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D4.3 - Analysis of FWC candidate areas to become a PED

WP4, Task 4.2

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Table of content

List of figures

List of tables

Abbreviations and acronyms

Acronym	Description
GIS	Geographical Information System
ISUDS	Integrated Sustainable Urban Development Strategies
LU	Land Use
MCDA	Multi-Criteria Decision Analysis
PEB	Positive Energy Blocks
PED	Positive Energy District
PESTEL	Political, Economic, Social, Technological and Legal
PV	Photovoltaic
RA	Resource Availability
RES	Renewable Energy
SCC	Smart Cities and Communities
SEAP	Sustainable Energy Action Plan
SECAP	Sustainable Energy and Climate Action Plan
SET	Strategic Energy Technology
SS	Social Structure
TPI	Technical Physical Infrastructure
UM	Urban Macroform
VI	Virtual infrastructure
WP	Work Package

Executive Summary

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

Taking into account this definition, deliverable 4.3 *Analysis of FWC candidate areas to become a PED*, studies the potential of the areas preselected by MAKING-CITY follower cities at proposal stage to reach an annual positive non-renewable energy balance. This work has been carried out within the task 4.2 *Selection of areas to design PED in six follower cities* and is based on the work done in task 4.1 *Methodology/guidelines for PED design*.

The method defined to identify candidate areas to become positive in terms of energy is a GIS-conducted method that is supported by the information collected through a multicriteria questionnaire developed specifically for standardizing the process and the criteria considered in all the cities. The methodology takes into account both the physical and technical characteristics of the cities at city level or macro-scale, together with socio-economic, environmental, legal and regulatory issues, and allows the adaptation of the analysis to cities' characteristics.

Results show the suitability of preselected areas to reach an annual positive non-renewable energy balance in Bassano del Grappa (Italy), Kadiköy (Turkey), León (Spain), Lublin (Poland), Trencin (Slovakia) and Vidin (Bulgaria). In most of the cases, preselected districts include some areas with suitable potential to become positive, while others will need higher efforts to convert them towards becoming positive. Therefore, and following the PED definition, the exact size of the areas to be selected does not necessarily coincide with the official limits of existing district.

The PED selection work presented will serve as a basis for a more detailed or micro analysis of the chosen areas, work which will be carried in the following tasks of MAKING-CITY project before defying the technological solutions for the conversion.

Keywords

Smart Cities, Positive Energy Districts (PED), Geographical Information System (GIS), Multi-Criteria Decision Analysis (MCDA), Macro scale analysis.

1 Introduction

The potential for large energy savings in the building stock has long been recognized, and different policies have been put in place for achieving those savings at European Level. From the original Energy Performance of Buildings Directive (EPBD) in 2002, when more strict building regulations and energy certification schemes were introduced, the policies have evolved towards the requirement of "nearly zero energy building", in the EPBD 2010 update, where it is defined as "*a building that has a very high energy performance. The nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby*". This directive already required that calculation of energy performance in buildings should look at district heating or cooling solutions, as they can have potential benefits for the buildings' performance. The amendment of EPBD Directive in 2018, included no additional requirements to evaluate district level energy performance, although it does state that the Commission should review the EPBD before January 2026, to *"examine in what manner Member States could apply integrated district or neighbourhood approaches in Union building and energy efficiency policy".*

In the meantime, there are different EU initiatives promoting strategies and technologies for improving energy efficiency and increasing renewable energy at district level. For example the Strategic Energy Technology (SET) Plan Action 3.2, *"Energy Districts and Neighbourhoods for Sustainable Urban Development"* aims to support the planning, deployment and replication of 100 Positive Energy Neighbourhoods by 2025. A number of Horizon 2020 research projects such as MAKING-CITY, also aim to achieve Positive Energy Districts (PEDs) in "Lighthouse" cities, and support "follower cities" to replicate the experience.

In this context, this deliverable intends to support the cities of Bassano (Italy), Kadiköy (Turkey), Leon (Spain), Lublin (Poland), Trencin (Slovakia) and Vidin (Bulgaria), on the selection of areas within the cities with potential to become PED, as one necessary preliminary step towards planning and realization of PEDs. This document describes the methodology applied for the selection of city areas or districts where there is a greater potential, or a greater benefit, of developing a PED. It also presents the results of the application of the methodology on these cities.

As it will be explained in the following sections, the applied methodology takes into account both the physical and technical characteristics of the cities, together with socio-economic, environmental, legal and regulatory issues. Methodology draws from GIS data for the different aspects, which is collected and processed in order to have a detailed perspective of the different city areas. The criteria and preferences from the involved city officials are also accounted for, as there is an important prioritization step where the relative importance different aspects must be weighted. The applied methodology is therefore adjusted for each case, and its application process and obtained results varies considerably from city to city.

The work carried for selection of PEDs, which results are presented in this deliverable, intends to complement and enrich the initial work by the cities for the pre-selection of potential areas for PED development, which was carried when developing the MAKING-CITY research proposal (2019). The PED selection work presented will serve as a basis for a more detailed analysis of the chosen areas, work which will be carried in the following tasks of MAKING-CITY project.

