuing energy and technical audits | (+) Energy costs reduction<br>(+) Better thermal conditions<br>(+) Extending the life of buildings<br>(-) Some restrictions for renovation of buildings culture heritage<br>(-) Low skilled staff, short deadlines and low procurement prices lead to poor performance<br>(-) Lack of regulatory penalties and fines for poor quality of the renovation processes, before and after their implementation | (+) Improving environmental quality through reduced greenhouse gas emissions, and mitigating the effects of climate change | (+) Restrictions in the Ownership Act (CA) and in the Regulations for the Management, Order and Supervision of Households cooperation regarding the Insulation and windows replacement by individuals | (+) More aesthetic appearance of the renovated residential buildings compared to the rest, resulting in a change in the appearance of entire neighborhoods |
| | Bassano Del Grappa | (+) the Municipality has the RES Regolamento Edilizo Sustainable (Sustainable building Roles)<br>(+) the residential retrofitting is depending from the national policies and strategies | (+) since many years in Italy there is the possibility to have fiscal earning in 10 years of the 65% of the final bill<br>(+)opportunities for ESCO solution especially for big building or financial models designed specifically for retrofitting and energy efficiency improvement projects | | (+) Most of companies are able to install the retrofitting solution. The technology is well known.<br>(-) a lot of building are historical or the Heritage list: So, the retrofitting solutions are more complicate and/or expensive | (+) there are many advantages for having less consumption of fossil fuel | (+) Recent modification of Regional building law allow to increase the volume of 10% in order to reduction the global consumption of energy<br>(-) Projects that affect common parts of residential buildings needs high percentage of agreement | (+) in many small properties is possible to retrofit the building<br>(-) in heritage building is not possible to modify the existing situation and the spatial characteristics<br>(-) in the historical area the building attached and is difficult to retrofit |

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| | Leon | (+) Residential retrofitting is part of State and Regional policies and strategies | (+) ESCO solution or financial models designed specifically for retrofitting and energy efficiency improvement projects<br>(-) Difficult economical context. Low incomes or lack of economical sources to afford the costs of retrofitting<br>(-) E-S-T many owners change their windows through individual retrofitting thus it is sometimes difficult to implement more efficient global projects | (+) Property managers (real state managers) are useful stakeholders.<br>(+) Existing examples can be used to increase social interest and awareness<br>(-) Aged citizens, more reluctant to changes<br>(-) Difficulties to reach agreements between community of owners<br>(+) Fast and easy to feel comfort improvements after retrofitting | (+) SATE systems are quite known<br>(-) Façade or roof structures sometimes are incompatible with retrofitting<br>(-) In protected areas/buildings retrofitting solutions are more complicate and/or expensive<br>(+) free technical tools (e.g. SG-Save)<br>(-) scarce use of energy modelling or advanced tools | (-) Econ-Envir_Retrofitting of some roofs includes the management of asbestos materials (complicate and expensive protocols) | (+) Recent modification of building bylaw to allow volume increase<br>(-) Projects that affect common parts of residential buildings needs high percentage of agreement<br>(-)(+) IEE, ITE and CE*<br>The IEE is only compulsory for some kind of interventions (usually public funding ones)<br>The ITE is mandatory for buildings older than 40 years<br>CE is mandatory for public buildings, for new buildings, and in commercial transactions<br>* IEE: (Informe de Evaluación de los Edificios_Evaluation Report of Buildings), ITE: (Informe Técnico de Edificación Technical Report of Building), CE: (Certificación Energética (Enegy Certification or Label) | (-) Floor retrofitting is not always viable due to spatial characteristics<br>(-) Party walls or elements adjacent to different properties are difficult to profit |
| S1b Residential (Private House) retrofitting | Kadikoy | (-) inadequacy of promotional campaign<br>(-) inadequacy of sustainable and integrated policies.<br>(+) Commitments/ agreements | (-) High housing costs<br>(+) incentives and grants<br>(+) financial savings of customers in long-term (from bills, invoice of heating-cooling) | (+) raising of ecological trends<br>(-) difficulties of changing of daily routine<br>(+) raising of wondering to new and smart technologies | (-) difficulties of implementations<br>(-) time and labor constraint<br>(-) difficulties of changing of routine implementations | (+) reduction of CO2 emissions<br>(+) raising of use of eco and recyclable materials | (-) difficulties in individual act<br>(-) Lack of incentives<br>(-) Lack of inspections | (-) Rebuilding is more popular |
| S1b Residential (Private House) retrofitting | Vidin | (+) Existing and updated Residential buildings strategy at national level<br>(+) Existing financial mechanism for renovation: National program for renovation of Bulgarian homes<br>(+) Increasing responsibility from the institutions related to the building renovation<br>(+) Decentralized management - local responsibilities from the municipalities<br>(-) Slowly and hard administrative procedures<br>(-) Lack of trust in the authorities | (+) Existing financial mechanism for 100% funding of the residential buildings renovation<br>(+) Financial savings realized by energy costs reduction - reduction of household heating costs<br>(+) profits both in the construction sector and in building materials manufacturers, engineers, architectural and design companies<br>(-) Relatively high price of the EE services<br>(-) Lack of trust in the energy service providers | (+) Improved living environment<br>(+) Energy poverty decreasing<br>(+)Improving healthy living conditions - thermal and hygienic comfort in buildings is greatly increased<br>(+) More aesthetic appearance of the renovated residential buildings is achieved<br>(+) Increased market value of the property<br>(-) Lack of trust in the energy service providers<br>(-) Lack of interest in issuing energy and technical audits | (+) Energy costs reduction<br>(+) Better thermal conditions<br>(+) Extending the life of buildings<br>(-) Some restrictions for renovation ob buildings culture heritage<br>(-) Low skilled staff, short deadlines and low procurement prices lead to poor performance<br>(-) Lack of regulatory penalties and fines for poor quality of the renovation processes, before and after their implementation | (+) Improving environmental quality through reduced greenhouse gas emissions, and mitigating the effects of climate change | (+) Restrictions in the Ownership Act (CA) and in the Regulations for the Management, Order and Supervision of Households cooperation regarding the Insulation and windows replacement by individuals | (+) More aesthetic appearance of the renovated residential buildings compared to the rest, resulting in a change in the appearance of entire neighborhoods |
| S1b Residential (Private House) retrofitting | Leon | Most of the (+) and (-) are same ones of High-Rise Residential Buildings. The difference may be the degree of the (-) and (+). Share of cost of retrofitting are usually higher in private houses than in high rise residential buildings. On the other hand, improvements in comfort and energy bills are usually better in this kind of retrofitting. | | | | | | |
| S2a New High-Performance | Kadikoy | (-) Inadequacy of sustainable and integrated policies. | (-) High investment costs<br>(+) financial savings of customers in long-term (from bills, invoice of heating-cooling)<br>(-) High housing costs<br>(+) incentives and grants | (+) prestige for companies<br>(+) raising of ecological trends<br>(+) promoting eco and healthy life | (-) difficulties of implementations<br>(-) time and labor constraint | (+) negative effects of climate change on life | (-) Inadequacy of law and regulations<br>(+) Gaps in law and regulations<br>(-) Lack of incentives<br>(-) Lack of inspections | (+) Set an Example for neighborhood<br>(-) Limited areas |

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| | Vidin | (+) Existing National NZEB action plan which states that until 21.12.2020 all new buildings have to be NZEB<br>(+) Existing National EE action plan<br>(+) Comprehensive and well-structured EPC scheme<br>(+) Strict regulations regarding the implementation of the EPCs<br>(-)Lack of targeted actions for implementation of the NZEB action plan<br>(-)lack of trained experts | (-) EU structural funds are a major source of funding for energy efficiency measures in public and municipal buildings, as well as in the housing sector | (+) Buildings that have a certificate of energy performance rated A or B may be exempted from Building tax<br>(-) Lack of expertise regarding the NZEB directive among the construction sector<br>(-) Lack of creatively integrated approach by teams of architects, engineers, builders, consultants to match contemporary energy efficient forms of buildings with modern building materials, products and technologies | (+) Energy costs reduction<br>(+) Better thermal conditions<br>(-) lack of expertise for EE in architects to design High performance buildings<br>(-) Lack of interest in investors to implement ambitious EE solutions in residential buildings | (+) Improving environmental quality through reduced greenhouse gas emissions, and mitigating the effects of climate change<br>(-) | (+) Existing National NZEB action plan which states that until 21.12.2020 all new buildings have to be NZEB | |
| | Bassano Del Grappa | (+) the Municipality has the RES Regolamento Edilizio Sustainable (Sustainable building Roles) that give economic advantages to the owners (+) the residential retrofitting is depending from the national policies and strategies | (+) High performance building have much more value in market | (+) for young owners the high Energy Class or energy is a priority | (-) New solutions for energy efficiency enter slowly into the market | (+) there are many advantages for having less consumption of fossil fuel | (+) the national law number 10 give the imposition to calculate the energy consumption and certificate new buildings and also the ancient one. | (+) in many small properties is possible to retrofit the building<br>(-) in heritage building is not possible to modify the existing situation and the spatial characteristics<br>(-) in the historical area the building attached and is difficult to retrofit |
| | Leon | (+) Part of national and regional policies and strategies | (-) High performance building are more expensive but | (-) Low demand. Energy Class or energy behaviour of housings is not a priority for new owners. | (-) New solutions for energy efficiency enter slowly into the market | (-) Climate conditions (cold winter + hot summer and high daily temperature swing) | (+) Legal imposition to certificate new buildings in two phases<br>(-) CTE (Technical Building Code), reviewed every 5 years and updated to European directives. It regulates energy savings requirements. Strict compliance to the CTE means an Energy Class lower than B. | (-) High performance buildings need thicker envelopes |
| S3a Retrofitting of tertiary buildings | Kadikoy | (-) Inadequacy of sustainable and integrated policies. | (-) technology transfer and implementation costs<br>(-) high investment costs<br>(+) incentives and grants | (+) prestige for companies<br>(+) raising of ecological trends<br>(+) raising of wondering to new and smart technologies | (-) difficulties in applying standards | (+) negative effects of climate change in life | (-) Inadequacy of law and regulations<br>(+) Gaps in law and regulations<br>(-) Lack of incentives<br>(-) Lack of inspections | (-) Rebuilding is more popular |
| | Vidin | (+) Existing National NZEB action plan which states that until 31.12.2018 all public buildings have to be NZEB<br>(+) Existing National EE action plan<br>(+) Comprehensive and well-structured EPC scheme<br>(+) Strict regulations regarding the implementation of the EPCs<br>(-)Lack of targeted actions for implementation of the NZEB action plan<br>(-)lack of trained experts | (-) EU structural funds are the major source of funding for energy efficiency measures in public and municipal buildings, as well as in the housing sector<br>(-) Lack of interest in ESCO approach | (+) Improved environment<br>(+) Improving healthy working conditions<br>(+) More aesthetic appearance of the renovated public buildings is achieved<br>(-) Lack of trust in the energy service providers<br>(-) Lack of expertise regarding the NZEB directive among the construction sector<br>(-) Lack of creatively integrated approach | (+) Energy costs reduction<br>(+) Better thermal conditions<br>(-) Some restrictions for renovation of buildings culture heritage<br>(-) Low skilled staff, short deadlines and low procurement prices lead to poor performance<br>(-) Lack of regulatory penalties and fines for poor quality of the renovation processes, before and after their implementation | (+) Improving environmental quality through reduced greenhouse gas emissions, and mitigating the effects of climate change | (+) Existing National NZEB action plan which states that until 31.12.2018 all public buildings have to be NZEB | |
| | Bassano | | (+) High performance building have much more value in market | | (-) New solutions for energy efficiency enter slowly into the market | (+) there are many advantages for having less consumption of fossil fuel | there is new N-ZEB building | |

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| | Leon | | (-) Incompatibility of retrofitting works with normal activity | | | | | |
| S4a New High-Performance Building (Shopping Mall)<br><br>S4b (Academy Building)<br><br>S4c (Sport Complex) | | (+) Part of national and regional policies and strategies<br>(-) Inadequacy of sustainable and integrated policies.<br>(+) Part of national and regional policies and strategies | (-) technology transfer and implementation costs<br>(-) high investment costs<br>(+) incentives and grants<br>(-) lack of financial resources | (+) prestige for companies<br>(+) raising of ecological trends<br>(+) raising of wondering to new and smart technologies | (-) inadequacy of knowledge of new implements and technologies<br>(-) time constraint<br>(-) difficulties of transferring technology<br>(-) New solutions for energy efficiency enter slowly into the market | (+) reduction of CO2 emissions<br>(+) raising of use of eco and recyclable materials<br>(-) Climate conditions (cold winter + hot summer and high daily temperature swing)<br>(-) New solutions for energy efficiency enter slowly into the market | (-) Inadequacy of law and regulations<br>(+) Gaps in law and regulations<br>(-) Lack of incentives<br>(-) Lack of inspections<br>(+) Current CTE regulates that new buildings (except residential ones) must be Class B or A. A review will be soon approved and it will be even more strict introducing NZEB concept. | (-) Limited areas<br>(-) politic risks |
| S5a Smart Control / Advanced Metering / Wireless Advanced Control in Buildings | | (-) Inadequacy of sustainable and integrated policies.<br>(+) Promotion of ISO 50001 for Energy management | (-) technology transfer and implementation costs<br>(-) high investment costs<br>(+) incentives and grants<br>(-) lack of financial resources<br>(+) financial savings of customers in long-term<br>(-) Still relatively high price of BEMS devices<br>(+) Fast return of investment for installation of smart metering system at city level due to the high level of energy savings<br>(+) Better decision making in an open energy market with variable prices | (-) Loss of manual control over the system can be seen as something undesirable<br>(-) Aged people has difficulties to understand new technologies<br>(+) raising of wondering to new and smart technologies<br>(+) promoting healthy life<br>(-) Loss of manual control over the system<br>(+) Energy monitoring encourages behavior change<br>(+) Misuse of unscrupulous neighbors<br>(+) Increase of the customer's awareness about energy efficiency and smart metering system<br>(+) Setting and achievement of individual targets for energy efficiency savings<br>(+) Attracting of clients towards the smart metering and related services<br>(+) Evaluation of expenses/ benefits for clients from the use of smart metering system at customer level. | (-) Need of expert management<br>(-) Security<br>(-) difficulties of implementations<br>(-) time and labor constraint<br>(-) difficulties of changing of routine implementations<br>(+) Energy savings increased<br>(+) Easier operation and maintenance of energy systems in buildings<br>(+) lack of transparency in the calculation and approval of regulated electricity prices will be eliminated<br>(+) Possibility for energy production and consumption forecasts<br>(-)The only technical possibility for accounting for the heat consumed in the homes and its distribution is by installing individual distributors of each heating unit.<br>(-) Inefficient and old heating systems - barrier for energy management implementation<br>(-) Lack of experts for implementing BEMS in buildings | (+) Set an example for public<br>(+) reduction of CO2 emissions<br>(+) Improving environmental quality through reduced greenhouse gas emissions, and mitigating the effects of climate change | (-) depends on individual initiatives<br>(-) Inadequacy of law and regulations<br>(+) Gaps in law and regulations<br>(-) Lack of incentives<br>(-) Lack of inspections | |
| S5b Visulation Units to study human behaviour regarding the energy consumption | | (-) Inadequacy of sustainable and integrated policies. | (-) high investment costs<br>(+) incentives and grants<br>(-) lack of financial resources<br>(+) financial savings of customers in mid or long-term | (+) raising of ecological trends<br>(+) raising of wondering to new and smart technologies<br>(+) promoting eco and healthy life | (-) difficulties of implementations<br>(-) time and labor constraint<br>(-) difficulties of changing of routine implementations<br>(-) incompatibility of infrastructure | (+) negative effects of climate change in life<br>(+) increased awareness and people's desire to learn consumption data | (-) depends on individual preference | |

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| S5c Demand Response Smart Grid | (-) PED concept is quite unknown<br>(-) Difficulties involving institutional and different levels of administration and/or stakeholders to co-design, co-build and co-manage the Smart Grid<br>(-) PED concept is quite unknown<br>(-) Difficulties involving institutional and different levels of administration and/or stakeholders to co-design, co-build and co-manage the Smart Grid<br>(+) city-level decision support to authorities and energy service providers | (-) is not clear what is the real advantage of smart grid. | (+) young people are more sensible about this matter<br>(-) There is a general social preference towards individual energy systems<br>(+) decision making in an open energy market with variable prices<br>(+) Social engagement<br>(+) Engagement consumers and prosumers by capturing near real-time data related to their energy consumption<br>(+) city-level decision support to authorities and energy service providers | (-) There is no site experience implementing and managing energy districts<br>(+) optimal integration of all resources such as connections between elec., gas and water<br>(+) Planning of new energy producers for the future needs of the city<br>(+) Flexibility of the production to the change of demand<br>(+) Reduce of energy costs through participation in Demand Response pro-grams<br>(+) Reduce of peak demand | (+) Improving environmental quality through reduced greenhouse gas emissions, and mitigating the effects of climate change | (-) There are some legal gaps in district energy infrastructures and some barriers.<br>(-) existing limited energy laws and regulations (for storage-transfer etc.)<br>(-) Inadequacy of law and regulations<br>(+) Gaps in law and regulations<br>(-) Lack of incentives, inspection<br>(-) There are some legal gaps in district energy infrastructures and some barriers. However, a new regulation of electricity sector was recently approved, some administrative proceedings are long and complicate. | (-) Some areas of the city are quite dense, with little spare space<br>(-) Some areas of the city are quite dense, with little spare space |
| S5d Heat Matcher | (-) Inadequacy of sustainable and integrated policies.<br>(-) lack of communication and collaboration among the public-public or public-private sector institutions | (-) high investment costs<br>(+) incentives and grants<br>(-) lack of financial resources<br>(-) technology transfer and implementation costs | | (-) unexperienced in thermal grids (-) difficulties of implementations<br>(-) time and labor constraint<br>(-) incompatibility of infrastructure | (+) reduction of CO2 emissions<br>(+) raising of use of eco and recyclable materials<br>(+) Set an example for public | | |
| S6a Smart Lighting, power LED | (-) Inadequacy of sustainable and integrated policies. | (-) high investment costs<br>(+) incentives and grants<br>(-) lack of financial resources<br>(-) technology transfer and implementation costs<br>(-) maintenance and repair expenses | (+) raising of wondering to new and smart technologies | (-) difficulties of implementations<br>(-) time and labor constraint<br>(-) difficulties of changing of routine implementations | (+) Mostly available<br>(+) reduction of CO2 emissions<br>(+) raising of use of eco and recyclable materials<br>(+) Set An example for public | (+) Legal obligation in new buildings | |
| S6b LoRa (Long Range) wireless network and activity sensors | (-) Inadequacy of sustainable and integrated policies.<br>(-) Poor awareness about Lora Network among policy makers | (-) high investment costs<br>(+) incentives and grants<br>(-) lack of financial resources<br>(-) technology transfer and implementation costs<br>(-) maintenance and repair expenses<br>(-) Few or none possibilities to introduce additional improvements in lighting system<br>(+) The cost of small LoRa cellular base stations (gateways) is very low<br>(+) LoRa stations are very cost effective<br>(+) Low costs for info transfer | (+) raising of wondering to new and smart technologies<br>(+) numerous city and business process management solutions<br>(+) it will contribute to the automation, simplification and improvement of living quality<br>(+) it will make life in urban areas smarter, safer and more sustainable<br>(+) public security solutions | (-) difficulties of integration current systems<br>(+) easy to implement technology<br>(+) In addition to its large range, it also has extremely low power consumption<br>(+) possibility of integrate smart monitoring solutions for energy, environment, air quality, traffic, process optimization, etc.<br>(-) network management algorithms and implementation process are complex and require a lot of radio expertise | (+) reduction of CO2 emissions<br>(+) raising of use of eco and recyclable materials<br>(+) Set an example for public<br>(+) Improving environmental quality through reduced greenhouse gas emissions, and mitigating the effects of climate change | (+) No legal restrictions | |
| S6c Energy data monitoring of PED | (+) help you make more accurate decision | (+) help you make more accurate decision<br>(-) Cost to maintain monitoring and management of the system in a long time period | (-) Private residents could reject to allow systems that monitor their equipment | (+) help you make more accurate decision<br>(-) Smart City Platform is a project of the city, but it is still in design phase | (+) help you make more accurate decision | | |
| S6d Integration of new services | | | (-) Mismatch of city characterization | (-) Mismatch of city characterization | (-) Mismatch of city characterization | | |