1.1 Purpose and target group

The purpose of task 4.2 is to validate the suitability of the districts preselected by the follower cities to become positive. Therefore, the target group of task 4.2 are the follower cities as it is shown in Table 1.

Bassano del Grappa	Kadiköy	León	Lublin	Trenčín	Vidin

Table 1: Target group

1.2 Contribution partners

Table 2 summarizes the contributing partners to the study included in this report and their responsibilities.

Partner	Method definition	Data providers	Data treatment	Case studies	Validation	Deliverable description
Tecnalia	✓		✓	✓	✓	✓
Demir	✓		✓	✓	✓	✓
Bassano del Grappa		✓		✓	✓	
Kadiköy		✓		✓	✓	
León		✓		✓	✓	
Lublin		✓		✓	✓	
Trenčín		✓		✓	✓	
Vidin[1]		✓		✓	✓	
Cartif					✓	

Table 2: Contribution partners

1.3 Relation to other activities in the project

The herein presented report, related to the analysis of candidate areas to become a PED, is tightly connected to the work being done in WP1, in which the City vision 2050 is being developed. The City Vision indeed depends in part on the potential feasibility of the cities to create and develop PEDs within their cities. For this purpose, the first step is to define the grounds for the definition and identification of the candidate areas, which is the work that will be presented here, and which will indeed use in part,

[1] Municipality of Vidin and Green Synergy Cluster

the information developed in WP1 (i.e. the shape with the energy demand of the city developed in Enerkad, the study about the prioritization and replication of the PED solutions, etc.).

Thus for the reasons mentioned above WP1 and WP4 and strongly linked one to the other. The relation to WP2 and WP3, comes from the fact that important conclusions are being and will be able to obtain from the LHCs' real implementations and work being done focused on the PEDs construction.

2 Positive Energy Districts Concept

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 Blocks2 (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 urbanisation3.

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 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.

2.1 Definition and scope of PED

JPI Urban Europe[2] defined PEDs and Neighborhoods as*" an integral part of comprehensive approaches towards sustainable urbanisation including technology, spatial, regulatory, financial, legal, social and economic perspectives. They require interaction and integration between buildings, the users and the regional energy, mobility and ICT system. In this sense, a Positive Energy District is seen as an urban neighbourhood with annual net zero energy import and net zero CO_2 emissions working towards a surplus production of renewable energy, integrated in an urban and regional energy system. 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 Positive Energy District 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. Furthermore, implementation has to come with a high and affordable standard of living for its inhabitants."*

According to the latest JPI White Paper on Reference Framework for Positive Energy Districts and Neighborhoods from February 2020[3], a framework definition for PEDs could be defined as follows*: "Positive Energy Districts are energy-efficient and energy-flexible urban areas which produce net zero greenhouse gas emissions and actively manage an annual local or regional surplus production of renewable energy. They require integration of different systems and infrastructures and interaction between buildings, the users and the regional energy, mobility and ICT systems, while optimizing the livability of the urban environment in line with social, economic and environmental sustainability."*

[2] Positive Energy Districts (PED) | JPI Urban Europe (jpi-urbaneurope.eu)
[3] White-Paper-PED-Framework-Definition-2020323-final.pdf (jpi-urbaneurope.eu)

2.2 Definition of PED for MAKING-CITY

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

Beyond this general definition, each city should consider three different aspects to narrow the previous definition to their specific characteristics and objectives:

Final energy uses: A positive energy balance can be achieved for different final energy uses, both within the buildings (heating , cooling, hot water, lighting, appliances) , or even for services and other energy uses outside the buildings (public lighting, water and waste management, mobility).

Boundaries of the analysis: A positive energy balance within a geographical district boundary can be in many cases (particularly in high density urban areas), very difficult to achieve. Functional PED boundaries can be therefore useful to define a PED, for example in relation to a district heating network or a micro-grid, which connects the different buildings and through which a positive energy balance can be achieved. The concept of the Virtual PED boundaries has also been introduced as contractual boundaries, for example for cases where there is some energy generation outside the district, but which is owned or directly supplies its output to the district.

Energy flexibility and balancing period: The achievement of the positive energy balance within a district in an annual basis is the most common requirement for a PED definition. However, energy flexibility is an important characteristic of a PED that is not evaluated through an annual energy balance. Carrying out energy balances in shorter time periods, can give a better perspective on the district performance at different times of the day, and through the different days or months. For example, a district could become "positive energy" solely in specific hours of the day for certain months, as can occur in PEDs focused on the use of solar energy during central hours of the day in summer. Storage or demand management could help to increase the number of hours or days where a positive energy balance is achieved, and also to reduce peak loads for the district. A detailed hourly or sub-hourly balance is therefore important to assess the interactions between a district and the energy grids, and to evaluate specific strategies to increase energy flexibility.

3 PED Methodology in a nutshell

3.1 Objective and Scope of 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, the MAKING-CITY project works on identifying a method that firmly pursues this ambition.

The PED Methodology focuses on the procedure considering the identification process of the PED concept boundary and selection of proper PED solutions particular 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 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.

3.2 Phases of PED Methodology

The next sections explain the general context, introduction, and identify phases for planning and deployment of PED, stakeholders involved and citizen engagement strategies in the MAKING-CTY Methodology (The methodology is developed in D4.1). Regarding planning of PED areas, **identification of the PED concept boundary and identification of technical and non-technical solutions are considered**. In addition, the deployment of PED areas, **verification of PED calculation, identification of urban/land use planning support, stakeholders, financial schemes and citizen engagement are evaluated**. The PED Methodology also highlights replication view by standardization and workshop activities that will be held in Follower Cities and other potential cities.

The 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 a PED. Phase V offers an annual energy balance calculation relying on the method defined in D4.2 and monitors whether 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 1.

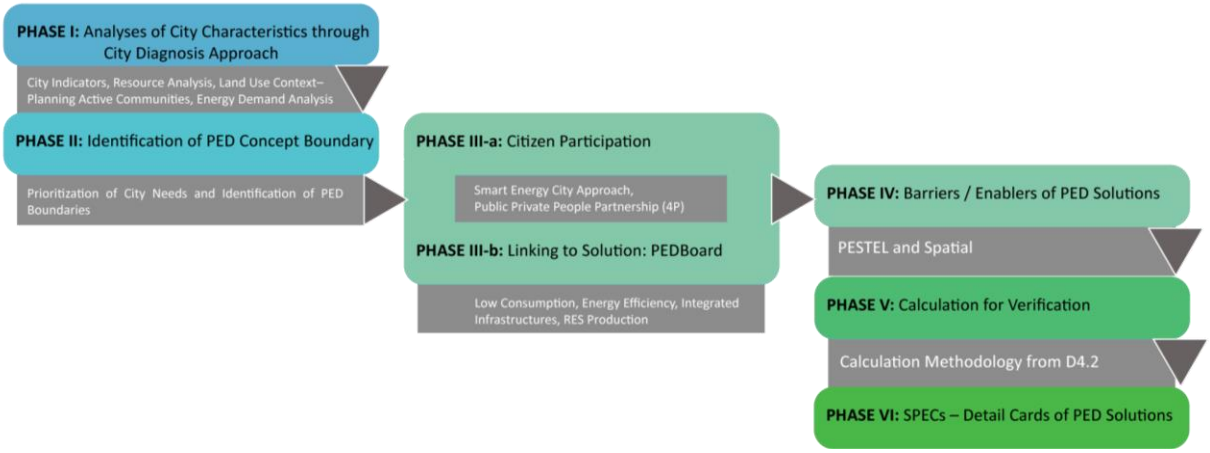


Figure 1: Phases of MAKING-CITY PED Methodology

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 analyzed under four steps:

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

Detailed information regarding steps of Phase I is mentioned in D4.1 Section 4.1_Phase I: Analyses of City Characteristics through City Diagnosis Approach. Cities should follow the instructions and gather data for cited analyses in order to identify PED Concept Boundaries in Phase II. Prioritization studies and tools will be adopted by the process to determine macro-scale and micro-scale analyses and selection of zones for defining most appropriate PED concept boundary in the cities.

Phase I and Phase II are the most relevant parts of the methodology which will be partly applied for the selection in each of the city districts which have the potential of transformation into PEDs.

Within Phase I, an assessment of the Local Urban Planning, Land Use Planning and Urban Design Support for the PED implementation will be conducted: The local spatial planning systems will be checked, to assess the availability of urban planning, land policy, land use planning, and urban design to foster PED development and the potential to develop Public-Private-People-Partnerships that support PED implementation within this processes. In addition, the FWC will assess the potential PED areas in relation to the urban plans and land use plans of the city, and in relation to the potential investment agreements in the PED area.

Following this selection, and working towards PED design, Phases III to VI are to be applied. Phase III pursues a parallel process between social and technical dimensions of PED design. 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 (explained in detail in D4.1 – Section 4.3)

On the other hand, 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 according to the data obtained from Phase I and Phase II. The solutions are classified under the main solution categories of the 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. Technical and economic aspects are braced with social considerations 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. Therefore, PED solutions must also be selected based on the benefits they bring to the parties of PED development, as this will be a crucial motivation for them to participate in the learning process.

Afterwards, an 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. Regarding 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 reach the energy positivity of the district.

Finally, 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.

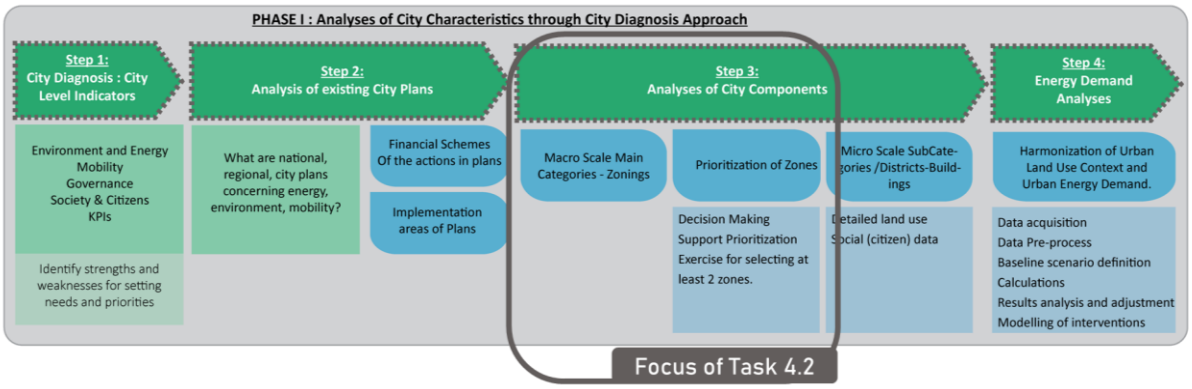


Figure 2: Phase I of MAKING-CITY PED Methodology: Analyses of City Characteristics through City Diagnosis Approach