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| to the data platform | | | | (-) Smart City Platform is a project of the city, but it is still in design phase | | | |
| S6e Installation of IoT infra | (-) Inadequacy of sustainable and integrated policies.<br>(+) good awareness about IoT technologies among policy makers and local authorities<br>(+) already implemented projects | (-) high investment costs<br>(+) incentives and grants<br>(-) lack of financial resources<br>(-) technology transfer and implementation costs<br>(+) relatively low costs for implementing IoT technologies | (+) possibility for air quality control, waste management, smart lighting and smart parking | (-) failure to share data of institutions or individuals<br>(-) difficulties of collect and follow the data<br>(+) made easier data collecting data and following the process<br>(+) Low energy consumption<br>(+) possibility to optimize the processes | (+) Improving environmental quality through reduced greenhouse gas emissions, and mitigating the effects of climate change | (+) No legal restrictions | |
| S7a Open Urban Platform adaptation | (+) The Municipality is collecting all the data about energy of the public buildings<br>(-) There is no platform to manage, monitor and show the set of municipal buildings energy data.<br>(+) Better estimate future local needs through access to local data<br>(+) Empowering consumers and providing accurate and frequent billing<br>(+) Possible win-win data exchange collaboration scenario between energy data providers and public authorities | (-) High cost to stablish, manage and control data management and protection of privacy<br>(+) Insufficient resources in terms of time, costs or tools to undertake energy planning and systematically monitor and implement actions. | (+) transparent services at any occasion will increase public trust and confidence in local authorities<br>(+) new jobs created, impact on fuel poverty<br>(+) allowing evaluation city plans implementation<br>(+) availability of local and accurate energy data<br>(+) driving forces for engaging energy data providers | (-) Smart City Platform is a project of the city, but it is still in design phase.<br>(-) Low experience in open data management. Inexistence open data platform<br>(-) failure to share data of institutions or individuals<br>(+) Processing (aggregating or disaggregating) and modelling of raw data provided by data providers at national, regional and local levels<br>(+) Possibility to correlate data and estimate local energy consumptions and GHG emissions<br>(+) Energy planning facilitator improves access to energy data for energy planning purposes. | (+) Joint participation of local authorities and experts and joint efforts against climate change | (-) until 2 years ago there was a monopoly of energy of ENEL. Now the market has been liberalized and data collection is much more difficult.<br>(-) Complicate privacy procedures in data management<br>(-) restriction for the sharing of individual private data with third parties<br>(-) no obligations for TSO and DSO to provide local energy data to public authorities at sub-national level<br>(+) Sustainable energy legislation needs to have provisions that facilitate easy access to energy data by all Public Authorities | (+) P-T-S National center for ciber-security (INCIBE) is settled in Leon city; with a wide experience and skills on ciber-security that can act as lever to solve some barriers; In addition, there is considerable number of SMES from IoT and ICT sector. |
| S8a High Speed data transfer network | (+) help you make more accurate decision | (+)Public funds to develop that kind of projects<br>(-) The economical context of the city in general it is not a good one. There is a lack of financial resources (private and/or public)<br>(+) As European, national and regional policies are in favor of energy efficiency it is a good momentum to get public funds to develop that kind of projects | (+) many stakeholder like Confindustria, Confartigianato, private companies and others have agreed to Making City project and well understood the potential | (-) failure to share data of institutions or individuals<br>(-) difficulties of collect and follow the data<br>(+) possibility to use the existing government high speed transfer network implemented to connect the public institutions | (+) help you make more accurate decision | | (+) P-T-S National center for ciber-security (INCIBE) is settled in Leon city; with a wide experience and skills on ciber-security that can act as lever to solve some barriers; In addition, there is considerable number of SMES from IoT and ICT sector. |

| Name of the Solution | POLITICAL | ECONOMIC | SOCIAL | TECHNICAL | ENVIRONMENTAL | LEGAL | SPATIAL |
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| S9a Neighbourhood electro storage facility | (+) regional advertising campaign about this opportunity<br>(-) inadequacy of promotional campaign<br>(-) inadequacy of sustainable and integrated policies<br>(-) The Energy Storage Systems have not been set in any way in any official policy document<br>(-) Energy storage and energy storage systems are a new innovative technology, not yet proven among policy makers, design engineers, construction and engineering companies and also to individual households<br>(-) Energy storage infrastructure remains in a conflict with the FiT<br>(-) lack of a clear and specific regulatory approach to energy storage | (+) Regional fiscal advantages for this kind of technology<br>(-) investment costs<br>(+) incentives and grants<br>(-) lack of financial resources<br>(+) financial savings of customers in mid or long-term<br>(-) Storage is economically not attractive option for households<br>(-) high investment costs required for deployment of PVs coupled with energy storage and also due to the low electricity costs currently marketed<br>(-) Currently there is also lack of appropriate compensation for the beneficial services that a storage system can provide to the grid. | (-) Not in my backyard<br>(+) raising of ecological trends<br>(+) raising of wondering to new and smart technologies<br>(-) difficulties of changing of daily routine<br>(-) Low level of awareness among the community about benefits of electricity storage<br>(-) There are no incentives for stimulating energy storage or increased RES self-production | (-) technical failures for solar power storage installation<br>(-) Permission process for establishment of any rooftop PV installation in a building already connected to the grid can be obtained only as a backup source.<br>(+) The distribution grid system will require more flexibility if higher shares of renewable energy are integrated and energy storage is one of the available flexibility options<br>(+) Energy storage enables the optimization of production and consumption 'behind-the-meter'<br>(+) Energy storage is an alternative to provide more stability, reliability and resilience to transmission and distribution gridsp0 | (+) reduction of CO2 emissions<br>(-) ¿Noise? | (-) legal barriers or legal limits for energy production and storage<br>(-) The current Law on Energy from Renewable Sources doesn't recognize energy storage, respectively energy storage systems<br>(-) no law prohibiting Electric energy storage in buildings with PVs, however there is also no clear signal whether is permitted. | (-) Difficulties to find free space in existing buildings or urban space<br>(-) lack of suitable area for installation |
| S10a Phase transfer Liquid tank | | (-) investment costs<br>(+) incentives and grants<br>(-) lack of financial resources<br>(-) technology transfer and implementation costs<br>(+) financial savings of customers in long-term (from bills, invoice of heating-cooling<br>(-) Not profitable as an investment | (+) increasing demand for individual energy production | (-) difficulties of implementations<br>(-) time and labor constraint<br>(-) incompatibility of infrastructure<br>(-) Not applicable as it requires large volumes for a small amount of energy<br>(-) Requires a change in concentration to increase energy absorption | | | |
| S10b Seasonal storage | (-) Geothermal energy is not a priority in energy policies | | | (-) Lack of detailed information about soil of the urban area and its behavior<br>(-) Some areas of the city are not very efficient for geothermal well<br>(+) Capability of high accumulative potential kW/m3<br>(-) High price of the dwelling process<br>(-) Not very applicable for this case as the efficiency is depending by the soil type and Vidin is near to big river | (+) reduction of CO2 emissions<br>(+) raising of use of eco and recyclable materials<br>(+) Set An example for public | (-) Long and complicate administrative process to get permits, especially open transfer wells | |
| S10c Thermal Storage | | (-) high investment costs<br>(+) incentives and grants<br>(-) lack of financial resources<br>(-) technology transfer and implementation costs | | (+) known technology, with a wide range of solution in currently market<br>(-) difficulties of implementations<br>(-) time and labor constraint<br>(-) incompatibility of infrastructu<br>(+) Low energy transfer costs | (+) reduction of CO2 emissions<br>(+) raising of use of eco and recyclable materials<br>(+) Set An example for public | (-) Inadequacy of law and regulations<br>(+) Gaps in law and regulations<br>(-) Lack of incentives<br>(-) Lack of inspections | (-) Difficulties to find free space in existing buildings |

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| S11a Low Temp regional transfer pipeline | | (-) high investment costs<br>(+) incentives and grants<br>(-) lack of financial resources<br>(-) technology transfer and implementation costs | | (-) difficulties of implementations<br>(-) time and labor constraint<br>(-) incompatibility of infrastructure<br>(+) very applicable for new buildings with new heating installations designed for low temperature mode<br>(-) not applicable to old buildings with high-temperature heating installations<br>(-) heating units should be radiant heating or fan coils (convective heating) | | (-) Inadequacy of law and regulations<br>(+) Gaps in law and regulations<br>(-) Lack of incentives<br>(-) Lack of inspections<br>(-) (+) pipelines are in a legal gap, they are not specifically considered in public services regulations<br>(-) Regulation on heat supply that states the supply and return temperature of the district heating providers | (-) Compatibility with other existing services that use shame soil under road space |
| S11b Adjust geothermal district heating for using low temperature | | (-) high investment costs<br>(+) incentives and grants<br>(-) lack of financial resources<br>(-) technology transfer and implementation costs | (+) raising awareness and demand technological applications<br>(-) reluctancy about a new and unknown system | (-) time and labor constraint<br>(-) incompatibility of infrastructure<br>(+) very applicable for new buildings with new heating installations designed for low temperature mode<br>(-) not applicable to old buildings with high-temperature heating installations installed<br>(-) heating units should be radiant heating or fan coils | (-) Some areas of the district are not very suitable for the geothermal applications. | (-) Inadequacy of law and regulations<br>(+) Gaps in law and regulations<br>(-) Lack of incentives<br>(-) Lack of inspections | (-) Some areas of the district are not very suitable for the geothermal applications. |
| S11c Connection to the low temperature district heat | | (-) high investment costs<br>(+) incentives and grants<br>(-) lack of financial resources<br>(-) technology transfer and implementation costs | | (-) difficulties of implementations<br>(-) time and labor constraint<br>(-) incompatibility of infrastructure<br>(-) existing thermal emitters of houses (mainly radiators) are high temperature ones | | (-) Inadequacy of law and regulations<br>(+) Gaps in law and regulations<br>(-) Lack of incentives<br>(-) Lack of inspections | |
| S12a Building energy connectivity for energy sharing | | (-) high investment costs<br>(+) incentives and grants<br>(-) lack of financial resources<br>(-) technology transfer and implementation costs<br>(-) maintenance and repair expenses | | (-) difficulties at integration of current systems<br>(-) difficulties of implementations<br>(-) time and labor constraint<br>(-) incompatibility of infrastructure<br>(+) new buildings with new heating installations designed for low temperature mode<br>(-) not applicable to old buildings with high-temperature heating installations installed<br>(-) heating units should be radiant heating or fan coils | (+) reduction of $CO_2$ emissions<br>(+) raising of use of eco and recyclable materials<br>(+) Set An example for public | | (-) Difficulties to find free space in existing buildings |
| S13a $CO_2$ based heat pump | | (-) high investment costs<br>(+) incentives and grants<br>(-) technology transfer and implementation costs<br>(-) maintenance expenses | | (-) lack of experience and information | | | |

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| S13b Advanced Heat Pump (high COP) | (-) Inadequacy of sustainable and integrated policies.<br>(-) lack of communication and collaboration among the public-public or public-private sector institutions | (-) high investment costs<br>(+) incentives and grants<br>(-) lack of financial resources<br>(-) technology transfer and implementation costs<br>(-) maintenance and repair expenses | (+) raising of ecological, innovative and economic trends<br>(+) aerothermal pumps are helping to introduce heat pump technology into housing energy systems, us there are currently a viable and quite common market solution | (-) difficulties at integration of current systems<br>(-) difficulties of implementations<br>(-) time and labor constraint<br>(-) incompatibility of infrastructure<br>(-) lack of information and experiences | (+) reduction of $CO_2$ emissions<br>(+) raising of use of eco and recyclable materials<br>(-) Heat pumps generally has a remarkable reduction of their COP under very low temperature, and climate in Leon has many frosty days, that coincides with energy demand peak | (-) En-L Acoustic emissions | |
| S13c Acoustic Air Heat Pump | (-) Inadequacy of sustainable and integrated policies.<br>(-) lack of communication and collaboration among the public-public or public-private sector institutions | (-) investment costs<br>(+) incentives and grants<br>(-) lack of financial resources<br>(-) technology transfer and implementation costs<br>(-) maintenance and repair expenses | (+) complaints about on noise pollutions | (-) difficulties at integration of current systems<br>(-) difficulties of implementations<br>(-) time and labor constraint<br>(-) incompatibility of infrastructure | | (-) lack of noise audit<br>(-) lack of legal obligation | |
| S13d Acoustic Hybrid heat pump | | (-) high investment costs<br>(+) incentives and grants<br>(-) lack of financial resources<br>(-) technology transfer and implementation costs<br>(-) maintenance and repair expenses<br>(+) financial savings of customers in mid or long-term | (+) raising of ecological, innovative and economic trends<br>(+) raising of wondering to new and smart technologies | (-) difficulties at integration of existing systems<br>(-) difficulties of implementations<br>(-) time and labor constraint<br>(-) incompatibility of infrastructure<br>(-) lack of experiences and information | (+) negative effects of climate change in life | | |
| S13e Geothermal Heat Pump | (-) Inadequacy of sustainable and integrated policies.<br>(-) lack of communication and collaboration among the public-public or public-private sector institutions | (-) high investment costs<br>(+) incentives and grants<br>(-) lack of financial resources<br>(-) technology transfer and implementation costs<br>(-) maintenance and repair expenses | (+) raising of ecological, innovative and economic trends<br>(+) raising of wondering to new and smart technologies | (-) difficulties at integration of existing systems<br>(-) difficulties of implementations<br>(-) time and labor constraint<br>(-) incompatibility of infrastructure<br>(-) Lack of detailed information about soil of the urban area and its behavior<br>(-) Some areas of the city are not very efficient for geothermal wells | (+) negative effects of climate change in life<br>(+) increasing awareness | (-) depends on individual initiatives<br>(-) Inadequacy of law and regulations<br>(+) Gaps in law and regulations<br>(-) Lack of incentives<br>(-) Lack of inspections<br>(-) Long and complicate administrative process to get permits, specially open transfer wells | |

| Name of the Solution | POLITICAL | ECONOMIC | SOCIAL | TECHNICAL | ENVIRONMENTAL | LEGAL | SPATIAL |
|---|---|---|---|---|---|---|---|
| S14a Solar PV on roofs and parking lot | (+) the national government is lancing a green new deal that should increase the investment in solar PV | (-) Lack of economic resources (public and private). There is a need of an initial investment that owners could not be able to afford<br>(-) Lack of economic resources (public and private). There is a need of an initial investment that owners could not be able to afford | (+) increasing awareness about environmental issues<br>(-) Complex legal framework<br>(-) Old-aged people with low inco.<br>(-) Vandalism (in parking lot) | (+) in the area of proposed PED there are several flat roofs where to collocate the PV panels<br>(-) In existing buildings, roofs and building structures may be not prepared to support additional loads.<br>(+) high solar potential of the region | (-) In protected areas material of roof must be ceramic curved tiles<br>(-) In protected areas material of roof must be ceramic curved tiles<br>(+) new bylaws (beyond national building laws) facilitating or compelling solar pv in new buildings could be an enabler<br>(-) Complicate legal system for prosumers | (+) new bylaws (beyond national building laws) facilitating or compelling solar pv in new buildings could be an enabler<br>(-) Complicate legal system for prosumers<br>(-) legal barriers or legal limits for energy production and storage | (+) Climate in Bassano is very appropriate for solar, hydro and wind energy<br>(+) Climate in Leon is very appropriate for solar energy<br>(+) Several open-air public parking lots available<br>(-) Few buildings have flat roofs. That are covered with tiles |
| S14b Building Integrated PV (on the façade) | (-) Long legal process<br>(-) The RES Low doesn't recognize energy storage<br>(-) No any net-metering or net net-billing scheme have been established in the country<br>(-) There is general uncertainty, due to the innovative aspect of the scheme, which renewable technologies will be facilitated in order a building to meet the 55 % renewable goal set in the nZEB definition. | (+) financial savings of customers in long-term (from bills, invoice of heating-cooling)<br>(-) High costs<br>(+) incentives and funds<br>(-) residential PV systems can be financially supported only through one scheme - the FiT scheme. However, the scheme is introduced in a way that doesn't stimulate investment.<br>(-) Low electricity prices compared to the high investments currently required for implementation of PVs are making them still unattractive solution<br>(+) Lower electricity costs for households | (+) raising of eco-friendly implementations trends<br>(+) raising of wondering to new and smart technologies<br>(-) The PV technologies still sound in abstract way to the community<br>(-) low level of awareness among end users | (-) Lack of experience in practice<br>(-) Sun blockage of existing building heights<br>(-) In existing buildings, building façades or structures may be not prepared to support additional loads.<br>(-) Permission process for establishment of any rooftop PV installation in a building already connected to the grid can be obtained only as a backup source.<br>(-) Households PV implementation is accompanied with autocratic and time-consuming procedure<br>(+) high solar potential of the region<br>(+) already a lot of technology suppliers at the local market | (+) Set an Example for people | (-) legal barriers or legal limits for energy production and storage<br>(-) There is only one compensation policy for small-scale residential PV installations put on practice in the country, namely the Feed in Tariff (FiT) scheme. It is a policy mechanism designed to accelerate investment in renewable energy, where small-scale residential and non-residential PV installations are distinguished according to their capacity<br>(-) In order a household to implement a residential rooftop PV system it should meet a number of national requirements and also clear a number of procedures before actual pilot implementation takes place | |
| S14c Floating Solar pontoons | | (-) Limited Municipal budget<br>(-) Lining comes expensive from face<br>(-) risk infestation | (+) raising of eco-friendly implementations trends<br>(+) raising of wondering to new and smart technologies | (+) wide sea coastline<br>(+) higher efficiency due to the fact that the modules are cooled by the evaporating water below the<br>(-) many risks due to the potential for destruction in natural disasters<br>(-) Variable river level<br>(-) Difficulty in transporting the energy received<br>(-) risk of freezing of the water surface | | (-) River space is competence of a public regional administration (Confederación Hidrográfica del Duero) and use permits are under its jurisdiction | (-) Few water surface within the city |
| S14d Solaroad | | (+) incentives and funds<br>(-) limited municipal budget<br>(-) High costs<br>(-) new investment and employment field<br>(-) High infestation in risky technologies | (+) raising of eco-friendly implementations trends<br>(+) raising of wondering to new and smart technologies | (-) difficulties at integration of existing infrastructure or road surface<br>(-) time and labor constraint<br>(-) incompatibility of infrastructure<br>(-) Poor performance because there is no optimal angle of | (+) negative effects of climate change in life<br>(+) increasing awareness | | |

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| | | | | inclination, this results in less power and more often shades<br>(-) The panels are also covered with dirt and dust and require much thicker glass than ordinary panels to withstand the traffic burden, further limiting light absorption.<br>(-) air circulation is impeded, panels will inevitably heat up more than photovoltaic panels placed on roofs | | | |
| S15a Hybrid Heat collector | | | | (-) Mismatch of energy management systems | (+) reduction of CO2 emissions<br>(+) raising of use of eco and recyclable materials<br>(+) Set An example for public | | |
| S15b PVT Panels* | | (+) financial savings of customers in long-term<br>(-) High costs<br>(+) incentives and funds<br>(-) maintenance and repair expenses | (+) raising of eco-friendly implementations trends<br>(+) raising of wondering to new and smart technologies | (-) difficulties at integration of existing systems<br>(-) inadequacy of knowledge of new implements and technologies<br>(-) time constraint<br>(-) difficulties of transferring technology | | (-) legal barriers or legal limits for energy production and storage<br>(+) CTE requirements about ACS production in residential buildings | |
| S15c Ridge Boiler | (-) Inadequacy of sustainable and integrated policies.<br>(-) lack of communication and collaboration among the public-public or public-private sector institutions | | | (-) Mismatch of energy management systems | | (-) legal barriers or legal limits for energy production and storage | |
| S16a Near to surface Geothermal energy | (-) Inadequacy of sustainable and integrated policies.<br>(-) lack of communication and collaboration among the public-public or public-private sector institutions | (+) financial savings of customers in long-term (from bills, invoice of heating-cooling)<br>(-) High costs<br>(+) incentives and funds<br>(+) Surface-mounted soil collectors are a cost-effective alternative to a geothermal heat pump. | (+) raising of eco-friendly implementations trends<br>(+) raising of wondering to new and smart technologies | (+) very efficient during operation.<br>(-) horizontal collectors require a large area | (-) environmental pollutions | (-) lack of legal regulations | |
| S16b Deep Geothermal District Heating | (-) Inadequacy of sustainable and integrated policies.<br>(-) lack of communication and collaboration among the public-public or public-private sector institutions | (-) investment costs | | (-) difficult access to geothermal energy in our region (Very Deep) | | | |
| S17a Heat recovery system from AC and sewage water | | (+) financial savings of customers in long-term (from bills, invoice of heating-cooling)<br>(-) High costs<br>(+) incentives and funds | (+) raising of eco-friendly implementations trends<br>(+) raising of wondering to new and smart technologies | (-) sewage water heat recovery system is carried out in an off-site facility | | | |
| S17b Heat recovery system from return | | | | (-) Mismatch of energy management systems | (+) regulation for district suppliers states that it is obligatory (a scheme when DHW load exceeds the heating load energy recovery from return pipeline to DHW is obligatory) | | |