Highlithed in the figure as “Focus of Task 4.2”, this deliverable responds to the first point of the step 3, the Macro scale analysis that requires GIS-based city context data on resources availability, urban macroform, landusage, energy and e-mobility structure, energy service availability and social structure of the city. These city data layers play a decisive role in the creation of potentials and resources for PED implementation and are called “PED analytical components”. In T4.3 PED Designs in FWCs of the WP4, the second point of step 3; Micro-scale analysis will be conducted within the identified potential PED zones that are calculated from macro-scale analysis. This detailed study for definning the exact PED concept boundary (geographical, functional or virtual), also influcing the technology selection according

to the resource potential in the city will be conducted aligned with a more fluent study next year that will be reported in D4.4 PED Designs in FWCs.

4 Methodology followed to identify candidate areas to become a PED

The method defined to identify candidate areas to become positive in terms of energy is a GIS-conducted method that is supported in the information collected through a multicriteria questionnaire. Figure 3: GEOPROCESSING Steps and MCDA integration for identification of macro and micro scale potential PED areas, reflects the connection between the two main elements of the methodology (MCDA questionnaire and Geoprocessing steps).

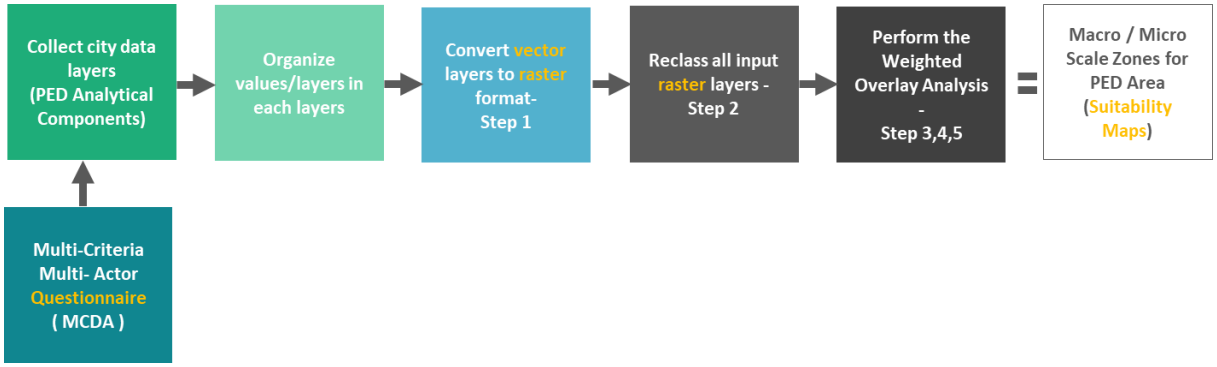


Figure 3: GEOPROCESSING Steps and MCDA integration for identification of macro and micro scale potential PED areas

The following sections describe firstly, how the MCDA questionnaire was created and the role that it played in the assessment and secondly, how the analysis was supported in GIS software tools (geoprocessing steps).

4.1 MCDA questionnaire

Geoprocessing Analysis has been supported in a Multi-Criteria Decision Analysis (MCDA) in which a detailed questionnaire guides the cities in understanding how to evaluate the relevant spatial references that could define the suitability of an area to become positive. The MCDA questionnaire plays an important role in the assessment in 5 different ways:

1) It standardises the application of the geoprocessing analysis. All the cities are studied using the same criteria. Different scores are given to each PED Analytical Component depending on the status of the city on each criteria. These characteristics of the questionnaire allow both to standardise the method and to adapt it to city needs.

2) It helps to select the PED Analytical Components to be considered in the assessment.

3) It allows obtaining reclassification scores to each Analytical Component through the consideration of all the criteria that is relevant. This also helps to consolidate the analysis and to adapt it accordingly to the city state of play.

4) It provides information for prioritization. Therefore, the weighting phase of the methodology is supported with the information provided by the MCDA questionnaire results.

5) Going beyond the spatial analysis, it helps the cities in identifying the strengths and weaknesses of the city. In this sense, economic, legal, technical environmental and legal are taken into account in the process of selecting areas with potential to become PED. As shown in the results, the MCDA questionnaire is relevant for identifying in a consensual way issues that are of interest for the city, but the city has not identified yet and/or, in the opposite case, issues that are not suitable. For example, the legal framework could facilitate or obstruct the implementation of specific solutions that have potential depending on the city context.

Considering the relevance of the questionnaire and the impact that it was going to have over the different phases of the analysis, a careful selection of the PED analytical components was made by Demir in *T4.1 – D4.1: Methodology/guidelines for PED design* , establishing the basis of the assessment through the identification of the elements that are critical for PED planning, design and implementation in cities.

According to the 6 categories that organize the PED Analytical Components (Table 3), a set of discussion sessions was organized between Tecnalia experts with different areas of knowledge. Each session worked on a specific category following the process explained below for the second to the seventh steps.

RA. Resource Availability	UM. Urban Macroform	LU. Land Use Context	TPI. Technical – Physical Infrastructure	VI. Virtual Infrastructure	SS. Social Structure

Table 3: Categories of the PED analytical components

- First: identify PED analytical components of each category (see Table 3: Categories of the PED analytical components) to be considered in the assessment and describe how each of them are going to be analysed in GIS based spatial data. This work was done in Task 4.1 and is detailed in D4.1 Methodology and guidelines for PED design.
    - For example, component “Solar energy investment zones” will use digital maps indicating solar parks, solar farms or solar districts in the city considering irradiance level, terrain elevation, specific PV output.
- Second: identify from economic, social, technical, environmental, legal and spatial the criteria relevant for the PED analytical component in evaluation in order to assess the PED analytical components in a robust way.
    - Following the example, in the case of * Existing solar energy investment zones, economic, technical and spatial criteria were selected.
- Third: establish the information that is going to allow the analysis of each of the selected criteria.
    - Following the example, the size and solar potential of the solar energy investment zone was considered relevant for analyzing the spatial criteria.
- Fourth: Each of the criteria considered was divided in different possibilities and, according to the suitability of these possibilities, scores were given.
    - Following the example, zones with high solar potential higher than 20.000m^2 were considered the most suitable and, thus, maximum scores were given to this situation.

Zones with high solar potential with a size between 10.000 and 20.000m^2 were also considered suitable but with lower scores than the previous situation.

- Fifth: considered criteria was prioritized. GIS analysis established that the sum of the best possibilities of each criteria has to be a 9. According to this, scores were divided between the considered criteria.
    - Following the example, the economic maximum criteria scored 3, technical scored 2 and spatial criteria scored 4.
- Sixth: restrictive criteria were identified. This means that if these possibilities are selected, the final score of the raster is determined only with this value.
    - Following with the example, for the spatial criteria of the * Existing solar energy investment zones, if the possibility "4) There are no zones that fulfil the previous criteria" is selected, meaning that there are no zones owned by the community or the public administration with higher than 10.000m2 with medium-high solar potential, this PED component is no needed to be considered in the assessment.
- Seventh: Give extra points and/or minus points to some PED components in order to include criteria that was not considered in the previous options.
    - Following with the example, extra points will be given in case that this possibility exists: "1) Surrounding the city there are zones owned by the community or the public administration with potential to become solar parks." and minus points will be given in case that this possibility exists: "1) The most suitable zones for implementing solar energy are green areas"
    - Note that the extra point can nullify the restrictive criteria. Following with the example, if the extra points possibility exists: "1) Surrounding the city there are zones owned by the community or the public administration with potential to become solar parks" The restrictive criteria "4) There are no zones that fulfil the previous criteria" related to the spatial availability of zones with medium-high solar potential, is nullify.

All of the PED Analytical Components have been reviewed by technical experts in the consortium and their advice is taken into consideration while assessing the layers.

Regarding the sessions, a total of nine Tecnalia´s experts from different areas of knowledge participated in the creation sessions. After the specific sessions, one session was organized to put in common developed questionnaire between all the participants. In total, seven sessions were internally organized. This version was explained in a call conference to experts from Demir, who commented and validated the approach. Validated by Demir version was presented to experts from Cartif, who analyze and provide feedback to it. Several iterations between the three mentioned research centres were made before obtaining resulted MCDA questionnaire that is presented in its full version in the Annex I: MCDA questionnaire (template). A summary of the criteria considered for each PED component and a short description on how to evaluate the component is given below.

Note that acronyms stand to: Economic (EC), Social (SO), Technical (TC), Environmental (EN), Legal (LE) and Spatial (SP).

First category is the resource availability in cities, consisting of solar, wind, earth, geothermal water, surface water, biomass and waste heat potential. The resources, their spatial references and detailed descriptions are displayed in Table 4.