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| **pipeline to DHW** | | | | | | | |
| S17c **High pressure waste water digester** | (-) Inadequacy of sustainable and integrated policies.<br>(-) lack of communication and colalboration among the public-public or public-private sector institutions | | | (-)Mismatch of energy management systems | | (-) lack of authorization for district municipality | |
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| Name of the Solution | POLITICAL | ECONOMIC | SOCIAL | TECHNICAL | ENVIRONMENTAL | LEGAL | SPATIAL |
|---|---|---|---|---|---|---|---|
| S18a Integrated Sustainable Energy Planning | (+) positive view towards energy saving and sustainability of new way of living<br>(-) needs of different political levels can be confronted<br>(-) there is lack of collaboration between different administrations<br>(-) Lack of technical skills and energy data collection in municipalities<br>(-) Poor information at local level on thermal renewable sources, difficulties to get information<br>(-) Lack of coordination structures<br>(+) Local and Regional Energy Observatories established to support Sustainable energy plans | (+) two different hydroelectric power plants are already present in the municipal territory<br>(-) local resources can be more expensive than others<br>(-) there are not many economical resources (nor public neither private)<br>(-) Insufficient resources in terms of time, costs or tools to undertake energy planning and systematically monitor and implement actions. | (+) there is a general positive feeling of Bassano citizens about using local products and resources<br>(-) integrated solutions can be studied for implementing collaboration between stakeholder<br>(+) the use of local resources can be an enabler us there is a general positive feeling of Leon citizens about using local products and resources<br>(-) integrated solutions can face social confrontation between different neighborhoods, urban areas or regions (not in my backyard, not by my property, not my resources, etc.)<br>(-) Commercial sensitivity and data privacy can hinder the collection and use of data. | (-) Mismatch of energy management systems<br>(-) lack of monitoring of energy system at local and urban level<br>(-) Availability of data: Often, there are insufficient data available for energy planning purposes or for improving the energy efficiency of public and domestic sector buildings<br>(-) The challenge of using energy data and statistics is complex; continuously engaging with a range of stakeholders is important for raising awareness and understanding data, but also for identifying stakeholder needs and priorities in order to develop tailored and durable solutions.<br>(+) some undertaken and recognizable projects related to sustainable energy planning | (+)Bassano del Grappa is located at the end of a valley: wind and water flow constantly<br>(-) image and landscape preservation can be confronted with exploitation of some resources (solar or wind infrastructures)<br>(+) rational use of some resources can help to environmental preservation (e.g. use of forest biomass can help to forest maintenance)<br>(+)Regularly inventory of the GHG | (+) heritage law that create problem for using the natural energy<br>(-) next year the energy market will be totally free in Italy<br>(-) Energy regulation is a national competence, but urban planning is regional<br>(-) Lack of obligations for data providers in energy data sharing with public authorities<br>(-) Strict data protection regulations in Bulgaria | (+) the extension of the town is large and give the possibility of different site for collecting energy<br>(-) Leon municipality has a small surface and the city is quite dense |
| Solution 19 Business Model | (+) Possibility to development of innovative business solutions | | | | | | |
| Solution 20 Social Awareness | (+) Implemented project for effective stakeholders' involvement in the process of amending, improving and implementing the municipality's policies<br>(+) Possibility to generate successful, innovative business ideas and community projects<br>(+) Social awareness is considered in all municipality's strategic plans | (+) High social awareness for energy efficiency will decrease the energy costs<br>(+) Social awareness campaigns don't require high budget | (+) there is a program of meeting with the population for creating a positive feeling about MC<br>(-) Energy efficiency is not recognized as a major issue for consumers, as energy costs are often low compared to the cost of many other factors. | | | (-) Practice shows that problems most often arise from the diversity of owners, with different social, financial, age and psychological profile, which leads to a poorly functioning mechanism for managing condominium buildings. | |

# ANNEX II SPEC CARDS of SOLUTIONS

## S01a Wind strategies

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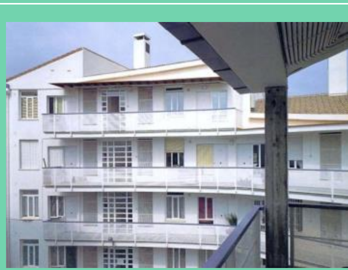
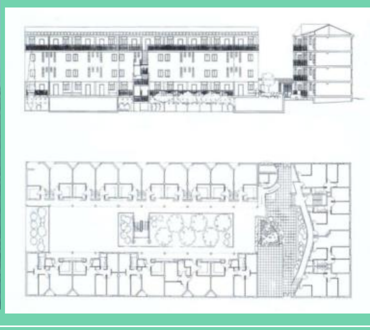
| SPEC CARD | DEMAND SIDE SOLUTIONS | | |
| | Category 1<br>LOW ENERGY DEMAND | | |
| | Solution 0.1<br>Climate change adaptation - District Strategies | | |
| Title | Graphical Detail | | |
| S0.1a Wind strategies |     | | |
| | 49 dwellings complex with natural ventilation and other bioclimatic strategies<br>- Location: San Pedro de Alcántara, Málaga, Andalusia, Spain<br>- Area: 2500 m2<br>- Year of commitment: 1993<br>- Funding Type: Public | | |
| City / Country | Making_City | Technical Partner Name & contact Details | |
| San Pedro de Alcántara (Spain) | No | Margarita de Luxán (ETSAM, Universidad Politécnica de Madrid) Subsequent studies of energy monitoring and analysis of the building in use:<br>CIEMAT (Center for Energy, Environmental and Technological Research) www.ciemat.es | |
| Implementation Time | 3 years | Initial Investment | 1,653,600 € |
| What is Solution? | | How does it work? | |
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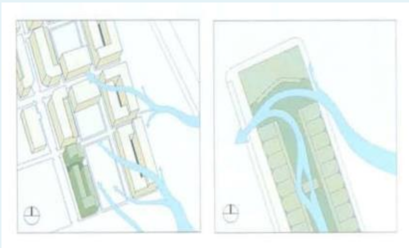
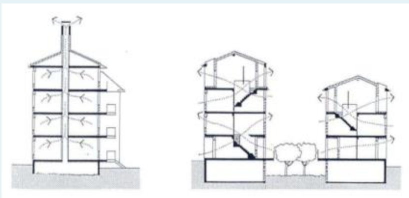
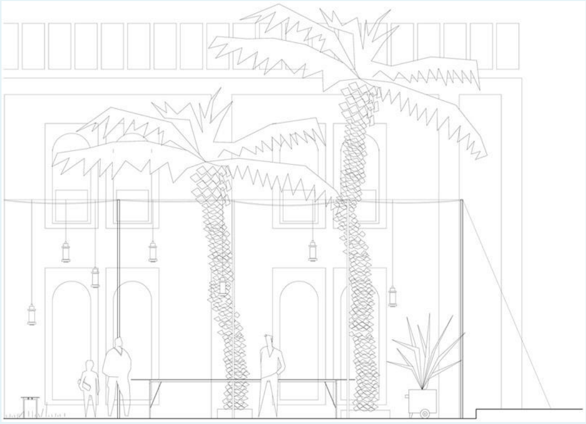
| Wind studies and layout and shape strategies for building volumes and housing distribution, to achieve the best natural ventilation.<br><br> | Climate studies indicated the need for different seasonal uses, and mainly for cooling in summer. The overall volumetry of the set has been designed, therefore, to take advantage of the seasonal wind and breeze regime. The dominant ones in the area are the following:<br>• Terral: it comes from the Northwest, from the interior, of a dry and gusty character, it alternates with the levante in a breeze and wind regime.<br>• Poniente (west): it comes from the Atlantic, with a humid and temperate character.<br>• Levante: comes from the Southeast; Of humid and fresh character it is alternated with the terral in breeze regime, dominating in the daytime hours.<br>• South of the Strait: it comes from Tarifa, produces storms. On the plot, the mountains that cover the north front obstruct the passage of the terral, raising it and preventing the wind and breeze regime from being so clear, and there are buildings that cut the poniente, so the winds that act on the building are the south in summer and the levante throughout the year. It is the action of this last wind, dominant in summer, that has been sought for cooling, adapting the volumetry of the building for its use. All dwellings are developed with at least two opposite orientations on the facades, facilitating cross ventilation due to temperature differences between them. In duplex dwellings, the effect is increased with the ventilation established between the two levels. Specific, new elements have been designed for this project, such as solar cooling chimneys, which suck up the hot air accumulated in the upper part of the rooms and which are statically self-regulated by their shape and orientation, for a suction action in the hottest months. |
| **Stakeholder Analysis** | |
| **Developer** (if relevant) Who has developed this solution? | Regional Government of Andalusia |
| **Operator** Who is operating this solution? | Office of Public Works and Transportation of the Regional Government of Andalusia |
| **Customer(s) or user(s)** Who is this solution targeting? For instance, who is saving energy thanks to the implementation of this solution? | |
| **Implementer** Who is implementing this solution? | |
| **Financer** How / By whom has the implementation of this solution been financed? | |
| **Other impacted stakeholder(s)** (if relevant) Who else is impacted by the deployment of this solution? | Architects: Margarita de Luxán G. de Diego, Flavio de Celis D'Amico, Ernesto Echevarría Valiente |
| **Revenue Streams/ Monetized Value** | |
| | |

| Integration with other smart solutions | BARRIERS / ENABLERS _ PESTEL STUDIES |
|---|---|
| The houses are designed trying to make the best use of the capacities of the environment in the aspects of solar collection, natural cooling, seasonal variations, as well as the specificity in the choice of materials and construction details, and in the creation and plant treatment of outdoor use spaces. | **Political:**<br>**Economic:**<br>**Social:**<br>**Technical:**<br>**Environmental:**<br>**Legal:** |
| **Potential for Replication** | **Expected Impacts - Benefits** |
| The research has been conducted so that it could be carried out with extremely economic and simple means, so that the solutions that it provides can be incorporated into the promotions of publicly promoted housing without higher costs than usual. | The premise to carry out this project has been the consideration that bioclimatic or energy conscious buildings are not so much the result of an application of specific techniques, as of the maintenance of a logic, directed towards the adaptation and use of environmental conditions, maintained during the planning and design process of the architectural form; without losing the rest of the implications: constructive, functional, aesthetic, economic, etc. |
| **Relevant Publications / Presentations / Services / Products to this Solution** | |
| **(1)** Luxán García de Diego, M. de, Celis D'Amico, F., Casa Martín, F. da, Echeverría Valiente, E., Villota Rocha, I. de. (1997). 49 viviendas en San Pedro de Alcántara, Málaga. In Dirección General de Arquitectura y Vivienda (Junta de Andalucía) (Ed.), Arquitectura y clima en Andalucía. Manual de diseño (pp. 213-220). Sevilla: Consejería de Obras Públicas y Transportes de la Junta de Andalucía. (ISBN 84-8095-095-1) | |
| **(2)** Article about the project in the book 'Arquitectura y clima en Andalucía. Manual de diseño' (Spanish) | |
| **(3)** The project was presented at the Third European Conference on Architecture "Solar Energy in Architecture and Urban Planning" (Florence, 1993) and published by the Commission of the European Community | |
| **Reference Applications of this Solution** | |
| **(1) Microclimate** is a major part of urban living and is experienced by people in public spaces. The main elements affected by microclimate on a city level are: the temperature, humidity ,wind and solar radiation | http://www.iaacblog.com/programs/urban-microclimate/ |
| **(2)** WINEUR projects EU: | https://ec.europa.eu/energy/intelligent/projects/en/projects/wineur |
| **(3)** WINEUR projects EU - Wind Turbines Guide: | http://www.urban-wind.org/pdf/SMALL_WIND_TURBINES_GUIDE_final.pdf |
| **(4)** WINEUR projects EU - Report: | https://ec.europa.eu/energy/intelligent/projects/sites/iee-projects/files/projects/documents/wineur_publishable_result_oriented_report.pdf |
| **(5)** Rheologic: Basic Urban Wind Effects - Video: | https://rheologic.net/en/urban-wind-assessment |
| **(6)** Wind based urban design in dense urban context. Prefacing wind nuisance and optimizing the human wind comfort for outdoor relaxation. | https://repository.tudelft.nl/islandora/object/uuid:71f03228-175e-40b0-9fd2-5be4480dcfec/datastream/OBJ1/download |
| **(7)** Air flow: | https://salientedge.com/blog/2018cleaning-up-the-big-smoke |

## S01b Solar orientation strategies

| SPEC CARD | DEMAND SIDE SOLUTIONS<br>Category 1<br>LOW ENERGY DEMAND<br>Solution 0.1<br>District level strategies according to local environmental conditions | |
|---|---|---|
| Title | Graphical Detail | |
| S0.1b<br>Solar orientation strategies | <br>The Bab al Bahrain pavilion is a temporary public space that had been transformed into a comfortable area with several activities for the public, by using only the perks of the site, a minimal light structure and a low-tech element to protect from the sun. | |
| City / Country | Making_City | Technical Partner Name & contact Details |
| Bab Al-Bahrain, Manama (Bahrain) | No | Noura Al Sayeh & Leopold Banchini |
| Implementation Time | 2012 | N/A |
| What is Solution? | | How does it work? |



The Bab al Bahrain pavilion is a temporary public space. It had an extraordinary success during its permanence and it was constantly used and visited, it held events and even workshops. Its success can be attributed to a good mix of factors, the first one surely being the special value of the place and the second one the its good bioclimatic design based mainly on shadowing.

The first good virtue of this project is the creation of the public space itself, closing the crossing to the traffic and giving back this historical place to the citizens, although it was only for a limited time this demonstrated the power of this kind of intervention and the need for quality public space that this city has. The second important virtue was the design of a comfortable public space using only the perks of the site, a minimal light structure and a low tech element to protect from the sun.

Based on a regular grid of thin steel columns the project is basically made by its “canopy”, a light sun-reflecting fabric (generally used in greenhouses) that reflects most of the energy of the sun giving to the place a nice diffused illumination. To make this design really effective the architects took advantage of a large fountain already existing in the site, the fountain with its fresh water favours evapotranspiration and contributes to lower the temperature of the air, favouring a light breeze that crosses the pavilion.

Lowering the square's temperature with this intervention favours the reduction of energy demand (air conditioning...) of the surrounding buildings.

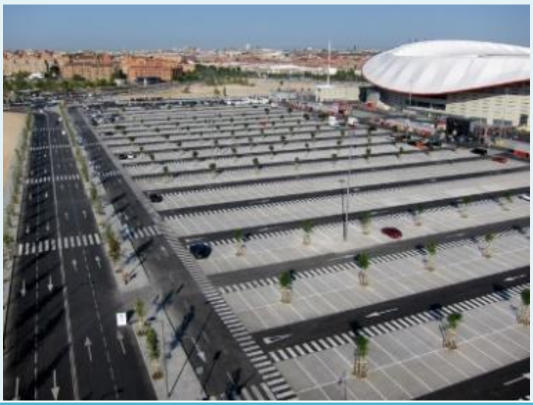
Material Used:
1. Reflective shade mesh for the cover
2. Metallic painted pillars
3. Glass and steel showcases

| Stakeholder Analysis | |
|---|---|
| Developer (if relevant) Who has developed this solution? | Ministry of Culture, Kingdom of Bahrain |
| Operator Who is operating this solution? | Office of Public Works and Transportation of the Regional Government of Andalusia |
| Customer(s) or user(s) Who is this solution targeting? For instance, who is saving energy thanks to the implementation of this solution? | |
| Implementer Who is implementing this solution? | Syed M. Ahmed, Masy Int. Creative wrought iron factory. Bu Hussain aluminium and mirrors. |
| Financer How / By whom has the implementation of this solution been financed? | Manama Capital of Arab Culture 2012, Ministry of Culture, Kingdom of Bahrain |

| | |
|---|---|
| **Other impacted stakeholder(s) (if relevant)** Who else is impacted by the deployment of this solution? | Architects: Noura Al Sayeh & Leopold Banchini |
| **Revenue Streams/ Monetized Value** | |
| | |
| **Integration with other smart solutions** | **BARRIERS / ENABLERS _ PESTEL STUDIES** |
| Shadowing elements combined with vegetation and water bodies (fountains, lakes,...) favor evapotranspiration and contribute to lower the temperature of the air. This favors the reduction of energy demand (air conditioning,...) of the sourrounding buildings. | **Political:**<br>**Economic:**<br>**Social:**<br>**Technical:**<br>**Environmental:**<br>**Legal:** |
| **Potential for Replication** | **Expected Impacts - Benefits** |
| The choice of a light structure and easy assembly dry materials allows easy repair and maintenance. Likewise, this is an economic solution. | Lowering the square's temperature with this intervention favors the reduction of energy demand (air conditioning...) of the sourrounding buildings.<br><br>The creation of quality public space, closing the crossing to the traffic and giving back this historical place to the citizens. In addition, a thermally comfortable public space contributes to achieve citizens comfort and allows that several activities take place. |
| **Relevant Publications / Presentations / Services / Products to this Solution** | |
| **(1)** Bar Al Bahrain Pavillion - Archdaily | https://www.archdaily.com/222125/bar-al-bahrain-pavillion-noura-al-sayeh-leopold-banchini |
| **(2)** Bar Al Bahrain Pavillion - Metalocus | https://www.metalocus.es/es/noticias/bab-al-bahrain-pavillion-por-noura-al-sayeh-leopold-banchini |
| **(3)** Bar Al Bahrain Pavillion - Designboom | https://www.designboom.com/architecture/noura-al-sayeh-leopold-banchini-bab-al-bahrain-pavilion/ |
| **(4)** Bar Al Bahrain Pavillion - Archello | https://archello.com/project/bab-al-bahrain-pavillion |
| **(5)** Video | https://vimeo.com/manama |
| **Reference Applications of this Solution** | |
| **(1) Microclimate** is a major part of urban living and is experienced by people in public spaces. The main elements affected by microclimate on a city level are: the temperature, humidity ,wind and solar radiation: | http://www.iaacblog.com/programs/urban-microclimate/ |
| **(2)** Tejiendo la calle: | https://submarina.info/tejiendo-la-calle/ |
| **(3)** Palette 2030 Solar Shading: | http://www.2030palette.org/solar-shading/ |

## S01c Water resources strategies

<table>
<tr><td rowspan="3">SPEC CARD</td><td colspan="3">DEMAND SIDE SOLUTIONS</td></tr>
<tr><td colspan="3">Category 1<br>LOW ENERGY DEMAND</td></tr>
<tr><td colspan="3">Solution 0.1<br>District level strategies according to local environmental conditions</td></tr>
<tr><td>Title</td><td colspan="3">Graphical Detail</td></tr>
<tr><td>S0.1b<br>Water resources strategies</td><td colspan="3"><br>Permeable concrete parking in the Atlético de Madrid Stadium</td></tr>
<tr><td>City / Country</td><td>Making_City</td><td colspan="2">Technical Partner Name & contact Details</td></tr>
<tr><td>Madrid (Spain)</td><td>No</td><td colspan="2">Cruz y Ortiz Arquitectos<br>+34 910 052 675 / info@cruzyortiz.com</td></tr>
<tr><td>Implementation Time</td><td>2011 - 2017 (Whole project of the stadium</td><td>Initial Investment</td><td>20 - 35 €/m2</td></tr>
<tr><td colspan="2">What is Solution?</td><td colspan="2">How does it work?</td></tr>
</table>



The permeable pavements are a supporting structure, which allows the passage of both pedestrians and vehicles, as well as the filtering of the runoff towards a lower layer of temporary storage (sub-base), composed of gravels, cells and/or reticular boxes. After storage, water is evacuated by infiltration or through drains. The surface layer may be of continuous pavement, such as porous concrete or asphalt, or modular. The latter type includes porous pavers, permeable joint pavers or reinforced grass.

It is not recommended in places with heavy vehicle traffic (e.g. trucks), places with high sediment loads or areas where there are many trees.

The urbanization project on the Atlético de Madrid Stadium has implemented SUDS techniques using permeable pavements and buried detention tanks. On the parking beaches, the deposit is constituted by the granular sub-base itself on which the permeable concrete of the parking spaces sits. The application of SUDS allowed to reduce, in a global way, approximately the 69% of the peak flows for the design storm (return period 10 years and peak intensity of 60.2 mm / h) compared to a conventional scheme (waterproof pavement + drain to collector).

| Stakeholder Analysis | |
|---|---|
| **Developer** (if relevant) Who has developed this solution? | Ministry of Culture, Kingdom of Bahrain |
| **Operator** Who is operating this solution? | FCC |
| **Customer(s) or user(s)** Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution? | Atlético de Madrid Club |

| | |
|---|---|
| **Implementer** Who is implementing this solution? | Cruz y Ortiz Arquitectos |
| **Financer** How / By whom has the implementation of this solution been financed? | Atlético de Madrid Club |
| Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution? | Service Provider: Ecobloc system - GRAF |
| **Revenue Streams/ Monetized Value** | |
| | |
| **Integration with other smart solutions** | **BARRIERS / ENABLERS _ PESTEL STUDIES** |
| | **Political:**<br>**Economic:**<br>**Social:**<br>**Technical:**<br>**Environmental:**<br>**Legal:** |
| **Potential for Replication** | **Expected Impacts - Benefits** |
| | · Reduction of the flow and volume of stormwater runoff.<br>· Improvement of water quality by retaining sediments, oils, fats, heavy metals and some nutrients.<br>· Reduces the area dedicated only to runoff management, as it allows the transit of both pedestrians and vehicles.<br>· Possible aquifer recharge and rainwater use.<br>· Wide variety of designs and flexibility to adapt to different urban environments.<br>· It needs to be integrated into a treatment chain, as it has no inherent capacity to eliminate contaminants. |
| **Relevant Publications / Presentations / Services / Products to this Solution** | |
| (1) Videos | https://www.youtube.com/watch?time_continue=21&v=EPRguq1WC34<br>https://www.motor16.com/videos/alfalto-topmix-permeable-el-suelo-del-futuro/ |
| (2) GRAF - SuDS system | https://www.grafiberica.com/suds-drenaje-sostenible.html |
| **Reference Applications of this Solution** | |
| (1) SuDS: Sustainable drainage systems guide: | https://www.madrid.es/UnidadesDescentralizadas/Agua/TODOSOBREAGUA(Informaci%C3%B3nSobreAgua)/SistemaUrbanosDrenajeSostenible/Gu%C3%ADa%20b%C3%A1sica%20de%20dise%C3%B1o%20sistemas%20de%20gesti%C3%B3n%20sostenible%20de%20aguas%20pluviales.pdf |

| | |
|---|---|
| (2) SuDS: Sustainable drainage systems excel calculation: | https://www.madrid.es/portales/munimadrid/es/Inicio/Medio-ambiente/Agua/SUDS-sistemas-urbanos-de-drenaje-sostenible/?vgnextfmt=default&vgnextoid=05ae02fc13557610VgnVCM2000001f4a900aRCRD&vgnextchannel=63d0e0f6fdc4f510VgnVCM2000001f4a900aRCRD |
| (3) SUD - Atlantis: | https://donosticity.org/la-empresa-suds-del-donostiarra-peio-lasa-entre-los-premios-europeos-de-medio-ambiente/ |
| (4) CONAMA - Water and city SuDS: Sustainable drainage systems: | http://www.conama.org/conama/download/files/conama2018//STs%202018/10_preliminar.pdf |
| (5) Nature-based solutions for local climate adaptation in the Basque Country: | http://growgreenproject.eu/wp-content/uploads/2018/05/NBS-Climate-Adaptation-Basque-Country.pdf |
| (6) Ecopolis - Ecosistema Urbano | https://ecosistemaurbano.com/plaza-ecopolis/ |
| (7) GrowGreen Project - Managing flooding with nature-based solutions in Brest: | |
| (8) Técnicas de Drenaje Urbano Sostenible | |