RA. Resource Availability						
PED analytical components	EC	SO	TC	EN	LE	SP
Existing solar energy investment zones Macro scale digital maps indicating solar parks, solar farms or solar districts in the city considering irradiance level, terrain elevation, specific PV power output. Micro-producers on building level are not included in these analyses. They will be detailed in micro-scale analyses.	✓		✓			✓
Potential solar energy investment zones Some cities conduct studies on calculations for identifying potential areas for solar energy installations. Potential solar energy investment zones may also be found in city plan analysis under implementation areas of the plans.	✓	✓	✓		✓	✓
Existing wind energy investment zones Macro scale digital maps indicating windmills, wind farms or wind parks in the city. Micro-producers on building level (roofs) are not included in these analyses. They will be detailed in micro-scale analyses.	✓		✓			✓
Potential wind energy investment zones Some cities conduct studies on calculations for identifying potential areas for wind energy installations by considering wind power density, wind speed and orientation. Potential wind energy investment zones may also be found in city plan analysis under implementation areas of the plans.	✓	✓	✓			✓
Soil types, formations, ground maps of the city for defining potential areas for Aquifer Thermal storages) Potential for the installation of geothermal heat pump systems and ground-coupled heat exchanger systems (Which also avoid heat island effect by placing the "cooling towers" underground). Landfill and alluvial deposit land would get less score when compared to clay soil in terms of thermal energy storage.	✓		✓		✓	✓
Geothermal water impact area and potential geothermal investment zones Existing geothermal water resources and their impact areas by locating existing wells, heat centres. Etc. If already conducted new areas for new geothermal wells. These zones may also be found in city plan analysis under implementation areas of the plans.		✓	✓			✓
Potential surface water resources for energy generation. Hydropower. Current sea, lakes, streams, creeks in the city with energy generation potential. These zones may also be found in city plan analysis under implementation areas of the plans.	✓		✓		✓	
Potential water resources utilized as heat source for heating / cooling purposes Current sea, lakes, streams, creeks in the city for heat source. E.g. Using constant temperature in deep sea for cooling/heating purposes by heat exchangers.	✓		✓		✓	

Water surfaces with evaporative potential Impact areas affected by evaporative cooling from nearby natural or artificial water surfaces. This would affect low energy demand in PED boundary.						✓
Potential energy generation areas by biomass Current intense green areas, waste collection areas with energy generation purpose. These zones may also be found in city plan analysis under implementation areas of the plans.		✓	✓	✓		✓
Industrial zones with Waste heat energy generation Potential Current industrial zones / thermal plants/ sewage systems defined in city plans for energy generation by waste heat.			✓			✓

Table 4: Criteria considered for resource availability PED analytical components analysis

Second category is related with the urban planning and strategies of the city so called "urban macroform" This category gives detailed information derived from city plans and strategies. New development, retrofitting, infill and re-use / transformation areas are sub-categories to be identified under this category and are described in Table 5.

UM. Urban macroform						
PED analytical components	EC	SO	TC	EN	LE	SP
New development areas New development areas are new urban areas where there are no existing buildings. Data can be gathered according to Strategic Growth plans and maps indicating the implementation areas of them.			✓		✓	
Retrofitting areas Retrofitting Areas are development or upgrading of buildings or technology within existing infrastructure. Data can be gathered according to Strategic Growth plans and maps indicating the renewal/retrofitting areas of the city.	✓				✓	✓
Infill areas Infill Areas are redevelopment or land recycling that occurs on previously developed land. Data can be gathered according to Strategic Growth plans and maps indicating the implementation areas of them.			✓		✓	✓
Urban Transformation / Reuse areas Industrial, historical areas for urban transformation purposes.	✓				✓	✓

Table 5: Criteria considered for Urban Macroform PED analytical components analysis

Third category is the again related with the urban context of the city by the land-use coverings. Sub-categories are categorized in residential/Mixed-use, Commercial/Industrial/Office, Active Green/Open Parking Lots, Public Administration and Social/Cultural/Educational/Sport areas that are displayed in Table 6.

LU. Land Usage Context Spatial information of land cover in zoning/islands scales. This data may be found in small scale city zoning/planning maps.						
PED analytical components	EC	SO	TC	EN	LE	SP
Residential & Mixed-Use Areas Any governmental or municipal plan offering investment plans, incentives for private integrated (mixed use areas) building stock, would be a key point for PED implementations.	✓	✓			✓	
Commercial areas Any governmental or municipal plan offering investment plans, incentives for private building stock, would be a key point for PED implementations	✓				✓	
Active Green / Open Parking Lot. Considering it as available urban areas Any governmental or municipal plan offering investment plans, incentives for public/private open spaces for energy generation, would be a key point for PED implementations.	✓		✓	✓	✓	
Public administration areas Any governmental or municipal plan offering investment plans, incentives for public building stock, would be a key point for PED implementations.	✓				✓	
Social / Cultural/Educational/Sport Areas Any governmental or municipal plan offering investment plans, incentives for public services building stock, would be a key point for PED implementations.	✓				✓	

Table 6: Criteria considered for Land Usage Context PED analytical components analysis

Fourth category is the Technical / Physical Infrastructure that analyses the energy and e-mobility structure of the cities. Off-grid systems may also play an interesting role for selecting PED areas for their potential in energy flexibility and trading opportunities. For this reason, under this category district heating, power heat network and e-mobility structure of the cities are considered.

TPI. Technical – Physical infrastructure						
PED analytical components	EC	SO	TC	EN	LE	SP
Heat grid - Existing District Heating / Cooling zones If any DH/C grid exists in the city, an area nearby for connecting and sharing energy or integration of a technology such as "heat pumps" would be a potential PED.	✓		✓		✓	✓
Power infrastructure – High / Low voltage power grid and its impact area Effective areas of power grid in the city. If all the is connected to low voltage infrastructure, spatial data is not needed.	✓		✓		✓	
Heat network – Natural gas pipeline network	✓	✓	✓		✓	✓

If all the is connected to NG infrastructure, spatial data is not needed.						
Mobility Infrastructure Existing EV charging stations and their ownership data is required in order to identify e-mobility loads in PED areas.	✓				✓	

Table 7: Criteria considered for Technical- physical infrastructure PED analytical components analysis

Fifth Category is the potential virtual infrastructure that the cities may test in terms of smart grid applications. A few cities in Europe has already started testing virtual power plants and their effect on grids. The impact areas of micro-grid applications may have a key role for selecting PED areas.

VI. Virtual infrastructure						
PED analytical components	EC	SO	TC	EN	LE	SP
Smart grid applications. Considering Virtual Power Plants, Micro Grid Applications Since this is a virtual data, the districts / negihbourhoods / islands that are conected to the facility, would be potential PEDs.	✓		✓		✓	✓

Table 8: Criteria considered for Virtual infrastructure PED analytical components analysis

Last category is the social structure of the city represented in spatial information. Socio-economic, socio-cultural context of the city is targeted under this category. Human behaviour on energy consumption and energy investment is analyzed and their spatial reference are identified. More details on description of the sub-categories may be found in Table 9.

SS. Social structure						
PED analytical components	EC	SO	TC	EN	LE	SP
Population Density identified in Spatial Data Population Density in macro-scale plays a key role for being participative and implementing PEDs economically and socially.	✓	✓				
Population Projections for new development zones Population Density in macro-scale plays a key role for being participative and implementing PEDs economically and socially.	✓	✓			✓	
Impact and organizational areas of energy Communities / cooperatives / housing associations Co-designing and collectively organising PEDs in areas where communities are active and effective.	✓	✓			✓	
Self-sufficient districts / neighbourhoods or Ecovillages (with a more circular economy perspective)	✓		✓			✓

Self-sufficient districts, neighbourhood would be pilot areas for implementing PEDs.						
Cultural Human Behaviour If possible, spatial data integrated with aging population, lifestyles, cultural backgrounds for estimating energy use.	✓	✓				
Vulnerable Communities / disadvantageous/ urban poor Neighbourhoods / districts / Zones Combating energy poverty and social exclusion.	✓				✓	

Table 9: Criteria considered for Social PED analytical components analysis

Each follower city has fulfilled the questionnaire in multi-actors call conferences. Before the conferences, the researchers fulfilled the questionnaire according to the answers given to the PESTEL developed in WP4. Thanks to this preliminary version, the discussion was fluent and the work between the different tasks is related. The extended version of the MCDA results for each city is included in Annex I: MCDA questionnaire (template). This multi-criteria, multi-actor evaluation process has been conducted as a parallel analysis to collection and evaluation of GIS-based data.

As it was mentioned before, the results from the questionnaire were used for GIS layers identification, reclassification and prioritization purposes.

4.2 GIS supported analysis: Overlay analysis

The methodology for areas with potential to become PEDs has been conducted in two different Geographical Information System software tools: ArcGIS and QGIS. Each software provides different opportunities to the assessment:

1) ArcGIS: it has a high number of functionalities, but it is private and the license to use it is expensive. Among other functionalities, it allows making the analysis in a semi-automatic way. Kadiköy, León, Lublin and Trencin have been analysed with it.

2) QGIS: it is a free to use software that can be downloaded, the functionalities are limited. For instance, some parts of the analysis have been done manually. Bassano del Grappa and Vidin have been analysed with it.

The process followed with both software tools has been similar. The differences are reflected in the following paragraphs.

Overlay analysis is a group of methodologies applied in optimal site selection or suitability modelling. It is a technique for applying a common scale of values to diverse and dissimilar inputs to create an integrated analysis. Therefore, it is suitable for the analysis of the spatial PED analytical components, as it allows to consider many different factors of different characteristics.

The Weighted Overlay tool applies one of the most used approaches for overlay analysis to solve multicriteria problems such as site selection and suitability models. Steps followed in ArcGIS for areas with potential to become positive identification are explained below. The process followed in QGIS is explained at the end of this section.

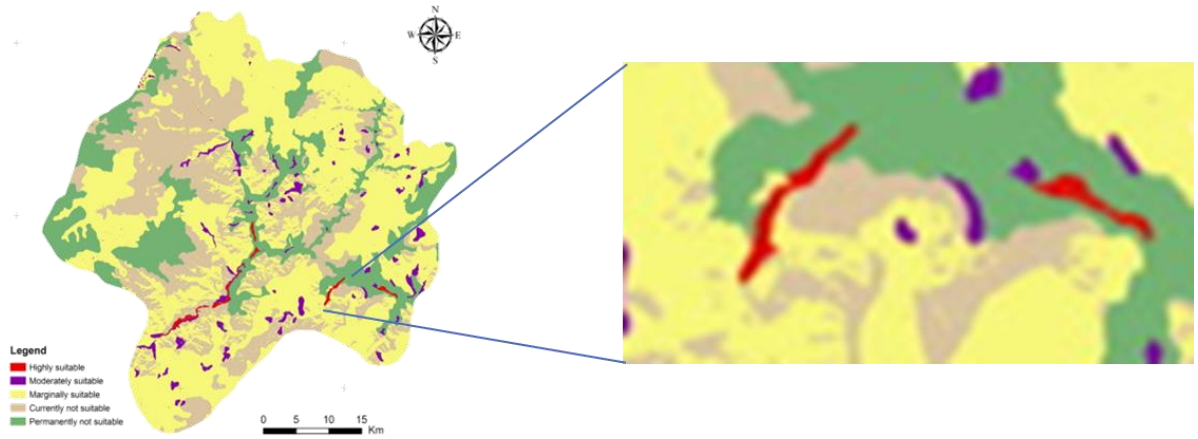


Figure 4: Example in ARCGIS of prioritization of zones from Weighted Overlay Macro-scale analysis