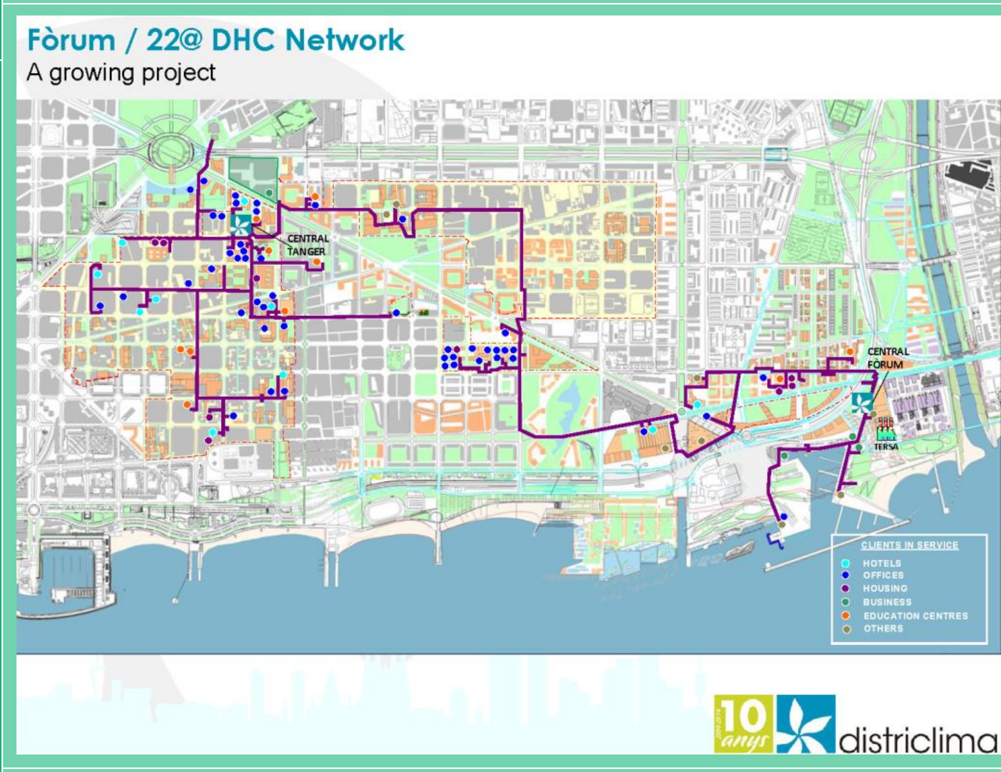
## S01d Ground coupling strategies

SPEC CARD

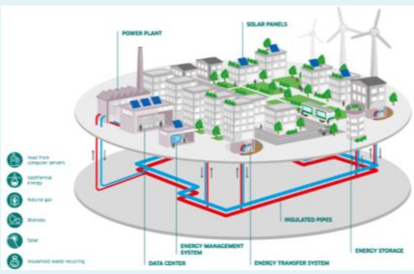
DEMAND SIDE SOLUTIONS

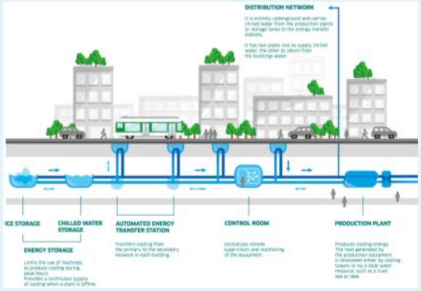
Category 1
LOW ENERGY DEMAND

Solution 0.1
District level strategies according to local environmental conditions

| Title | Graphical Detail |
|---|---|
| S0.1d Ground coupling strategies |   In Spain, ENGIE operates the country's first heating and cooling network: Districlima in Barcelona, which recover the heat generated by household waste processing for re-use as heat for a heating network and to produce chilled water. The network supplies 94 buildings. |

| City / Country | Making_City | Technical Partner Name & contact Details |
|---|---|---|
| San Pedro de Alcántara (Spain) | No | Districlima, S.A.: Engie: 50,8% Tersa: 20% Agbar: 19,2%<br>ICAEN: 5% IDAE: 5%<br>info@districlima.es |

| What is Solution? | How does it work? |
|---|---|
|   | Central Forum:<br>Heat and cold are produced taking advantage of the steam generated in the combustion of urban solid waste of the neighbouring TERSA treatment plant.<br><br>The production equipment is cooled by seawater, obtaining high yields, without the use of cooling towers. |

| | |
|---|---|
|  | Energy management is optimized using an accumulator tank of ice water of 5,000 m3. |
| **Stakeholder Analysis** | |
| Developer (if relevant) Who has developed this solution? | Districlima, S.A. |
| Operator Who is operating this solution? | |
| Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution? | Barcelona City Council |
| Implementer Who is implementing this solution? | |
| Financer How / By whom has the implementation of this solution been financed? | |
| Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution? | |
| **Revenue Streams/ Monetized Value** | |
| | |
| **Integration with other smart solutions** | **BARRIERS / ENABLERS _ PESTEL STUDIES** |
| This solution might be complemented with other energy efficiency solutions. | **Political:**<br>**Economic:**<br>**Social:**<br>**Technical:**<br>**Environmental:**<br>**Legal:** |
| **Potential for Replication** | **Expected Impacts - Benefits** |
| Similar projects focused on heating and cooling:<br>· In Marseille, three ENGIE subsidiaries (ENGIE Cofely Climespace, ENGIE Ineo and ENGIE Axima) have developed a new solution that uses a very local source of renewable energy: the heat of energy content of the Mediterranean Sea. Located at the Grand Port Maritime de Marseille, the Thassalia marine geothermal plant is the first in France and the wider Europe to use marine thermal | The Districlima solution helps to improve the quality of life of the neighborhoods:<br>· The reduction of CO2 emissions and the reduction of fossil fuels. In 2015, Districlima avoided the emissions into the atmosphere of 17,678 ton of CO2, with a reduction in the use of fossil fuels of 59%.<br>· The lack of machinery for air conditioning in buildings connected to Districlima translates, among others, in the absence of noise and vibration in the buildings and thus improving the acoustic quality of the city.<br>· Improvement in the air temperature of the neighborhood, by drastically reducing the equipment that refreshes the interior of the buildings, at the cost of emitting heat to the outside.<br>· Reduction of the global consumption of water and chemical products: elimination of cooling towers and other equipment that |

| | |
|---|---|
| energy to provide heating and cooling for all the buildings connected to its network - a combined footprint of 500,000 m2 ultimately - at the same time as reducing greenhouse gas emissions by 70 %.<br>· In Lisbon, the heating and cooling network operated by Climaespaço is famous for being the first city-scale centralized thermal energy distribution network. It has reduced the capital's annual CO2 emissions by 40 %, and serves 130 buildings. | consume water and chemical additives (biocides, water treatment, etc.).<br>In addition to these global benefits for the city, users of the buildings connected to the network enjoy the following advantages:<br>· Energy supply guarantee: the heat and cold network has excess supply, both in production plants and in thermal production equipment.<br>· Outsourcing of the thermal production service and associated risks (regulatory, service quality commitment ...).<br>· Elimination of machinery replacement costs, no breakdowns, and reduction of maintenance costs.<br>· Reduction of costs of supply of conventional energy (gas and electricity).<br>· Flexibility and adaptability. Ease to have more power, simply expanding the energy exchangers, with hardly any need for more space. |
| **Relevant Publications / Presentations / Services / Products to this Solution** | |
| **(1)** Districlima web | https://www.districlima.com |
| **(2)** Districlima downloads | http://www.districlima.com/es/descargas |
| **(3)** Districlima Barcelona | https://www.construction21.org/espana/city/es/la-red-urbana-de-calor-y-frio-de-di en-barcelona-y-sant-adria-de-besos.html |
| **(4)** User Guide | http://www.districlima.com/districlima/uploads/descargas/guias-tecnicas/Gu%C3%ADa%20del%20usuario%20Districlima%20Rev2016.pdf |
| **Reference Applications of this Solution** | |
| | |
| (1) ENGIE's worldwide operating presence - several projects | https://www.engie.com/en/businesses/district-heating-cooling-systems/ |
| (2) Training course on Geothermal District Heating | http://geodh.eu/wp-content/uploads/2014/11/Manual_corrected.pdf |
| (3) Sustainable cities with urban geothermal energy | http://www.conama11.vsf.es/conama10/download/files/conama2014/CT%202014/1896711817.pdf |
| (4) CHEAP-GSHPS PROJECT | https://cheap-gshp.eu/about-cheap-gshps-project/ |
| (5) Canadian Wells | https://www.ecopassivehouses.com/canadian-wells/<br>https://sgarq.com/en/canadian-or-provencal-well/ |

## S02a Cooling of surfaces

| SPEC CARD | DEMAND SIDE SOLUTIONS<br>Category 1<br>LOW ENERGY DEMAND<br>Solution 0.2<br>Climate change adaptation - District Strategies | |
|---|---|---|
| Title | Graphical Detail | |
| S0.2a Cooling of surfaces | <br><br>· The ‘Passeig Sant Joan’ (ENABLE project) is a promenade which connects the district of Gràcia with the Ciutadella Park. Part of it was redeveloped into one of the first Green Corridors in Barcelona, aiming at increasing ecological and social connectivity within the city.<br>· The total length of the renovated part is 1.2 km and it was completed in 2015.<br>· This design distributes the use of the space between: wide sidewalks, two car lanes, and a segregated bidirectional lane for bicycles.<br>· Eixample is one the districts with the lowest availability of green space per inhabitant. | |
| City / Country | Making_City | Technical Partner Name & contact Details |

| | | | |
|---|---|---|---|
| Barcelona, Spain | No | · Lola Domènech (+34 932 683 277) ld@loladomenech.com<br>· Barcelona City Council<br>· BIMSA | |
| Implementation Time | May 2009 - May 2015 | Initial Investment | 4127161.73 |
| What is Solution? | | How does it work? | |
| <br><br><br> | | Objectives<br>To improve public space functionality and use, to increase access to green spaces for district residents (Eixample), to contribute to higher biodiversity in the city, and to promote more and different retail activity at the ground floor of buildings, so to rejuvenate/boost the local economy.<br><br>Actions<br>Urban regeneration was enabled through the introduction of green infrastructure that: 1) is more welcoming, provides high quality cultural and regulating ecosystem services —thus increases direct use values, attracts more people and more local businesses, 2) through its design favors ground floor service-based retailers (bars and restaurants), which are attractive both to locals and tourists. New green space and amenities promote children’s play, relaxation, improved micro-cimate (shading) and less car circulation (pacification, better air quality), hence improving the quality of life in the area. Carbon sequestration is increased via an enlarged area for street trees and other vegetation comparing to traditional sideways in the city. The semi-permeable pavement and irrigation system installed in most part of Passeig Sant Joan allows for water collection and mitigates run-off while also promoting sustainable water use. | |
| Stakeholder Analysis | | | |
| Developer (if relevant) Who has developed this solution? | | Barcelona City Council | |
| Operator Who is operating this solution? | | FCC ( fomento de construcciones y contratas) | |
| Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution? | | Barcelona City Council | |
| Implementer Who is implementing this solution? | | BIMSA | |
| Financer How / By whom has the implementation of this solution been financed? | | Proeixample S.A. (Ajuntament de Barcelona) | |
| Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution? | | Designer: Lola Domènech (+34 932 683 277) ld@loladomenech.com, Cicsa-engineer | |
| Revenue Streams/ Monetized Value | | | |
| | | | |

| Integration with other smart solutions | BARRIERS / ENABLERS _ PESTEL STUDIES |
|---|---|
| Validate it with other solutions if possible, as a technology package - Grouping of technologies Tech-non-tech. | **Political:**<br>**Economic:**<br>**Social:**<br>**Technical:**<br>**Environmental:**<br>**Legal:** |
| **Potential for Replication** | **Expected Impacts - Benefits** |
| Indicate if the system is already in use in other cities, kind of a valuation is also possible | General aspects about the solution. Could be technical, economical, environmental, social more space. |
| **Relevant Publications / Presentations / Services / Products to this Solution** | |
| (1) Article – Archdaily | https://www.plataformaarquitectura.cl/cl/625586/paisaje-y-arquitectura-remodelacion-del-paseo-de-st-joan-un-nuevo-corredor-verde-urbano-por-lola-domenech |
| (2) Article - think nature | https://platform.think-nature.eu/nbs-case-study/18419 |
| **Reference Applications of this Solution** | |
| (1) Green Pavements | https://www.vitoria-gasteiz.org/wb021/was/contenidoAction.do?idioma=es&uid=u3fb0f976_168551e92d9__7f62 |
| (2) Cooling Paint - Coolseal Los Angeles | https://www.youtube.com/watch?v=Y3qc7Hm3D7A<br>https://www.sciencealert.com/la-s-new-grey-streets-are-one-way-to-fight-back-against-climate-change |
| (3) Solar reflectance of materials | https://www.cement.org/docs/default-source/fc_concrete_technology/sn2982-solar-reflectance-of-concretes-for-leed-sustainable-sites-credit-heat-island-effect.pdf |
| (4) Cool Pavements - Reducing Urban Heat Islands: Compendium of Strategies | https://www.epa.gov/sites/production/files/2014-06/documents/coolpavescompendium.pdf |
| (5) Green Pavements - Urban GreenUp Project | https://www.urbangreenup.eu/solutions/green-pavements--green-parking-pavements.kl |
| (6) Palette 2030 Solar Shading | http://www.2030palette.org/solar-shading/ |
| (7) Nature-based solutions for local climate adaptation in the Basque Country | http://growgreenproject.eu/wp-content/uploads/2018/05/NBS-Climate-Adaptation-Basque-Country.pdf |

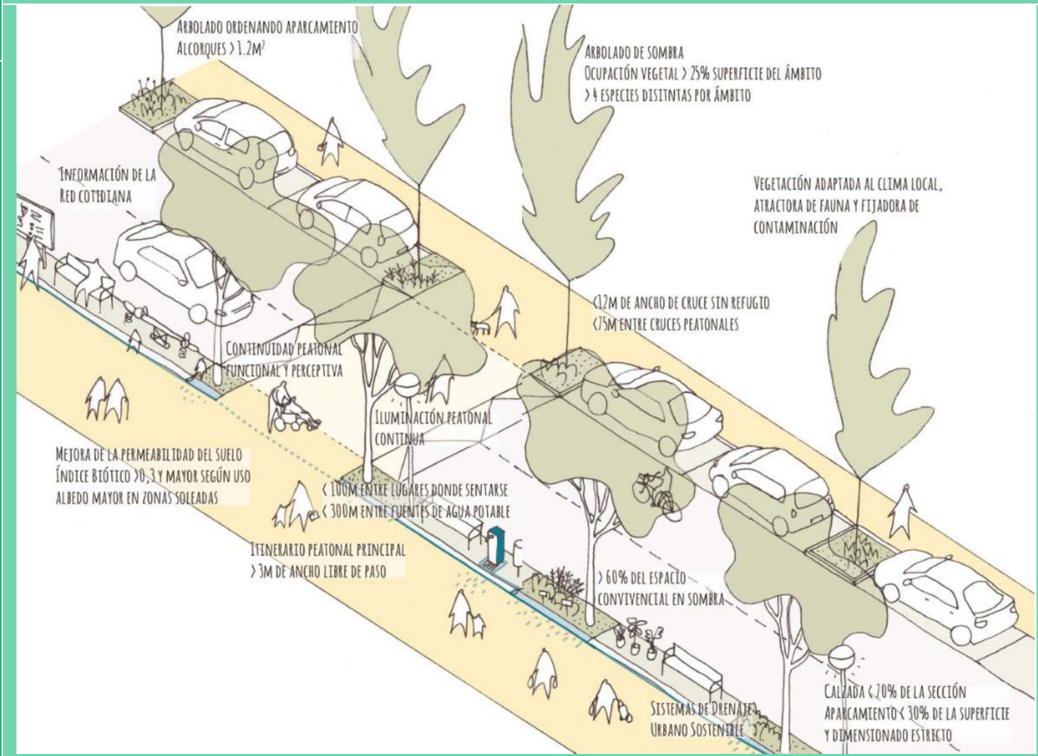
## S02b Evaporative cooling

| SPEC CARD | DEMAND SIDE SOLUTIONS<br>Category 1<br>LOW ENERGY DEMAND<br>Solution 0.2<br>Climate change adaptation - District Strategies | | |
|---|---|---|---|
| Title | Graphical Detail | | |
| S0.2b<br>Evaporative cooling | <br>Smart pavers to refresh from rainwater<br>- Location: Place du Forum, Montaudran, Toulouse<br>- Area: 130 m2<br>- Year of commitment: 2018<br>- Progress Status: Delivered<br>- Funding Type: Public/Private Partnership | | |
| **City / Country** | **Making_City** | **Technical Partner Name & contact Details** | |
| San Pedro de Alcántara (Spain) | No | 2EI Veolia<br>https://www.2ei.veolia.com/en<br>contact@2ei.com | |
| **Implementation Time** | | **Initial Investment** | 250.000€ |
| What is Solution? | | How does it work? | |
| Urban cooling system that uses evaporative pavers fed by depolluting drains.<br><br>This innovative device, tested for the first time in Europe, is a solution to cool pedestrian spaces during periods of high | | This solution allows rainwater to be reused for non-potable use: urban cooling.<br>The innovation also lies in rainwater treatment: runoff water is collected and treated through depolluting drains (developed by Veolia) before being stored.<br><br>Rainwater is collected and stored. Under the paving stones, a system of drip pipes is installed and the mortar to fix the pavers allows the water to rise by capillary action during its evaporation. In case of drought, | |

| | |
|---|---|
| temperatures, which reduces the effects of urban heat island.<br><br>Rainwater collected on the roadway and pre-treated by depolluting drains is injected together with potable water as a back-up, under a layer of paving stones capable of filtering these waters to the surface, where they evaporate. This evaporation allows to lower the temperature of the pavement locally and thus improve the comfort felt by pedestrians. | drinking water can take over, but the storage area is sized to cover 80 to 90% of needs, remaining neutral in terms of ecological balance.<br><br>The system is triggered when the weather sensor installed on the surface registers a certain level of heat. In the test phase, in summer, the ground cooling device has allowed a temperature reduction of more than 5°C and an improvement of the comfort index of 5°C.<br><br>It is an autonomous, fully automated solution: the cooling demand is controlled by meteorological sensors. The materials and equipment used are available on the market. The innovation lies in the management and monitoring of the system's performance through these UTCI measures.<br><br>The system can be remotely controlled by the user (to change the setpoints or parameters) and requires very little maintenance. |
| **Stakeholder Analysis** | |
| Developer (if relevant) Who has developed this solution? | Toulouse Métropole |
| Operator Who is operating this solution? | |
| Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution? | Toulouse Métropole / Oppidea |
| Implementer Who is implementing this solution? | |
| Financer How / By whom has the implementation of this solution been financed? | Caisse des Dépôts et Consignations |
| Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution? | Designer: 2EI Veolia Innove |
| **Revenue Streams/ Monetized Value** | |
| | |
| **Integration with other smart solutions** | **BARRIERS / ENABLERS _ PESTEL STUDIES** |
| This solution is intended to be combined with other types of cooling solutions (vegetation,...) to create outdoor spaces. | **Political:**<br>**Economic:**<br>**Social:**<br>**Technical:**<br>**Environmental:**<br>**Legal:** |
| **Potential for Replication** | **Expected Impacts - Benefits** |
| 2EI has developed innovative devices for humidifying pavements from recovered rainwater, raw | Innovation to fight urban heat island, that combines water recovery, decontamination and reuse through evaporation. |

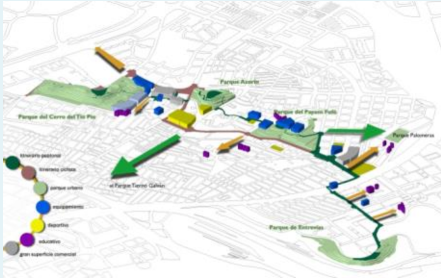
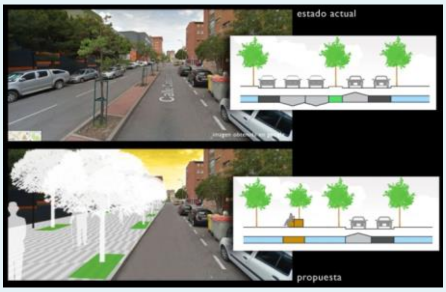
| | |
|---|---|
| water, etc. in Lyon, Toulouse and Nice (France).<br>In a similar system of evaporative pavers installed in Nice, the pavers come from the recycling of scallops, while those of Toulouse come from stone from Japan. | The solution could also be useful in winter to fight against snowfall since the water retained in the paving stones remains at a temperature of 10 to 15°C, which prevents the flakes from settling. |
| **Relevant Publications / Presentations / Services / Products to this Solution** | |
| (1) Case study description on Construction21 website | https://www.construction21.org/infrastructure/fr/smart-pavers-to-refresh-from-rainwater.html |
| (2) The project on Toulouse Métropole website | https://www.toulouse-metropole.fr/-/quand-la-fraicheur-vient-de-la-terre- |
| (3) 2EI Veolia website | https://www.2ei.veolia.com/en/news/2ei-solution-adapt-heat-waves-and-cool-city |
| (4) The project on the news (20 minutes) | https://www.20minutes.fr/toulouse/2533087-20190606-toulouse-lutter-contre-chaleur-voici-premiers-paves-rafraichissantes-testes-europe |
| (5) The project on the news (La Dépêche) | https://www.ladepeche.fr/amp/2019/05/29/a-toulouse-on-teste-les-premiers-paves-rafraichissants-deurope-en-cas-de-canicule,8228303.php |
| **Reference Applications of this Solution** | |
| **(1)** Evaporative towers in Eco-boulevard project, Madrid (Spain) | https://ecosistemaurbano.com/eco-boulevard/ |
| **(2)** Ecoquartier Cœur de ville - La Possession - vegetation for evaporative cooling / climate mitigation | https://www.construction21.org/france/city/fr/ecoquartier-c%C5%93ur-de-ville-la-possession.html<br>https://www.construction21.org/france/data/sources/users/11111/d1315-possession-ref-dd-construction-final.pdf |
| **(3)** Green Roofs | https://www.apabcn.cat/documentacio/areatecnica/PDFS_SHAREPOINT/Presentacions/FA%C3%87ANES-VERDES-07-10-2016/RAMON-MARTINEZ.PDF |
| **(4)** Vertical Gardens - Ecoquartier fluvial de l'île Saint Denis | http://www.philippon-kalt.fr/wp-content/uploads/2017/12/PK_E2R_15-1440x1080.jpg<br>http://www.philippon-kalt.fr/index.php/project/165-logements-bbc-facade-manteau-legere/?lang=fr |
| **(5)** Palette 2030 - Vegetative cooling | http://www.2030palette.org/vegetative-cooling/ |
| **(6)** Palette 2030 - Constructed wetland | http://www.2030palette.org/constructed-wetland/ |
| **(7)** Nature-based solutions for local climate adaptation in the Basque Country | http://growgreenproject.eu/wp-content/uploads/2018/05/NBS-Climate-Adaptation-Basque-Country.pdf |
| **(8)** Madrid Río - urban cooling | https://urbandesignprize.gsd.harvard.edu/madrid-rio/ |
| **(9)** Article: public space for the extreme: evaporation | https://ecosistemaurbano.org/english/public-space-for-the-extreme-evaporation/ |

## S03a Foster clean mobility

| SPEC CARD | DEMAND SIDE SOLUTIONS<br>Category 1<br>LOW ENERGY DEMAND<br>Solution 0.3<br>Mobility (eliminate vehicles emissions) |
|---|---|
| Title | Graphical Detail |
| S0.3a Foster clean mobility |  |
| | Pedestrian strategy for walkable districts:<br>· At least 1,000 more active travels per day<br>· High-quality pedestrian corridor improving accessibility |

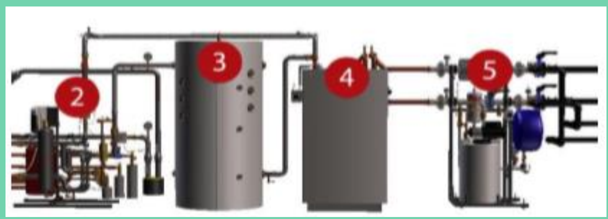


| City / Country | Making_City | Technical Partner Name & contact Details | |
|---|---|---|---|
| Madrid (Spain) | No | · Carmen Hernanz - Madrid City Council - hernanzcmc@madrid.es<br>· Grupo de Estudios y Alternativas 21 (GEA21) | |
| **Implementation Time** | The measure is expected to be fully operational by October 2019 | **Initial Investment** | The total budget 236.875 € This does not include the various construction works required, which will be financed through the Madrid City Council's regular budget |
| What is Solution? | | How does it work? | |
| | | | |

| | |
|---|---|
|    | Two pilot actions will be implemented in the living lab. The first one will implement a high-quality pedestrian corridor, connecting the major green areas in Puente de Vallecas, while improving north-south connectivity for pedestrians in the area. As action plan for a walkable district will improve access to key facilities (a hospital, cultural centre and a sports facility), and will connect them through a high-quality pedestrian axis, using physical design measures and new technology tools (e.g. smart signage). In particular, the plan will provide, more convenient access to the hospital to residents, crossing the current barrier created by a motorway. The high-quality pedestrian corridor will address both pedestrians and cyclists (also linking to Madrid's other CIVITAS ECCENTRIC measure 'Enabling cycling outside the city centre'). Several sections of this corridor are expected to be completed during 2018.<br>The second pilot action will transform a disconnected and car-dominated area into a high-quality public space devoted to pedestrian and social life. This will be addressed through the creation of an e-mobility centre (following the experience of similar CIVITAS ECCENTRIC measures in the cities of Munich and Turku, and also linked to Madrid's measure 'Enabling cycling outside the city centre') and will be coupled with a number of improvements in the pedestrian network in the vicinity of the e-mobility centre and in other streets within the city lab.<br>Both actions will be done in cooperation with residents and local stakeholders, following a participatory approach. |
| **Stakeholder Analysis** | |
| Developer (if relevant) Who has developed this solution? | Madrid City Council |
| Operator Who is operating this solution? | |
| Customer(s) or user(s) Who is this solution targeting? For instance, who is saving energy thanks to the implementation of this solution? | Madrid City Council |
| Implementer Who is implementing this solution? | |
| Financer How / By whom has the implementation of this solution been financed? | This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 690699. |
| Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution? | Designer: Grupo de Estudios y Alternativas 21 (GEA21) |
| **Revenue Streams/ Monetized Value** | |
| | |
| **Integration with other smart solutions** | **BARRIERS / ENABLERS _ PESTEL STUDIES** |
| Pedestrian strategy for walkable districts is complemented with other 10 strategies (tech and non tech) included in the Booklet: https://civitas.eu/sites/default/files/civitas_eccentric_booklet_madrid_web.pdf | **Political:**<br>**Economic:**<br>**Social:**<br>**Technical:**<br>**Environmental:**<br>**Legal:** |

| Potential for Replication | Expected Impacts - Benefits |
|---|---|
| The project ECCENTRIC (H2020 CIVITAS), focuses on sustainable mobility in suburban districts and innovative urban freight logistics, two important areas that have previously received less attention in urban mobility policies.<br>It is being implemented in 5 cities: Torku, Stockholm, Munich, Ruse and Madrid. For more info visit: https://civitas.eu/eccentric/ | In Madrid, ECCENTRIC will drive the CO2 reduction foreseen in the Air Quality Plan, targeting 51,100 tonnes/year in the laboratory area, with an upscaling potential of 134,500 tonnes in the whole suburban area. Other benefits:<br>· 6% reduction of car travel in Madrid, related to those using the new HOV parking management scheme<br>· Achieve a modal share of 2% for bicycle trips in the lab area<br>· Increasing the modal share for walking by 6% in the lab area<br>· 10-30% decrease of average speed in living lab after safety plans implementation<br>· 50% of reduction in accidents with injuries in the lab area<br>· 10% increase in commercial speed and 9% increase in regularity levels in the new high level bus corridor<br>· 6 new hybrid buses providing 30% energy consumption savings, and noise reduction<br>· 3 pedestrian interventions and 3 traffic safety plans at the neighbourhood level based on a participatory design process<br>· 8% decrease in the number of children travelling to the school by car in the city lab<br>· 20 electric vehicles introduced in Madrid's municipal fleet<br>· 5 urban delivery companies testing e-vehicles in their fleets<br>· 30% reduction of km-goods, thanks to the implementation of a consolidation centre linked to the use of electric vehicles in Madrid<br>· Ultra low emission electric-natural gas distribution vehicle developed and tested in Madrid |
| **Relevant Publications / Presentations / Services / Products to this Solution** | |
| (1) 2020 CIVITAS: Cleaner and better transport in cities ECCENTRIC Sustainable mobility solutions in Madrid (page 17) | https://civitas.eu/sites/default/files/civitas_eccentric_booklet_madrid_web.pdf |
| (2) Itinerario Miradores (Puente de Vallecas) - Urban regeneration strategies | https://www.arcgis.com/apps/MapJournal/index.html?appid=faaa60fa83364618b7238aafd1d78145 |
| (3) Itinerario Miradores (Puente de Vallecas) - Public Space Strategic Project | http://www-2.munimadrid.es/urbanismo_inter/visualizador/getPDF.do?id=47&nombrePDF=IT.13.02 |
| (4) Street Mix: design making tool to achieve "Complete Streets", ensuring that all streets are accessible to all people | https://streetmix.net/ |
| (5) Living lab area in Madrid | http://civitas.eu/eccentric/madrid |
| **Reference Applications of this Solution** | |
| (1) 2020 CIVITAS: Cleaner and better transport in cities<br>ECCENTRIC | https://civitas.eu/eccentric |
| (2) Lyon Confluence - Mobility project | https://www.construction21.org/france/city/fr/lyon-confluence.html |
| (3) Palette 2030 - Transit Oriented Development | http://www.2030palette.org/transit-oriented-development/ |

## S1a Residential Building (High Rise) retrofitting

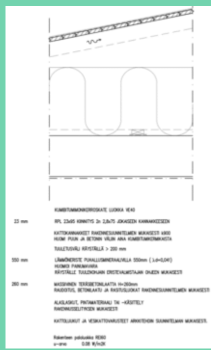
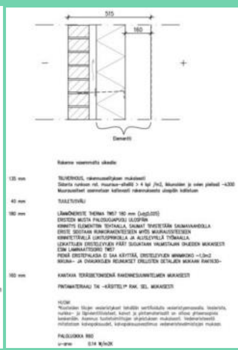
| SPEC CARD | DEMAND SIDE SOLUTIONS | | | |
|---|---|---|---|---|
| | Category 1<br>LOW ENERGY DEMAND | | | |
| | Solution 1<br>Building Envelope Retrofitting in Residential buildings | | | |
| Title | Graphical Detail | | | |
| S1a<br>Residential Building (High Rise) retrofitting |    <br>Air to fluid-heat exchanger + DH exchangers, heating and DHW + buffer s + heat pump. Sewage water heat exchanger on the right.<br><br>General Data for the solution in bullets | | | |
| City / Country | Making_City | Technical Partner Name & contact Details | | |
| Madrid (Spain) | Yes | · Sivakka (rental housing) | | |
| Implementation Time | Autumn 2019 | Initial Investment | Exhaust air heat pump about 2000 e/kW. Sewage water heat recovery about 20 000 e. | |
| What is Solution? | | How does it work? | | |
| Improvement of energy efficiency in the block of flats, built in 1972. Solutions are:<br>-exhaust air heat pump, combined with district heating<br>-PV<br>-heat recovery from sewage water<br>-heating system balancing<br>-replacement of room thermostats<br>-ventilation air flow rate adjustment<br>-apartment-wise tap water metering<br>-continuous measurements (temp, humidity and pressure difference)<br>-new windows. | | The larger applications here are described in more detail in their specific SPEC-cards. | | |
| Stakeholder Analysis | | | | |

| | |
|---|---|
| Developer (if relevant) Who has developed this solution? | Several suppliers |
| Operator Who is operating this solution? | Sivakka |
| Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution? | Building owner or flat owner, if there is apartment-wise heat consumption measuring |
| Implementer Who is implementing this solution? | Several suppliers |
| Financer How / By whom has the implementation of this solution been financed? | Own funding |
| Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution? | The tenants |
| **Revenue Streams/ Monetized Value** | |
| | |
| **Integration with other smart solutions** | **BARRIERS / ENABLERS _ PESTEL STUDIES** |
| Not necessarily dependent on other solutions, but the feasibility is the better the more expensive and "dirty" is the heating energy to be replaced by HP. And vice versa, the cleaner the electricity, the better is HP from environmental point of view. In more detail, HP use timing impacts the effect on the whole system: the more the HP use is weighted towards cheap electricity moments (in Nordic el. market system), the better is also the environmental performance. | Political: Climate targets support this. No major barriers.<br>Economic: HP investment may have pay-back time of e.g. 10 years, sewage heat recovery 20. Window improvements are generally feasible in Finnish context mostly only if the windows must be renewed in every case.<br>Social: If the starting level is weak, then living comfortability is increased (not in this case due to tolerable starting point). However, nearly in every case the change of windows help to decrease the draught from cold window surfaces. HP installation with pre-fabricated modules does not harm the residents.<br>Technical: The building should have hydronic space and DHW heating system. Sewage water collection centralized bottom plumbing is needed.<br>Environmental: In right places and usage patterns HP may decrease the emissions. Adding HP to CHP DH system is however not always environmentally feasible. HP uses electricity and replaces CHP heat and in further CHP power production. Saved energy must also be compared with that of embodied energy in materials and indirect emissions. The renewal generally decreases emissions, but not always.<br>Legal: No significant barriers. |
| **Potential for Replication** | **Expected Impacts - Benefits** |
| High. There are a lot of buildings, for which this is applicable. | Savings in the energy cost, from the building owner point of view, can be calculated quite easily. They depend on the starting level and on the actions done. The system impact is more complicated and depends on the context. |
| **Relevant Publications / Presentations / Services / Products to this Solution** | |
| | |
| **Reference Applications of this Solution** | |

## S1b Residential Building (Private House) retrofitting*

This SPEC card will be finalized in the final version of this deliverable

## S2a New High-Performance Building (residential)

| SPEC CARD | DEMAND SIDE SOLUTIONS<br>Category 1<br>LOW ENERGY DEMAND<br>Solution 2<br>New High performance residential buildings | | |
|---|---|---|---|
| Title | Graphical Detail | | |
| S2a New High Performance Building (residential) |   <br>Apartment block with low space and domestic hot water heating energy consumption | | |
| City / Country | Making_City | Technical Partner Name & contact Details | |
| | Yes | Sivakka & YIT | |
| Implementation Time | Round 1,5 year | Initial Investment | 6,1 Me |
| What is Solution? | | How does it work? | |
| Ceiling U=0,08 W/m2K<br>Wall U=0,14 W/m2K, insulation 180 mm PU<br>Windows and doors U=0,6 W/m2K<br>Floor U=0,011 W/m2K<br>Exhaust air heat recovery (air-to-air), pre-heating and -cooling from soil layer under the building | | Good insulation and windows and heat recoveries from outcoming streams keep the basic heat consumption small. | |

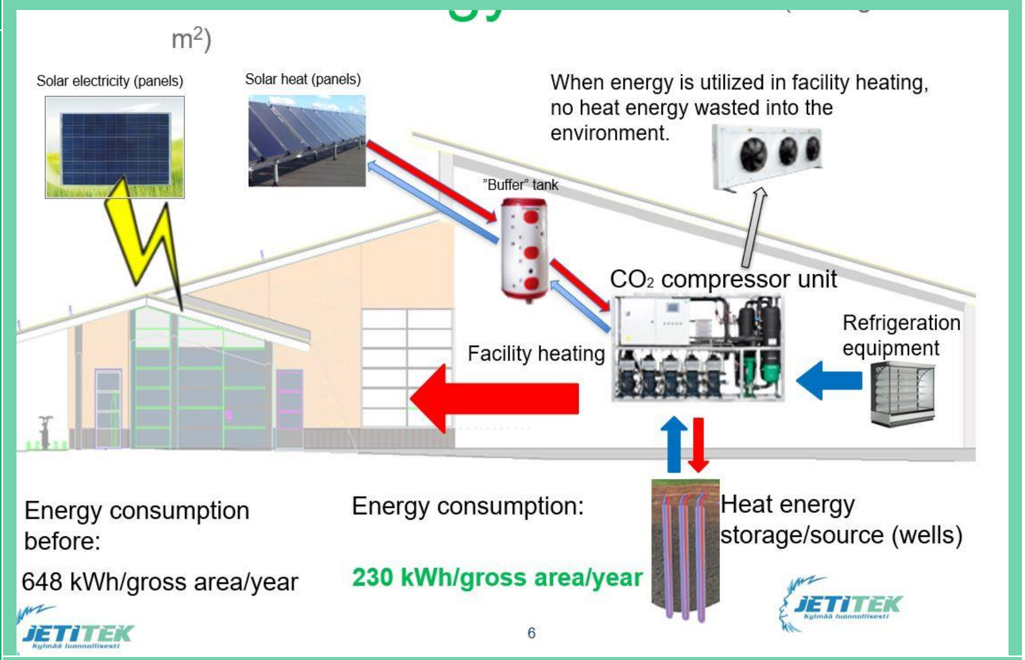
| | |
|---|---|
| Heat recovery with heat pump from district heating return line<br>Heat recovery from sewage water with water-to-water heat exchanger<br>Solar panels<br>Metering (temp, moisture, pressure difference in mech. ventilation)<br>Ventilation rate adjustable by inhabitant<br>Moisture-controlled ventilation in bathrooms | |
| **Stakeholder Analysis** | |
| Developer (if relevant) Who has developed this solution? | Several suppliers |
| Operator Who is operating this solution? | Sivakka |
| Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution? | Finally the tenant |
| Implementer Who is implementing this solution? | Several suppliers |
| Financer How / By whom has the implementation of this solution been financed? | Own funding |
| Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution? | All people, who has something to do with the buildings |
| **Revenue Streams/ Monetized Value** | |
| Pay-back time varies solution by solution, but in general the improvement over the minimum level set by law (which is quite high already) has a pay-back time of e.g. 20 years. However, the risk is generally low, so the investments are feasible in long term. | |
| **Integration with other smart solutions** | **BARRIERS / ENABLERS _ PESTEL STUDIES** |
| Not necessarily dependent on other solutions, but the feasibility is the better the more expensive and "dirty" is the heating energy the use of which is decreased or be replaced by HP heat. | Political: Largely supported by politics, even if the populistic parties tend to resist may "green" issues<br>Economic: Long pay-back time, but low risk<br>Social: Especially in this case the rents must be kept low. Long-sight investments help in this.<br>Technical: No major barriers, partly new technology however. Components, materials and solutions have a good availability in general.<br>Environmental: At some point the increase in e.g. insulation or building new buildings in general may override the savings. I.e. embodied energy may be larger than net energy consumed during use.<br>Legal: Good support by Finnish legislation ang gets probably even better. |
| **Potential for Replication** | **Expected Impacts - Benefits** |

| | |
|---|---|
| Very largely replicable | See barriers/enablers. This kind of energy performance is probably at least close to the lowest-cost alternative in long term. |
| Relevant Publications / Presentations / Services / Products to this Solution | |
| (links to suppliers?) | |

## S3a Retrofitting of the office building*

This SPEC card will be finalized in the final version of this deliverable

## S4a New High-Performance Building (Shopping Mall)

<table>
<tr><td rowspan="3">SPEC CARD</td><td colspan="3">DEMAND SIDE SOLUTIONS</td></tr>
<tr><td colspan="3">Category 1<br>LOW ENERGY CONSUMPTION</td></tr>
<tr><td colspan="3">Solution 4<br>New high performance tertiary buildings</td></tr>
<tr><td>Title</td><td colspan="3">Graphical Detail</td></tr>
<tr><td>S4a New High Performance Building (Shopping Mall)</td><td colspan="3">
<br>Efficient use of multiple energy resources: heat dwells, solar and heat recovery</td></tr>
<tr><td>City / Country</td><td>Making_City</td><td colspan="2">Technical Partner Name & contact Details</td></tr>
<tr><td>OULU</td><td>Yes</td><td colspan="2"></td></tr>
<tr><td>Implementation Time</td><td></td><td>Initial Investment</td><td>Depending of the scale, payback time less than 2 years</td></tr>
<tr><td colspan="2">What is Solution?</td><td colspan="2">How does it work?</td></tr>
</table>

| | |
|---|---|
| The system is based on advanced heat pump technology using environmentally friendly CO2 instead of F-gases. When cooling the beverages, the heat pump produces equal amount of heat. This heat is used in the building for heating, for hot domestic water and surplus can be also distributed to other surrounding buildings with reginal heating pipeline. The heat surplus can also be stored to heat dwells. | Efficient use of heat pump technology with advanced scada system, used to optimise the peaks and balance the use of heat and cold.<br>Heat dwells used to get extra energy or to store surplus to the ground (seasonal storage)<br>Solar panels for operating the system (100% self-sustainability on the summer period) for the heat and cold<br>Heat and cold storage by phase change material (improved energy coefficient)<br>Heat recovery from the AC system<br>50% improvement compared to the buildings with the similar size |
| **Stakeholder Analysis** | |
| **Developer (if relevant)** Who has developed this solution? | Jetitek |
| Operator Who is operating this solution? | Jetititek (since 9/2019 Caverion OY) |
| **Customer(s) or user(s)** Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution? | This solution is being used in 50 shops in the ARINA grocery store chain in Finland |
| **Implementer** Who is implementing this solution? | Arina implements this solution wih the help of Jetitek to every new and refurbished shop |
| **Financer** How / By whom has the implementation of this solution been financed? | The financing is coming from Arina the owner |
| **Other impacted stakeholder(s)** (if relevant) Who else is impacted by the deployment of this solution? | |
| **Revenue Streams/ Monetized Value** | |
| Depending the size of implementation, typical reduction in energy bill 50%, payback time less than 2 years | |
| **Integration with other smart solutions** | **BARRIERS / ENABLERS _ PESTEL STUDIES** |
| Validate it with other solutions if possible, as a technology package - Grouping of technologies Tech-non-tech. | **Political:**<br>**Economic:** very good, payback and references available<br>**Social:** highly appreciated by consumers<br>**Technical:** a solid tested model<br>**Environmental:** CO2 based, environmentally safe<br>**Legal:** |
| **Potential for Replication** | **Expected Impacts - Benefits** |
| The system can be replicated in Europe | |
| **Reference Applications of this Solution** | |
| 45 existing systems by ARINA; the most advanced developed for MAKING CITY project with the ability to share the resources with neighboring buildings | |

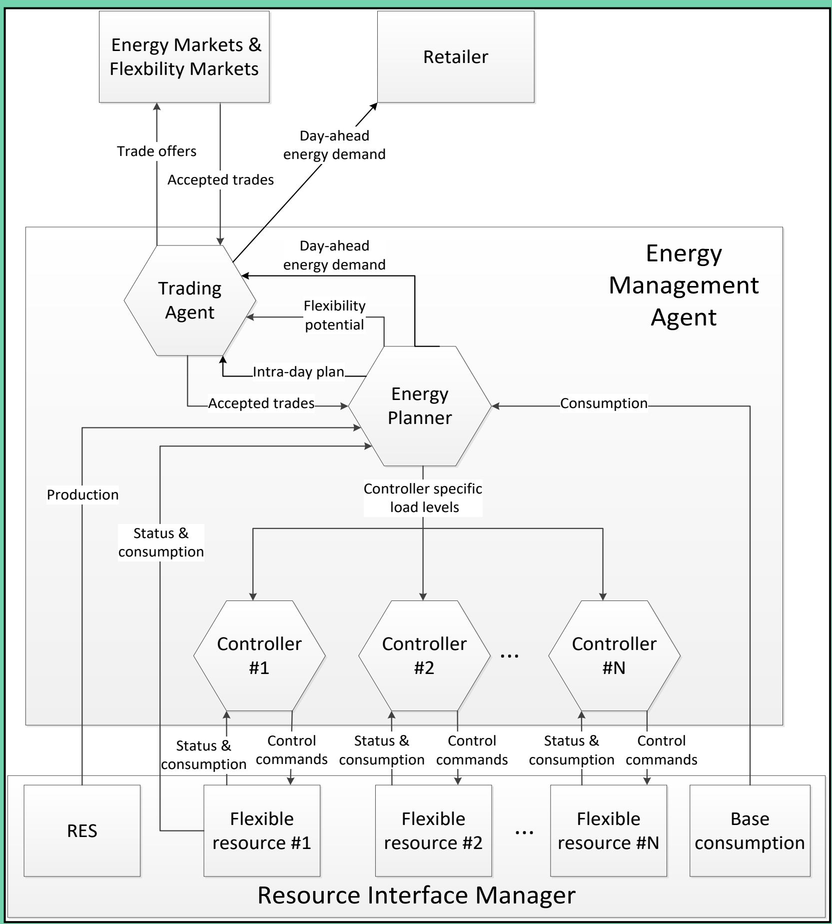
## S4b New High-Performance Building (Academy Building) *

This SPEC card will be finalized in the final version of this deliverable

## S4c New High-Performance Building (Sport Complex) *

This SPEC card will be finalized in the final version of this deliverable

## S5a Smart Control / Advanced Metering / Wireless Advanced Control in Buildings

<table>
<tr><td rowspan="3">SPEC CARD</td><td colspan="2">DEMAND SIDE SOLUTIONS</td></tr>
<tr><td colspan="2">Category 2<br>IMPROVE ENERGY EFFICIENCY</td></tr>
<tr><td colspan="2">Solution 5<br>Smart Building / Home energy controllers</td></tr>
<tr><td>Title</td><td colspan="2">Graphical Detail</td></tr>
<tr><td rowspan="2">S5a Energy Management Agent for energy optimization and demand response</td><td colspan="2">
</td></tr>
<tr><td colspan="2">- Novel solution for energy optimization and bottom-up based demand response,<br>- Energy Management Agent (EMA) automates flexibility management on building-level,<br>- EMA provides a load plan and flexibilities for each site,<br>- Supports peer-to-peer and aggregation-based flexibility management,<br>- Deep learning technologies utilized for learning building dynamics and optimal control policies</td></tr>
<tr><td>City / Country</td><td>Making_City</td><td>Technical Partner Name & contact Details</td></tr>
</table>

<table>
<tr><td>OULU / Finland</td><td>Yes</td><td colspan="2">VTT</td></tr>
<tr><td>Implementation Time</td><td></td><td>Initial Investment</td><td></td></tr>
<tr><td colspan="2">What is Solution?</td><td colspan="2">How does it work?</td></tr>
<tr><td colspan="2">EMA optimizes the energy usage within a site by controlling flexible resources and trading energy via local markets in order to maximize the reward function (i.e., objective) defined by the end-user. Typically, the reward function is money, but it can also include environmental aspects such as CO2 emissions. The money part of the reward function can in turn include various aspects such as the energy price, power tariffs, local power generation and cross-commodity energy trade.<br><br>Energy Management Agent is designed to interact with the outside world (i.e., other Energy Management Agents and/or Aggregators) via local markets.</td><td colspan="2">EMA can be divided into three logical parts as: Trading Agent, Energy Planner and Controller(s). The Trading Agent is the Energy Management Agent’s Interface to energy markets. It is responsible for maximizing the flexibility potential of the site in the markets by trading energy with other market participants.<br>The Energy Planner is a central component of the EMA. It is responsible for planning and optimizing the energy usage within the site at all times. The basic functionality of the Energy Planner can be roughly divided into four parts:<br>1. Once a day, before the day-ahead market closes, the Energy Planner provides the Trading Agent with a forecast of the next day’s energy demand.<br>2. Continuously during the day, the Energy Planner provides forecasts of the load for a configurable time window. Again, the Energy Planner can utilize information on the generation, demand and flexibility forecast, as well as, various incentives for making the plan.<br>3. The Energy Planner provides the Trading Agent with information about the flexibility potential of the site. This information contains the maximum up and down flexibility as well as the minimum price for adjusting the load in a given direction.<br>4. The Energy Planner monitors and plans the site overall load profile and assigns individual load profiles for each flexible resource. This is done continuously to be able to adapt to trades and other changes in the day-ahead demand plan.<br>Logically there is a Controller component for each flexible resource type within a site. Each Controller component is responsible for controlling a flexible resource according to the plan provided by the Energy Planner. Implementation of the Controller logic depends on the type of the resource. For example, with on/off device the Controller needs to manipulate the on/off pulse ratio so that the average load within the market resolution (i.e., 15 minutes) matches the load plan. With more complex devices such as heat pumps the control is executed by manipulating temperature set points</td></tr>
<tr><td colspan="4">Stakeholder Analysis</td></tr>
<tr><td colspan="2">Developer (if relevant) Who has developed this solution?</td><td colspan="2"></td></tr>
<tr><td colspan="2">Operator Who is operating this solution?</td><td colspan="2"></td></tr>
<tr><td colspan="2">Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution?</td><td colspan="2"></td></tr>
<tr><td colspan="2">Implementer Who is implementing this solution?</td><td colspan="2"></td></tr>
</table>

<table>
<tr><td>Financer How / By whom has the implementation of this solution been financed?</td><td></td></tr>
<tr><td>Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?</td><td></td></tr>
<tr><th colspan="2">Revenue Streams/ Monetized Value</th></tr>
<tr><td colspan="2"></td></tr>
<tr><th>Integration with other smart solutions</th><th>BARRIERS / ENABLERS _ PESTEL STUDIES</th></tr>
<tr><td>Validate it with other solutions if possible, as a technology package - Grouping of technologies Tech-non-tech.</td><td>Political:<br>Economic:<br>Social:<br>Technical:<br>Environmental:<br>Legal:</td></tr>
<tr><th>Potential for Replication</th><th>Expected Impacts - Benefits</th></tr>
<tr><td>Indicate if the system is already in use in other cities, kind of a valuation is also possible.</td><td>-Enables end-users to take more active role in the energy markets<br>-Makes energy systems more predictable by providing incentive for end-users to plan and optimize energy usage<br>-Supports local flexibility management<br>- Supports RES integration<br>- Reduces CO2 footprint</td></tr>
<tr><th colspan="2">Relevant Publications / Presentations / Services / Products to this Solution</th></tr>
<tr><td></td><td></td></tr>
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<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><th colspan="2">Reference Applications of this Solution</th></tr>
<tr><td></td><td></td></tr>
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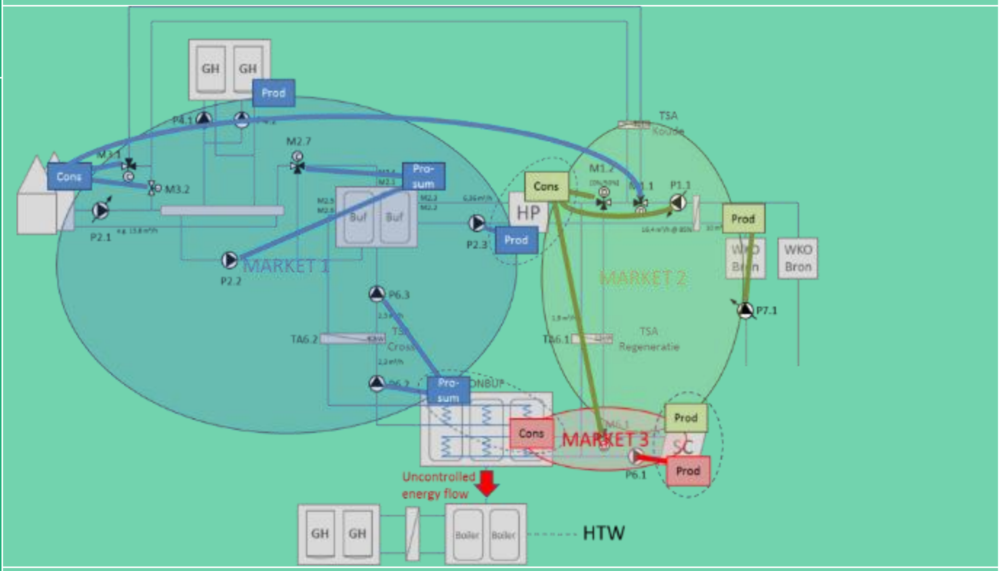
## S5b Visualization Units to study human behaviour regarding the energy consumption*

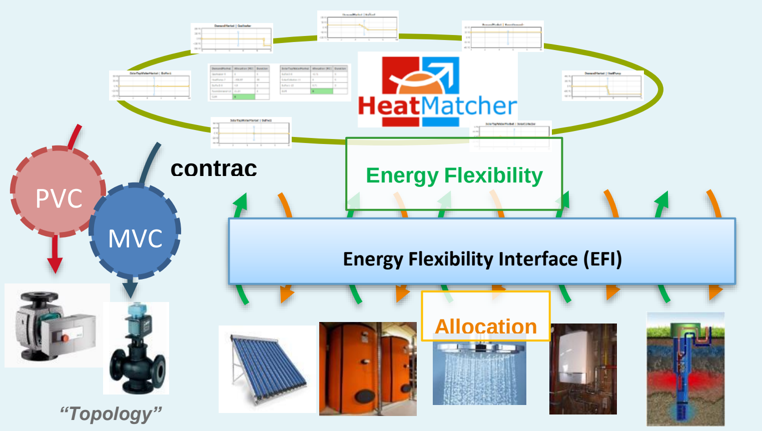
This SPEC card will be finalized in the final version of this deliverable

## S5c Demand Response / Smart Grid*

This SPEC card will be finalized in the final version of this deliverable

## S5d Heat Matcher

| SPEC CARD | DEMAND SIDE SOLUTIONS<br>Category 2<br>IMPROVE ENERGY EFFICIENCY<br>Solution 5<br>Smart Building / Home energy controllers | | |
|---|---|---|---|
| Title | Graphical Detail | | |
| S5d Heat Mather | <br>- Match heating and cooling supply and demand<br>- Maximize use of renewable energy sources<br>- Virtual market mechanism: agents sell and buy their energy on the markets<br>- Exploit the flexibility of all components and uses this flexibility in the optimization algorithm<br>Higher abstraction: Controls the energy flows, instead of temperatures used in traditional systems | | |
| City / Country | Making_City | Technical Partner Name & contact Details | |
| | Yes | TNO<br>Arun Subramanian (arun.subramanian@tno.nl) | |
| Implementation Time | 3 months | Initial Investment | 35000 |
| What is Solution? | | How does it work? | |
| | | | |

<table>
<tr>
<td>HeatMatcher is an innovative real-time matching solution for heating and cooling systems. It determines the optimal balance between producers (supply) and consumers (demand) of heat and cold. One of HeatMatcher's unique features is its ability to handle many energy consumers and producers at the same time, which is expected to be a prerequisite for heating and cooling networks in the near future. For instance, by optimising across multiple energy producing components – such as heat pumps with thermal storage, solar collectors and gas heaters – consumers benefit from low costs as the amount of renewable energy in the mix is maximised. With a certain buffer capacity required in the system to enable production of energy when costs are low and consumption occurs later, HeatMatcher is able to exploit the flexibility for each of the components and optimise the match.</td>
<td>

In HeatMatcher, each energy producer, consumer and prosumer is represented as an agent capable of expressing its flexibility as a bid curve (as defined in the EFI standard). HeatMatcher combines logically agents into a market and for each discrete time interval requests flexibilities from all participating agents in a market. Upon receiving these flexibility functions, it combines them to determine a market equilibrium, where supply and demand are in balance. Contracts are prepared on the basis of this equilibrium and device constraints and passed down to the agents who translate it to an actuation that the producer/consumer/prosumer device can understand.</td>
</tr>
<tr><th colspan="2">Stakeholder Analysis</th></tr>
<tr><td>Developer (if relevant) Who has developed this solution?</td><td></td></tr>
<tr><td>Operator Who is operating this solution?</td><td></td></tr>
<tr><td>Customer(s) or user(s) Who is this solution targeting? For instance, who is saving energy thanks to the implementation of this solution?</td><td></td></tr>
<tr><td>Implementer Who is implementing this solution?</td><td></td></tr>
<tr><td>Financer How / By whom has the implementation of this solution been financed?</td><td></td></tr>
<tr><td>Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution?</td><td></td></tr>
<tr><th colspan="2">Revenue Streams/ Monetized Value</th></tr>
<tr><td colspan="2">~20% financial savings in OPEX per year in energy costs</td></tr>
<tr><th>Integration with other smart solutions</th><th>BARRIERS / ENABLERS _ PESTEL STUDIES</th></tr>
<tr><td>Validate it with other solutions if possible, as a technology package -</td><td>Economic: Split between investor and benefeciary of technology<br>Social: N/A<br>Technical: Additional changes to heating installation may be necessary</td></tr>
</table>

| | |
|---|---|
| Grouping of technologies Tech-non-tech. | |
| **Potential for Replication** | **Expected Impacts - Benefits** |
| Solution was tested across 5 field trials in 4 locations in the Netherlands over multiple years. Definite potential for replication. | Reduction in gas consumption observed to be ~28% less in last field trial. |
| **Relevant Publications / Presentations / Services / Products to this Solution** | |
| | |

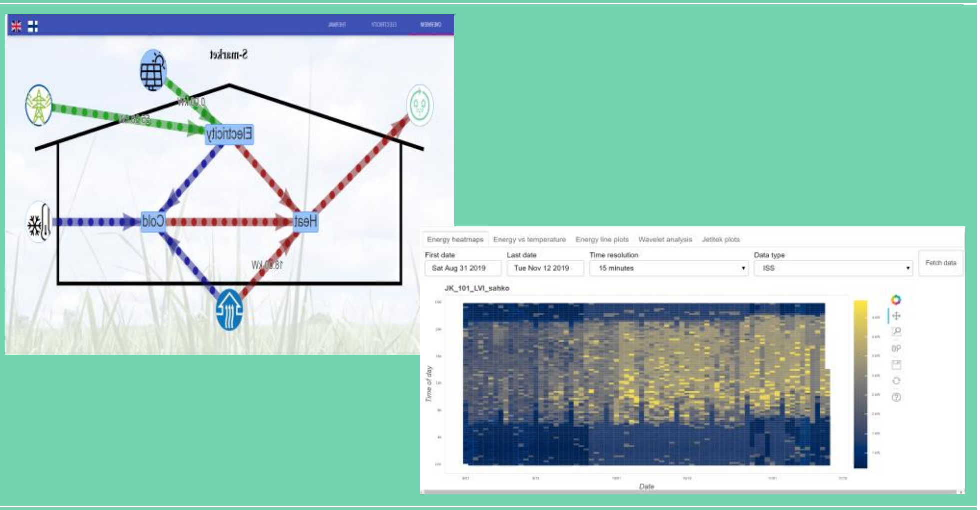
## S6a Smart Lighting, power LED*

This SPEC card will be finalized in the final version of this deliverable

## S6b LoRa (Long Range) wireless network and activity sensors*

This SPEC card will be finalized in the final version of this deliverable

## S6c Energy data monitoring of PED

| SPEC CARD | DEMAND SIDE SOLUTIONS | |
|---|---|---|
| | Category 2<br>IMPROVE ENERGY EFFICIENCY | |
| | Solution 6<br>IoT Monitoring | |
| Title | Graphical Detail | |
| S6c Energy data monitoring of PED |  | |
| | - Measures enery data and the state of the environment from the site<br>- Sends the energy data and environment state to the centralized data base<br>- Provides both technical and non-technical visualization user interfaces for monitoring the data<br>- data pipeline for intelligent control | |
| City / Country | Making_City | Technical Partner Name & contact Details |
| OULU / Finland | Yes | VTT |

| Implementation Time | | Initial Investment | |
|---|---|---|---|
| **What is Solution?** | | **How does it work?** | |
| Energy data monitoring is a key component for enabling intelligent ICT services. It covers the data collection, data storing and data quality monitoring. In addition, the solution provides both technical and non-technical views for both real time and historical data | | Data is measured from the sites. Then the data is transmitted to the ICT server who stores the data in database. Automatic data quality checks queries the database and validates that data storing is operating as specified. If the check detects any problems in the data stream it sends alerts to developers to correct the data pipeline. To see the data both technical and non-technical UIs are developed in top of the database to see both the real time data and historical data. | |
| **Stakeholder Analysis** | | | |
| Developer (if relevant) Who has developed this solution? | | | |
| Operator Who is operating this solution? | | | |
| Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution? | | | |
| Implementer Who is implementing this solution? | | | |
| Financer How / By whom has the implementation of this solution been financed? | | | |
| Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution? | | | |
| **Revenue Streams/ Monetized Value** | | | |
| | | | |
| **Integration with other smart solutions** | | **BARRIERS / ENABLERS _ PESTEL STUDIES** | |
| Validate it with other solutions if possible, as a technology package - Grouping of technologies Tech-non-tech. | | Political:<br>Economic:<br>Social:<br>Technical:<br>Environmental:<br>Legal: | |
| **Potential for Replication** | | **Expected Impacts - Benefits** | |
| Indicate if the system is already in use in other cities, kind of a valuation is also possible. | | Enables intelligent control and other data intelligent solutions Enables measuring the energy performance of PED | |

## S6d Integration of new services to the data platform*

This SPEC card will be finalized in the final version of this deliverable

## S6e Installation of IoT infra*

This SPEC card will be finalized in the final version of this deliverable

## S7a Open Urban Platform adaptation*

This SPEC card will be finalized in the final version of this deliverable

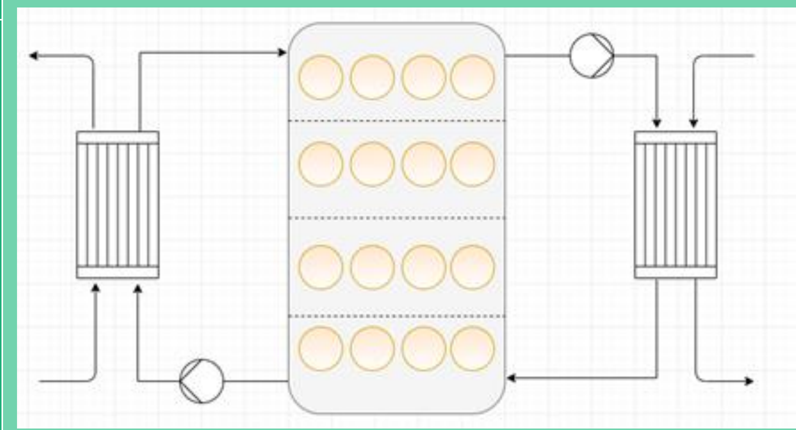
## S8a High Speed data transfer network*

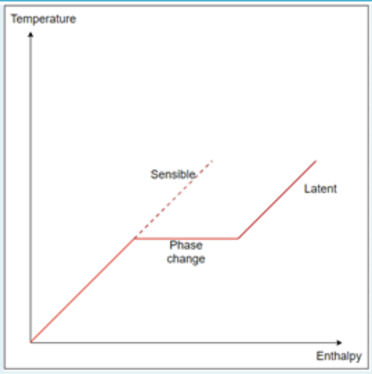
This SPEC card will be finalized in the final version of this deliverable

## S9a Neighbourhood electro storage facility*

This SPEC card will be finalized in the final version of this deliverable

## S10a Phase transfer Liquid tank

<table>
<tr><td rowspan="3">SPEC CARD</td><td colspan="3">SYSTEM INTEGRATION SOLUTIONS</td></tr>
<tr><td colspan="3">Category 3<br>INTEGRATED INFRSTRUCTURES</td></tr>
<tr><td colspan="3">Solution 10<br>Thermal storage</td></tr>
<tr><td>Title</td><td colspan="3">Graphical Detail</td></tr>
<tr><td rowspan="2">S10a Phase transfer Liquid tank</td><td colspan="3"></td></tr>
<tr><td colspan="3">'- Match hot water supply and demand<br>- Prolong the heat pump life time<br>- Increase thermal energy storage intensivity compared to conventional water thermal storage<br>- With increase of energy content it could be possible to have smaller thermal storage units</td></tr>
<tr><td>City / Country</td><td>Making_City</td><td colspan="2">Technical Partner Name & contact Details</td></tr>
<tr><td>OULU / Finland</td><td>Yes</td><td colspan="2">VTT Technical Research Centre of Finland Ltd</td></tr>
<tr><td>Implementation Time</td><td></td><td>Initial Investment</td><td></td></tr>
</table>

| What is Solution? | How does it work? | |
|---|---|---|
| To increase the energy content of the conventional water based thermal storage we can utilise phase change materials to increase the energy content of the tank. These phase change materials are commercial and they are made of either salt-based material or organic materials. As the temperature rises, material changes its form from solid to liquid. This transformation absorbs and releases energy which is called latent heat. This allows for greater energy capacity compared to conventional thermal storage. | Latent heat thermal storage is placed in the heating network with a heat pump for example and it can be charged during the night time or times when heat is not required. Heat is released during the peak hours to increase the life time of the heat pump by reducing it's start times. Latent heat storage can also be placed for storing heat from CO2 cold cycle in markets and release it to DH network. Water acts as a heat transfer fluid between PCM and heat exchangers. PCM is encapsulated to ensure better heat transfer rate. |  |

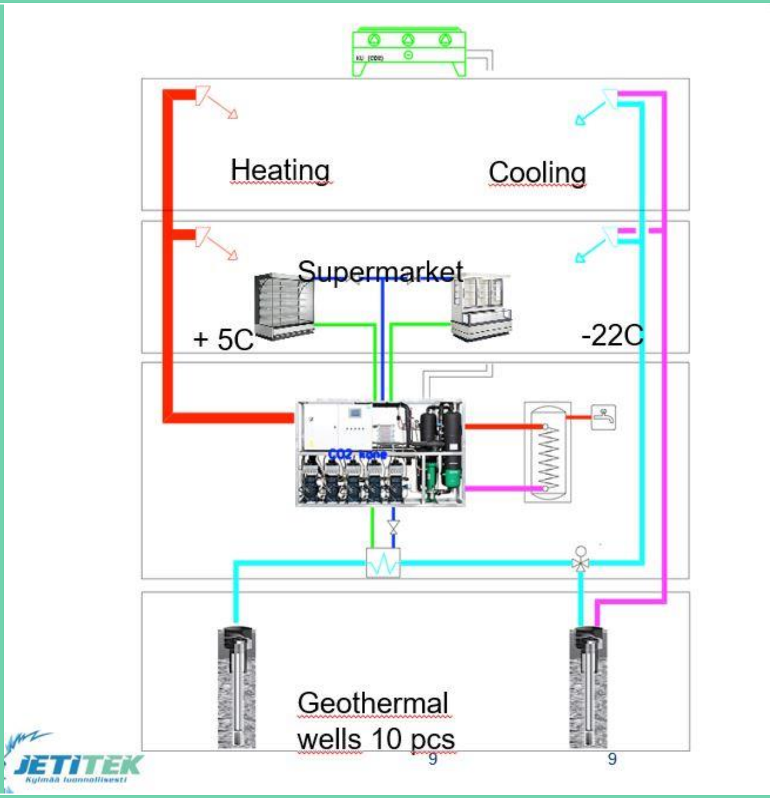
| Stakeholder Analysis | |
|---|---|
| Developer (if relevant) Who has developed this solution? | |
| Operator Who is operating this solution? | |
| Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution? | |
| Implementer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

| Revenue Streams/ Monetized Value |
|---|
| |

| Integration with other smart solutions | BARRIERS / ENABLERS _ PESTEL STUDIES |
|---|---|
| Using heat pumps we increase temperature of District heating low temperature return water and store it in to latent heat thermal storage tank. | **Political:**<br>**Economic:** Price compared to conventional tank is higher<br>**Social:**<br>**Technical:** Additional changes to heating installation may be necessary<br>**Environmental: Phase** change material used is not toxic<br>Legal: |
| **Potential for Replication** | **Expected Impacts - Benefits** |

| | |
|---|---|
| Indicate if the system is already in use in other cities, kind of a valuation is also possible. | If the size of the thermal storage can be reduced compared to conventional storage tanks, interest towards it will increase. additionally, if the energy capacity of it can be utilised fully it can solve some problems relating to drilling boreholes for energy storage. Since ground is used as a heat dump during the summer this could be possibly replace by using proper phase change materials. Problems regarding the thermal storage tanks usually are related to their size. |

## S10b Seasonal storage

<table>
<tr><td rowspan="3">SPEC CARD</td><td colspan="3">SYSTEM INTEGRATION SOLUTIONS</td></tr>
<tr><td colspan="3">Category 3<br>INTEGRATED INFRSTRUCTURES</td></tr>
<tr><td colspan="3">Solution 10<br>Thermal storage</td></tr>
<tr><td>Title</td><td colspan="3">Graphical Detail</td></tr>
<tr><td rowspan="2">S10b Seasonal storage</td><td colspan="3">
</td></tr>
<tr><td colspan="3">Heat dwells are used to storage heat on summer period<br>10 heat dwells are under the building, total length of the storage is 2,5 km</td></tr>
<tr><td>City / Country</td><td>Making_City</td><td colspan="2">Technical Partner Name & contact Details</td></tr>
<tr><td>OULU / Finland</td><td>Yes</td><td colspan="2">Jetitek (later Caverion)</td></tr>
<tr><td>Implementation Time</td><td></td><td>Initial Investment</td><td></td></tr>
<tr><td colspan="2">What is Solution?</td><td colspan="2">How does it work?</td></tr>
</table>

| | |
|---|---|
| Under the summer period the cooling of cold storages in the shop creates lots of heat<br>Normally this heat is evaporated to air with heat exchangers so all the enrgy is lost<br>In this application the heat is stored to the ground in the winter when extra heat is needed for the building and hot domestic water the heat will be recovered | Application description, figures if needed<br>The cooling of cold storages used temperatures from +10 to -22 C. These temperatures are created worth heat pumps using high pressurised CO2 (100 bars)<br>The hot gas is condensed with compressor and then transferred to the heat dwells into the ground.<br>Each dwell has got a pipe looping down from the surface, these pipes are connected together with a collector pipeline and this pipeline has got heat exchanger. This heat exchanger separated the heat collecting liquid from the highly pressurised CO2 |
| **Stakeholder Analysis** | |
| Developer (if relevant) Who has developed this solution? | |
| Operator Who is operating this solution? | |
| Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution? | |
| Implementer Who is implementing this solution? | |
| Financer How / By whom has the implementation of this solution been financed? | |
| Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution? | |
| **Revenue Streams/ Monetized Value** | |
| | |
| **Integration with other smart solutions** | **BARRIERS / ENABLERS _ PESTEL STUDIES** |
| This solution is used together with heat pumps, please refer to SPEC_S4a | Political:<br>Economic:<br>Social:<br>Technical:<br>Environmental:<br>Legal: |
| **Potential for Replication** | **Expected Impacts - Benefits** |
| The system can be applied in Europe if the soils and regulation allows to make heat dwells | General aspects about the solution. Could be technical, economical, environmental, social |
| **Relevant Publications / Presentations / Services / Products to this Solution** | |
| | |
| | |
| | |

## S10c Thermal Storage*

This SPEC card will be finalized in the final version of this deliverable

## S11a Low Temp regional transfer pipeline*

This SPEC card will be finalized in the final version of this deliverable

## S11b Adjust geothermal district heating for using low temperature*

This SPEC card will be finalized in the final version of this deliverable

## S11c Connection to the low temperature district heat*

This SPEC card will be finalized in the final version of this deliverable

## S12a Building energy connectivity for energy sharing

<table>
<tr><td rowspan="3">SPEC CARD</td><td colspan="3">SYSTEM INTEGRATION SOLUTIONS</td></tr>
<tr><td colspan="3">Category 3<br>INTEGRATED INFRSTRUCTURES</td></tr>
<tr><td colspan="3">Solution 12<br>Building energy connectivity for energy sharing</td></tr>
<tr><td>Title</td><td colspan="3">Graphical Detail</td></tr>
<tr><td rowspan="2">S12a Building energy connectivity for energy sharing</td><td colspan="3">   <br>CHP plant, biomass fuel + heat pumps -> DH network -> heat exchanger for consumer</td></tr>
<tr><td colspan="3">- District heating (DH) network<br>- Also feeding heat from buildings to DH network is possible<br>- Both supply and return sides can be utilised for space heating and domestic hot water heating</td></tr>
<tr><td>City / Country</td><td>Making_City</td><td colspan="2">Technical Partner Name & contact Details</td></tr>
<tr><td></td><td>Yes/No</td><td colspan="2"></td></tr>
<tr><td>Implementation Time</td><td>Year 2020.</td><td>Initial Investment</td><td>Ordinary DH exchanger round 3000-10000 euros, DH pipe construction underground > 100 e/m. Heat pump very roughly round 500 euros/heat-kW.</td></tr>
<tr><td colspan="2">What is Solution?</td><td colspan="2">How does it work?</td></tr>
<tr><td colspan="2"></td><td colspan="2"></td></tr>
</table>

| | |
|---|---|
| Connection to district heating network. Apartment buildings use return pipe as a heat source with heat pump, in addition to the normal connection to the supply side. The grocery store feeds excess heat from refrigeration to supply. | District heating connects is usually used so that the heat only-boiler or combined heat only-boiler feeds heat into the network and consumers are connected by heat exchangers between heating water circuit in the building and primary circuit, i.e. the one which consists of underground DH pipes between heat production and buildings. The heat in common solution is taken from supply side and the cooled flow is fed on the return pipe.<br>In this case also return pipe heat is used, mainly by heat pump that increases the temp so that it is suitable for heatinf and domestic hot water. In addition, in milder weather excess heat is fed from the building (grocery store) to the DH network. The prequisite is that supply temp is below about 85 C, which may take in about 0 degrees outside. |
| **Stakeholder Analysis** | |
| Developer (if relevant) Who has developed this solution? | DH in general many developers e.g. in Finland from 60's on. Return pipe and excess heat supply e.g. Oulu Energy, Jetitek, GST and Arina. |
| Operator Who is operating this solution? | Oulu Energy |
| Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution? | Heat customer, i.e. the owner of the building. Also the energy company and with that all the customers can benefit from the solution. |
| Implementer Who is implementing this solution? | Oulu Energy |
| Financer How / By whom has the implementation of this solution been financed? | Oulu Energy |
| Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution? | Jetitek and GST (heat pump suppliers), Arina (grocet store chain), Sivakka (rental housing company), YIT (construction company), inhabitants. |
| **Revenue Streams/ Monetized Value** | |
| | |
| **Integration with other smart solutions** | **BARRIERS / ENABLERS _ PESTEL STUDIES** |
| Good with especially those heat production methods, which benefit from economics of scale, like CHP, industrial excess heat, waste combustion, even small nuclear reactors. In more general, always when somebody has excess heat and the other need for it. | Political: May be seen as old-fashioned or vice versa, depending on the country and observer. Requires some central planning.<br>Economic: Expensive to implement. High capital cost and risk of getting customers and keeping them. However, cheap energy sources can be used, i.e. low operating cost.<br>Social: Price setting, its variability, depends on the markets. If the system has different kind of production methods (e.g. CHP and heat pumps with high capacity), the price may be quite stable.<br>Technical: Well-known pratices, but also some new solutions exist.<br>Environmental: Varies a lot. If properly set with a multiple set of energy sources, a flexible and environmentally sound system, potentially the best one. But can be also the opposite, in extreme when burning coal directly to heat (which is however nearly non-existent in Finland currently). |

| | |
|---|---|
| | Legal: Techno-economically it is of advantage to have obligatory joining to the network, but this of course is a reason for complaints and dissatisfaction. Generally legal issues are well arranged, with a lot of experience, in Nordic countries. |
| **Potential for Replication** | **Expected Impacts - Benefits** |
| Exists in practically all larger towns and cities in e.g. Finland, Sweden and Denmark. Replicability from scratch may involve quite high economical risk, but is technically generally possible especially when the heating need is large enough (peak load hours e.g. >2000/a) and heat consumption over round 2 MWh/a/pipe-m. | General aspects about the solution.Could be technical, economical, environmental, social |
| **Relevant Publications / Presentations / Services / Products to this Solution** | |
| | |
| **Reference Applications of this Solution** | |
| | |

## S13a CO2 based heat pump

| SPEC CARD | SYSTEM INTEGRATION SOLUTIONS | | |
|---|---|---|---|
| | Category 3<br>INTEGRATED INFRSTRUCTURES | | |
| | Solution 13<br>Heat Pumps | | |
| Title | Graphical Detail | | |
| S13a $CO_2$ based heat pump |   | | |
| | General Data for the solution in bullets | | |
| City / Country | Making_City | Technical Partner Name & contact Details | |
| | Yes | Jetitek, Arina | |
| Implementation Time | 2019 | Initial Investment | |

| What is Solution? | How does it work? |
|---|---|
| Refrigeration machines of the grocery store, which can also supply heat to district heating network. | Carbon dioxide is used as refrigerant, instead of F-gases.<br>The advantage of CO2 as a refrigeant is that it allows high temperature difference between source and sink, with moderate coefficient of performance, i.e. the ratio beween output heat and input electricity. The hot gas coming from compressor is cooled down gradually (due to its transcritical state), which allows different temperatures taken out of the flow.<br>Even if the carbon dioxide is a greenhouse gas, the warming effect of per mass unit is significantly lower than that of F-gases. This has importance, if there are leakages in the cooling system. |

| Stakeholder Analysis | |
|---|---|
| Developer (if relevant) Who has developed this solution? | Jetitek, among the others |
| Operator Who is operating this solution? | Arina |
| Customer(s) or user(s) Who is this solution targeting ? For instance, who | The store owner, Arina in this case |

| | |
|---|---|
| is saving energy thanks to the implementation of this solution? | |
| Implementer Who is implementing this solution? | Jetitek |
| Financer How / By whom has the implementation of this solution been financed? | Arina |
| Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution? | When excess heat is fed into the district heating network, the energy company and its customers |
| **Revenue Streams/ Monetized Value** | |
| | |
| **Integration with other smart solutions** | **BARRIERS / ENABLERS _ PESTEL STUDIES** |
| Distict heating network required to deliver the heat | Political: As an energy-saving concept supported by common policy<br>Economic: A bit more expensive than system based on F-gases, but pays off rather quickly<br>Social: No significant impacts<br>Technical: CO2-refrigeration is an old system in principle, but only recently it has been developed to reliable level. E.g. high pressures must be taken into account.<br>Environmental: Many benefits, no major barriers<br>Legal: Legislation favours CO2 refrigeration, as F-gases get more and more restrictions |
| **Potential for Replication** | **Expected Impacts - Benefits** |
| Very high potential, can be applied in principle to all stores, which need refrigeration equipment | Lower electricity consumption for cooling, possibility to feed the excess heat to DH network |
| **Relevant Publications / Presentations / Services / Products to this Solution** | |
| | |
| | |
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| **Reference Applications of this Solution** | |
| | |
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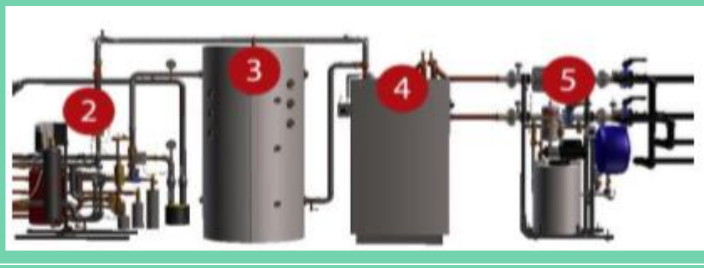
| | |

## S13b Advanced Heat Pump (high COP)

| SPEC CARD | SYSTEM INTEGRATION SOLUTIONS<br>Category 3<br>INTEGRATED INFRSTRUCTURES<br>Solution 13<br>Heat Pumps | | |
|---|---|---|---|
| Title | Graphical Detail | | |
| S13b Advanced Heat Pump (high COP) |  <br>- Exhaust air heat pump<br>-The system has also heat exchanger from DH network<br>- Heat factor (output/input) is about 4 | | |
| City / Country | Making_City | Technical Partner Name & contact Details | |
| | Yes | Oulu Energy / Sivakka | |
| Implementation Time | 2019-2020 | Initial Investment | About 2000 euros / heat-kW |



| What is Solution? | How does it work? |
|---|---|
| Exhaust air (multi-source) heat pump | Heat is gained from exhaust air, which is extracted mechanically, using fans, from bathrooms, toilets and kitchens. This is a commonplace solution in Finland. In new buildings the heat in exhaust air is recovered by air-to-air heat exchanger to incoming fresh air, but if that system lacks in existing buildings, it is expansive to install afterwards. Therefore it may make sense to take the heat out of the exhaust air with heat pump (HP) and increase the temperature so that it can be used for heating and domestic water (min. 55 C for DHW). Here this kind of HP is implemented. The system is modular, i.e. built using modules, which are easy to install and replace when needed. The whole installation includes also the heat exchanger from DH network together with HP. The system optimizes the parallel use of these sources.<br>Coefficient of performance (COP) is around 4, when heating water from 10 to 60 C and air source has a temperature of 20 C. |
| **Stakeholder Analysis** | |
| Developer (if relevant) Who has developed this solution? | Many developers |
| Operator Who is operating this solution? | Oulu Energy / Sivakka |

| | |
|---|---|
| Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution? | Owners of all the buildings, which do not have exhaust air heat recovery already |
| Implementer Who is implementing this solution? | Oulu Energy / Sivakka |
| Financer How / By whom has the implementation of this solution been financed? | Oulu Energy / Sivakka |
| Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution? | The tenants, even if they will probably notice at all that this has been installed. If the solution is feasible, the rents can be kept moderate and stable. |
| **Revenue Streams/ Monetized Value** | |
| | |
| **Integration with other smart solutions** | **BARRIERS / ENABLERS _ PESTEL STUDIES** |
| No obligatory other solutions in connection with this, but in this case HP is used together with DH | Political: Politically favourable, as potentially decrease the energy consumption and emissions<br>Economic: Pay-back time may be quite long, especially in system level. However, if properly implemented and used, feasible investment in long term.<br>Social: No significant impact. May help to keep the living cost tolerable.<br>Technical: Readily available technology, even if there are still details which can be still improved. In this case the target is a turn-key delivery.<br>Environmental: Depends on the ratio of emissions from electricity (for HP) and the alternative heating method. Especially when used as a "smart", i.e. timely flexibly used component, potentially decreases the emissions. |
| **Potential for Replication** | **Expected Impacts - Benefits** |
| Very high potential for replication. Suitable for all buildings, which have no heat recovery from exhaust air and more or less centralized exhaust air outtake. | Decreases the net energy consumption by e.g. 40%. But, heat is partly replaced by electricity use, so the total benefit depends on the ratio of values of heat and electricity. |
| **Relevant Publications / Presentations / Services / Products to this Solution** | |
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| | |
| | |
| **Reference Applications of this Solution** | |
| | |
| | |
| | |

## S13c Acoustic Air Heat Pump*

This SPEC card will be finalized in the final version of this deliverable

## S13d Acoustic Hybrid heat pump*

This SPEC card will be finalized in the final version of this deliverable

## S13e Geothermal Heat Pump*

This SPEC card will be finalized in the final version of this deliverable

## S14a PV in roofs and parking lot*

This SPEC card will be finalized in the final version of this deliverable

## S14b Building Integrated PV (on the facade)

<table>
<tr><td rowspan="3">SPEC CARD</td><td colspan="3">SUPPLY SIDE SOLUTIONS</td></tr>
<tr><td colspan="3">Category 4<br>RENEWABLE ENERGY SYSTEMS</td></tr>
<tr><td colspan="3">Solution 14<br>Solar PV Panels</td></tr>
<tr><td>Title</td><td colspan="3">Graphical Detail</td></tr>
<tr><td>S14b Building Integrated PV (on the facade)</td><td colspan="3"> On the left PV panel placement on Sivakka building, on the right other examples from Northern Finland <br>Southern facade covered by vertical solar panels</td></tr>
<tr><td>City / Country</td><td>Making_City</td><td colspan="2">Technical Partner Name & contact Details</td></tr>
<tr><td></td><td>Yes</td><td colspan="2">Sivakka</td></tr>
<tr><td>Implementation Time</td><td></td><td>Initial Investment</td><td></td></tr>
<tr><td colspan="2">What is Solution?</td><td colspan="2">How does it work?</td></tr>
<tr><td colspan="2"></td><td colspan="2"></td></tr>
</table>

| | |
|---|---|
| An apartment house from 70's has its southern facade covered with PV panels. | When maximising the production of solar, also vertical planes should be used. This gives not only more area, but also a favourable monthly gain of solar power. In Nordic climate enrgy is needed most in the wintertime or, with in this case better definition, outside summertime. Vertical panels may have e.g. 10% lower annual total gain than the "usual ones" with 45...60 degrees angle, but especially in springtime the production of vertical planes may be even manifold compared to angled ones. |
| **Stakeholder Analysis** | |
| Developer (if relevant) Who has developed this solution? | Many developers |
| Operator Who is operating this solution? | Sivakka |
| Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution? | Sivakka or building owner in general |
| Implementer Who is implementing this solution? | Oulu Energy and Sivakka |
| Financer How / By whom has the implementation of this solution been financed? | Oulu Energy and Sivakka |
| Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution? | If the solution is feasible, finally the tenants benefit from this. |
| **Revenue Streams/ Monetized Value** | |
| | |
| **Integration with other smart solutions** | **BARRIERS / ENABLERS _ PESTEL STUDIES** |
| If own consumption can be directed towards solar production, especially so that the peak loads are cut, it gives additional advantage | Political: Subsidies available in many countries, i.e. PV has political support<br>Economic: Long pay-back time<br>Social: Positivie and visible image from panels<br>Technical: Fastening the panels to the vertical plane requires some special attention, but if skilfully done, no special barriers<br>Environmental: Vertical installation is advantageous in terms of system impact and emission reduction (more production in cold seasons)<br>Legal: No major issues |
| **Potential for Replication** | **Expected Impacts - Benefits** |
| | |
| **Relevant Publications / Presentations / Services / Products to this Solution** | |
| | |
| | |

## S14c Floating Solar pontoons*

This SPEC card will be finalized in the final version of this deliverable

## S14d Solaroad

<table>
<tr><td rowspan="3">SPEC CARD</td><td colspan="3">SUPPLY SIDE SOLUTIONS</td></tr>
<tr><td colspan="3">Category 4<br>RENEWABLE ENERGY SYSTEMS</td></tr>
<tr><td colspan="3">Solution 14<br>Solar PV Panels</td></tr>
<tr><td>Title</td><td colspan="3">Graphical Detail</td></tr>
<tr><td rowspan="2">S14d<br>Solaroad</td><td colspan="3"></td></tr>
<tr><td colspan="3">General Data for the solution in bullets</td></tr>
<tr><td>City / Country</td><td>Delft</td><td colspan="2">SolaRoad BV, www.solaroad.nl</td></tr>
<tr><td></td><td>Yes/No</td><td colspan="2"></td></tr>
<tr><td>Implementation Time</td><td>months</td><td>Initial Investment</td><td></td></tr>
</table>

| What is Solution? | How does it work? |
|---|---|
| SolaRoad's products are based on a simple concept. Robust solar panels with a skid resistant, translucent coating are mounted on a concrete slab. The concrete provides support and loading capacity, the solar panel generates electricity from the sunlight, the coating protects the solar panel, and offers skid resistance for the traffic. The combination is a robust road surface, offering safety and comfort to bikes or vehicles, | through the integration of photovoltaic material in a road element, covered with a friction providing transparent coating renewable energy is produced. The PV modules are connected to micro inverters which ensure safety, shading tolerance and optimal yield. The electricity is transported to connection boxes where it is either fed back into the grid or can be used locally. This depends on the application. |

| | |
|---|---|
| while harvesting electricity from the sun. | |
| **Stakeholder Analysis** | |
| Developer (if relevant) Who has developed this solution? | Road authority |
| Operator Who is operating this solution? | N/A |
| Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution? | Road authority |
| Implementer Who is implementing this solution? | road construction company |
| Financer How / By whom has the implementation of this solution been financed? | Road authority |
| Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution? | |
| **Revenue Streams/ Monetized Value** | |
| the renewable energy generated can either be sold on the energy market, or used to reduce the energy costs of the owner. | |
| **Integration with other smart solutions** | **BARRIERS / ENABLERS _ PESTEL STUDIES** |
| the combination with the electrification of transport is highly appealing. (the combination with smart charging for instance). | Political: What is the value of integration? (this solution is non0-invasive). The market is a governmental market. A steady market growth is crucial for investors to further develop this concept.<br>Economic: investment cost must, and will decrease when volume grows.<br>Social: the fact that is is perfectly integrated (instead of other renewables) makes that there is a high social acceptance.<br>Technical: durability is still under research. the concept itself is proven.<br>Environmental: The product is under development, amongst others to increase the EOL scenario of the solution<br>Legal: for (very) large scale applications the energy production by road authorities might become an issue. |
| **Potential for Replication** | **Expected Impacts - Benefits** |
| system is installed in 2014 in Krommenie, since then multiple projects in the Netherlands and France are realized. | General aspects about the solution. Could be technical, economical, environmental, social |

## S15a Hybrid Heat collector (high pressurised CO2) *

This SPEC card will be finalized in the final version of this deliverable

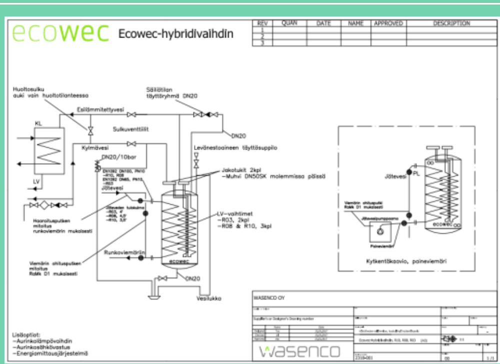
## S15b PVT Panels*

This SPEC card will be finalized in the final version of this deliverable

## S16a Geothermal energy*

This SPEC card will be finalized in the final version of this deliverable

## S17a Heat recovery system from AC and sewage water

| SPEC CARD | SUPPLY SIDE SOLUTIONS<br>Category 4<br>RENEWABLE ENERGY SYSTEMS<br>Solution 17<br>Waste Heat Recovery | | |
|---|---|---|---|
| Title | Graphical Detail | | |
| S17a Heat recovery system from sewage water |   <br>- Heat recovery from wastewater in apartment buildings<br>- Passive system without heat pump<br>- Intermediate, protective water layer between sewage and fresh water | | |
| City / Country | Making_City | Technical Partner Name & contact Details | |
| | Yes | Sivakka | |
| Implementation Time | 2019-2020 | Initial Investment | |
| What is Solution? | | How does it work? | |
| Heat recovery from wastewater to pre-heat cold water for hot tap water | | Sewage water from apartments is led through a large-diameter pipe spiral, which is in the water tank. In the tank there is another heat exchanger, from the tank water to fresh, incoming water, for hot tap water pre-heating. The whole installation is made of stainless steel. The tank with exchanger inside is located in the lowest point of the sewage system in the building, to avoid pumping.<br>The efficiency of the recovery is about 20%. In other words, the incoming water is heated by about 10 degrees. | |
| Stakeholder Analysis | | | |

| | |
|---|---|
| Developer (if relevant) Who has developed this solution? | Wasenco |
| Operator Who is operating this solution? | Sivakka |
| Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution? | Building owner |
| Implementer Who is implementing this solution? | Building owner |
| Financer How / By whom has the implementation of this solution been financed? | Building owner |
| Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution? | "Invisible" solution but if it works properly, finally the tenants get an advantage, in addition to environmental gains |
| **Revenue Streams/ Monetized Value** | |
| | |
| **Integration with other smart solutions** | **BARRIERS / ENABLERS _ PESTEL STUDIES** |
| Not necessarily need to have other solutions in place | Political: Promotes energy efficiency and is thus politically supported<br>Economic: Long pay-back time, about 20 years, but also a long lifetime<br>Social: No major barriers/enablers<br>Technical: Simple and robust design, movable parts minimised<br>Environmental: Saves about 20% of hot tap water heating energy<br>Legal: No major barriers. Tight energy regulation gives benefit to also this kind of solutions. |
| **Potential for Replication** | **Expected Impacts - Benefits** |
| Moderate potential. Requires space under the building (height about 2 m). Sewage system must be arranged so that as many as possible sewage branches are collected to one point, in which the heat recovery device can be installed. | About 20% energy savings in domestic hot water heating. |
| **Relevant Publications / Presentations / Services / Products to this Solution** | |
| | |
| | |
| | |
| | |
| | |
| **Reference Applications of this Solution** | |
| Wasenco Oy | http://wasenco.com/ecowec-hybridivaihdin_ottaa_lammon_talteen_jatevedesta/ |
| | |

## S17b Heat recovery system from return pipeline to DHW

| SPEC CARD | SUPPLY SIDE SOLUTIONS | | |
|---|---|---|---|
| | Category 4<br>RENEWABLE ENERGY SYSTEMS | | |
| | Solution 17<br>Waste Heat Recovery | | |
| Title | Graphical Detail | | |
| S17b Heat recovery system from return pipeline to DHW | - District heating return water is cooled down with a heat pump and the heat used for space and domestic hot water heating<br>- Advantage depends on the overall DH system. May be feasible, if there is CHP, solar heat, heat pumps and/or flue gas scrubber in the system. All these benefit from lower return temperature. | | |
| **City / Country** | **Making_City** | **Technical Partner Name & contact Details** | |
| | Yes | Sivakka | |
| **Implementation Time** | Year 2020. | **Initial Investment** | Ordinary DH exchanger round 3000-10000 euros, DH pipe construction underground > 100 e/m. Heat pump very roughly round 500 euros/heat-kW. |
| What is Solution? | How does it work? | | |
| Ordinary DH exchanger round 3000-10000 euros, DH pipe construction underground > 100 e/m. Heat pump very roughly round 500 euros/heat-kW. | Heat pump in the DH return side increases the water temperature to suitable level for space and hot tap water heating. Temperature lift is low (under 20 degrees), which may give COP of e.g. 6, i. e. very high.<br>The connection can be done either by cooling the return flow in the secondary circuit inside the building or district heating water in the primary circuit, which connects heat production and buildings together. Primary circuit connection (so-called three-pipe installation) gives the most advantage, but requires more work in especially existing buildings. | | |
| Stakeholder Analysis | | | |
| Developer (if relevant) Who has developed this solution? | Many developers | | |
| Operator Who is operating this solution? | Oulu Energy | | |

| | |
|---|---|
| Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution? | Building owner and the whole system |
| Implementer Who is implementing this solution? | Oulu Energy |
| Financer How / By whom has the implementation of this solution been financed? | Oulu Energy |
| Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution? | "Invisible" for inhabitants, but if works well, the whole system gets benefit. |
| **Revenue Streams/ Monetized Value** | |
| | |
| **Integration with other smart solutions** | **BARRIERS / ENABLERS _ PESTEL STUDIES** |
| Requires DH system and certain elements in the production side to be at its best. See "Expected impacts". | Political:<br>Economic:<br>Social:<br>Technical:<br>Environmental:<br>Legal: |
| **Potential for Replication** | **Expected Impacts - Benefits** |
| Applicable in many DH heated buildings, but suitability to system-specific properties must first be studied. | The solution is the more feasible, the more there are the following in the DH system:<br>- CHP plant. Increases the electricity production due to the lower condensing temperature (which partly compensates the electricity used by heat pump)<br>- Heat pump. Coefficient of performance increases, i.e. electricity consumption decreases, when the incoming water is cooler.<br>- Flue gas scrubber. Cooler return water cools the flue gas to lower temperature, which means that extra heat is gained to DH water.<br>- Solar heat. Lower incoming water temperature to solar collector means more solar gain per m2.<br>- Industrial waste heat. The lower is the incoming water temperature, the higher is usually the waste heat potential.<br>- Bottlenecks in the DH network. Decreasing the return water temperature increase the temp difference between supply and return and thus increases the pipe heat transfer capacity. |
| **Relevant Publications / Presentations / Services / Products to this Solution** | |
| | |
| **Reference Applications of this Solution** | |
| Wasenco Oy | [http://wasenco.com/ecowec-hybridivaihdin_ottaa_lammon_talteen_jatevedesta/](http://wasenco.com/ecowec-hybridivaihdin_ottaa_lammon_talteen_jatevedesta/) |

## S18a Integrated Sustainable Energy Planning

<table>
<tr><td rowspan="3">SPEC CARD</td><td colspan="3">NON-TECHNICAL SOLUTIONS</td></tr>
<tr><td colspan="3">Category 5<br>POLITICAL, SOCIAL, ECONOMICAL INTERVENTIONS</td></tr>
<tr><td colspan="3">Solution x<br>Policy Innovation</td></tr>
<tr><td>Title</td><td colspan="3">Graphical Detail</td></tr>
<tr><td rowspan="2">S18a<br>Integrated Sustainable Energy Planning</td><td colspan="3">INTENSSS PA<br>Integrated Sustainable Energy Planning</td></tr>
<tr><td colspan="3">> Holistic thinking: sustainable energy provision with pursuit of alternative regional ambitions and developments<br>> Integration: improved integration of spatial planning and energy planning to overcome sectorial divided planning<br>> Area-based: sensitive to regional and local conditions (e.g. local resources, institutional conditions, demand etc.)<br>> Societal engagement: bottom-up approach engaging key regional stakeholders and community driven<br>> Knowledge driven: locally appropriate technologies for production and efficiency while matching supply and demand</td></tr>
<tr><td>City / Country</td><td>Making_City</td><td colspan="2">Technical Partner Name & contact Details</td></tr>
<tr><td></td><td>Yes</td><td colspan="2">11 RUG - c.zuidema@rug.nl</td></tr>
<tr><td>Implementation Time</td><td>2 years</td><td>Initial Investment</td><td>depends</td></tr>
<tr><td colspan="2">What is Solution?</td><td colspan="2">How does it work?</td></tr>
<tr><td colspan="2">Integrated sustainable energy planning, presented as a holistic approach to combining spatial planning with the pursuit of a more sustainable (i.e. renewables based and efficient) energy system. ISEP is a plan developed based on a distinct approach to decision making including an area-based approach to identify local synergies between alternative societal challenges and ambitions, and explicitly means to be based on a wide inclusion of a variety of public and private stakeholders.</td><td colspan="2">Integrated sustainable energy planning requires cross-sectoral working and network governance due to the variety of social and economic stakeholders involved. It is supported by a specific protocol for making decisions, which is accessible as appendix.</td></tr>
<tr><td colspan="4">Stakeholder Analysis</td></tr>
<tr><td colspan="2">Developer (if relevant) Who has developed this solution?</td><td colspan="2">INTENSSS-PA project; (Dr. C. Zuidema)</td></tr>
</table>

| | |
|---|---|
| Operator Who is operating this solution? | Appplied in seven EU regional Living Labs (Groningen (NL), Middelfart (DK), Zemkale (LV), Pomurje (Slo), Karditsa (Gr), Reggio Calabria (It), Casilla y Leon (Sp)) |
| Customer(s) or user(s) Who is this solution targeting? For instance, who is saving energy thanks to the implementation of this solution? | Seven EU regions |
| Implementer Who is implementing this solution? | Seven EU regions |
| Financer How / By whom has the implementation of this solution been financed? | EU Horizon 2020 |
| Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution? | Designer: INTENSSS-PA project; (Dr. C. Zuidema) |
| **Revenue Streams/ Monetized Value** | |
| | |
| **Integration with other smart solutions** | **BARRIERS / ENABLERS _ PESTEL STUDIES** |
| This is a non-technical solution and essentially helps organize a structured process for energy policy making in regions and cities. It links directly with planning procedures and uses key elements of a living lab approach (co-creation, experiential learning and interactive policy making). Explicitly identifies and aims to use various renewable energy and energy efficiency technologies. | **Political:** B: short term focus (4 years political cycles), limited willingness (due to short term cost, long term benefits)<br>**E:** leadership of aldermen, coalitions with key stakeholders to create continuity<br>**Economic:** B: limited government resources, population decline, poverty (lack of investment opportunities for individuals), short term thinking, uncertainties technological development<br>**E:** dropping prices renewable technologies, synergetic effects between alternative activities (notably agriculture, transport and energy), government backed loans<br>Social: B: social resistance, lack of awareness, energy poverty,<br>**E:** growing social support for renewables, link energy to other issues (e.g. comfort, liveability, financial gain & savings), co-creation in an open setting, create mutual narrative of the future of a place<br>**Technical:** -<br>**Environmental:** -<br>**Legal:** B: lack of legal competences of local governments, inflexibility of policies for allowing novel technologies, fragmentation of regulations<br>**E:** subsidies, feed in tariffs, legal experimental room (pilots) |
| **Potential for Replication** | **Expected Impacts - Benefits** |
| Easy to replicate as a conceptual approach, but will vary in its detailed manifestation within each different locality. | The approach allows for identifying synergies and trade-offs betwene varous energy and non-energy related objectives. In doing so, it can make smart use ofr a variety of governmental (scetoral) budgets, attractc private investments and create societal benefits beyond the mere pursued of renewable energy targets. |
| **Relevant Publications / Presentations / Services / Products to this Solution** | |
| Giannouli et al. (2018) | Giannouli,I., C.Tourkolias, C. Zuidema, A. Tasopoulou, S. Blathra, K. Salemink, K. Gugerell, P. Georgiou, T. Chalatsis, C. Christidou, V. Bellis, N. Vasiloglou, N. Koutsomarkos (2018) A methodological approach for holistic energy planning using the living lab concept: the case of the prefecture of Karditsa, European Journal of |

| | |
|---|---|
| | Environmental Sciences, Vol.8, No.1, DOI: 10.14712/23361964.2018.3 |
| Giannouli et al. (2017) | Giannouli, I. , C. Christidou, A. M. Marinero Peral , S. Cantero Celada, J. L. de las Rivas Sanz , M. Fernández Maroto, C. Zuidema, K. Salemink , K. Gugerell, S. Blathra, K. Leonhart Petersen, A. Tasopoulou, A. Papaioannou , N.Koutsomarkos A Co-planning Approach for Area-Based Holistic Energy Planning: The Experience of INTENSSS-PA project, Proceedings of the international conference Changing Cities III. http://www.intensspa.eu/wp-content/uploads/2018/02/INTENSSSPA_paper_CCIII_140517_AC.pdf |
| Report 'Area Based Integrated Sustainable Energy Planning Concept' | http://www.intensspa.eu/wp-content/uploads/2018/11/D3.2_INTENSSS_PA_v1_1.pdf |

## S18b Land use planning fostering energy actions

| SPEC CARD | NON-TECHNICAL SOLUTIONS<br>Category 5<br>POLITICAL, SOCIAL, ECONOMICAL INTERVENTIONS<br>Solution x<br>Policy Innovation | |
|---|---|---|
| Title | Graphical Detail | |
| S18bLand use planning fostering energy actions | <br>Picture source: City of Oulu/Department of Urban Planning/Hiukkavaara Center<br>> Land use planning is portrayed as a tool to foster energy actions<br>> Integration: land use planning is considered as a capacity to integrate the aims of the city, energy network operators, private developers and citizens<br>> Knowledge driven: assessments and surveys produced during land use planning process can be utilized to generate knowledge about energy opportunities<br>> Societal engagement: participatory planning process can be utilized for energy-related participation<br>> Implementability: bridges energy targets and implementation | |
| City / Country | Making_City | Technical Partner Name & contact Details |
| | No | 14/UOU/Sari Hirvonen-Kantola (sari.hirvonen-kantola@oulu.fi) |

| Implementation Time | 1-10 years | Initial Investment | Public land |
|---|---|---|---|
| **What is Solution?** | | **How does it work?** | |
| Cities can utilize land use planning as a tool to foster energy actions, by adopting the integrative urban development approach. The integrative approach takes the development aspirations of all the PED stakeholders as a starting point of land use planning, and creatively develops them further to discover mutual gains. In strategic land use planning opportunities can be explored together with energy companies, enterprises, citizens and other relevant stakeholders. | | City of Oulu utilized a district-level structural scheme for Hiukkavaara area and iterative planning process to facilitate discussions and explore opportunities for energy actions with the energy company and construction companies. To establish advantages, Hiukkavaara area was profiled as a sustainable winter city with innovative energy solutions. In Hiukkavaara center area, the city of Oulu utilized innovative plot lease and conveyance for innovation procurement of energy solutions from construction and development companies. Opportunities have been exploited in detailed plans that juridically enable implementation of building projects, including energy actions. The cities then can build advantage by profiling areas suitable for implementing energy actions. For exploiting these opportunities for implementation, the cities can utilize detailed land use planning. | |
| **Stakeholder Analysis** | | | |
| Developer (if relevant) Who has developed this solution? | | INURDECO-project (University Oulu, City of Oulu) | |
| Operator Who is operating this solution? | | The City | |
| Customer(s) or user(s) Who is this solution targeting ? For instance, who is saving energy thanks to the implementation of this solution? | | Property owners, residents | |
| Implementer Who is implementing this solution? | | Energy companies, energy solution providers, construction and development companies | |
| Financer How / By whom has the implementation of this solution been financed? | | The City, construction and development companies, energy companies, property owners, residents | |
| Other impacted stakeholder(s) (if relevant) Who else is impacted by the deployment of this solution? | | | |
| **Revenue Streams/ Monetized Value** | | | |
| | | | |
| **Integration with other smart solutions** | | **BARRIERS / ENABLERS _ PESTEL STUDIES** | |
| Land use planning can be used as a tool to integrate solutions and implement them in specific locations and in collaboration with digital platforms utilizing location intelligence. | | Political:<br>Economic:<br>Social:<br>Technical:<br>Environmental:<br>Legal: | |
| **Potential for Replication** | | **Expected Impacts - Benefits** | |
| Easy to replicate as a conceptual approach, but will vary in its detailed | | The approach allows for identifying synergies and trade-offs betwene varous energy and non-energy related objectives. In doing so, it can make smart use ofr a variety of governmental (scetoral) | |

| | |
|---|---|
| manifestation within each different locality. | budgets, attractc private investments and create societal benefits beyond the mere pursued of renewable energy targets. |
| **Relevant Publications / Presentations / Services / Products to this Solution** | |
| Hirvonen-Kantola, S., Ahokangas, P., Iivari, M., Heikkilä, M., & Hentilä, H-L. (2015). Urban development practices as anticipatory action learning: Case Arctic Smart City Living Laboratory. Procedia Economics and Finance, 21, 337–345. Available at: https://www.sciencedirect.com/science/article/pii/S221256711500 | |
| **Reference Applications of this Solution** | |
| Hiukkavaara area, Oulu, Finland | |