ARCGIS overlay analysis: process in 6 steps

- Step 1. Conversion to rasters

The tool only accepts **integer rasters** as input, such as a raster of land use or soil types. Continuous (floating-point) rasters must be reclassified (2nd step) to integer before they can be used.

Generally, the values of continuous rasters are grouped into ranges, such as for slope, or Euclidean distance outputs. Each range must be assigned a single value before it can be used in the Weighted Overlay tool.

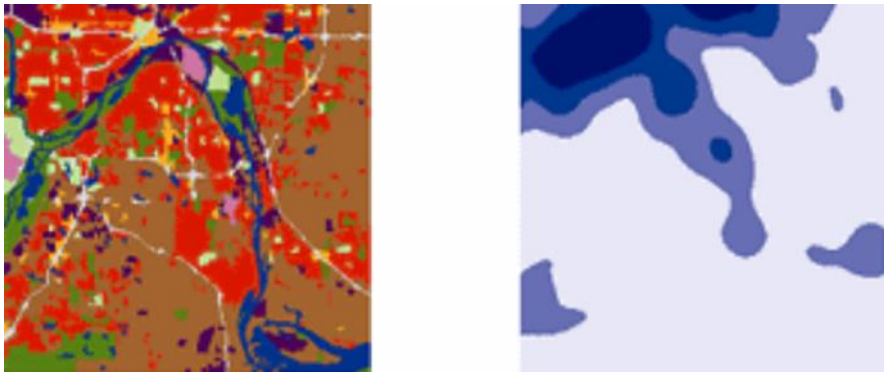


Figure 5: Raster conversion example in ArcGIS

- Step 2. Raster Reclassification

The Reclassify tool allows rasters to be reclassified. The reclassification tools reclassify or change cell values to alternative values using a variety of methods. You can reclass one value at a time or groups of values at once using alternative fields; based on a criteria, such as specified intervals (for example, group the values into 10 intervals); or by area (for example, group the values into 10 groups containing the same number of cells). The tools are designed to allow you to easily change many values on an input raster to desired, specified, or alternative values.

Each value class in an input raster is assigned a new value based on an evaluation scale. These new values are reclassifications of the original input raster values. A restricted value is used for areas you want to exclude from the analysis. As an example, the values inside a layer (regarding one PED analytical component) - e.g. Land-usage, could be residential/mixed use/commercial.. the importance of land-usage regarding PED implementations depend heavily on political, economic context. If the city has incentives or legislations for retrofitting the existing residential use in city, then residential group values would get the highest value.

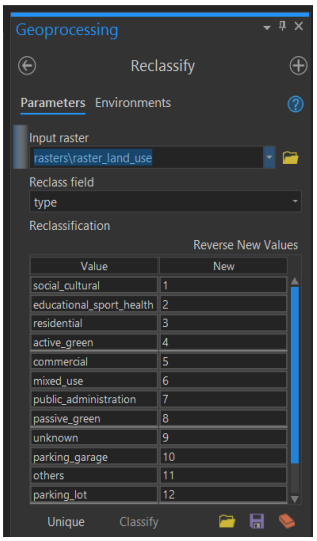


Figure 6: Reclassification example in ArcGIS

According to MAKING-CITY Methodology for PED Concept Boundary Identification, the reclassification step is supported in the MCDA questionnaire that in this sense aims to collect relevant information from the city that could affect the spatial assessment.

For example, the impact area of a specific PED analytical component can be defined through a buffer zone (if the layer is gathered as "point feature" in GIS format). The size of this buffer is generated depending on the existing regulations, conducted studies on economic feasibility, promoted subsidies or incentives available in each city context. The relation between spatial information and technical, political, economic, and social point of view is targeted to achieve more suitable results.

Since the GIS background and infrastructure of cities highly vary from each other (especially on clarity of data and values indicated inside each layer (matching the PED analytical components), the reclassification methodology is specific for the city.

- Step 3. Select an evaluation scale

The evaluation scale represents the range of suitability (or other criterion); the values at one end of the scale represent one extreme of suitability (or other criterion); values at the other end represent the other extreme. The default evaluation scale is from 1 to 9 in increments of 1 (for example, with least suitable being 1, most suitable being 9). If your input rasters are already reclassified to a common measurement scale using the Reclassify tool, it is important to select an evaluation scale that matches the scale used when reclassifying.

Evaluation Scale	1	2	3	4	5	x
1 - 3	least suitable	suitable	most suitable			
1 - 5	very low suitability	low suitability	moderate suitability	high suitability	very high suitability	
1 - x	lowest					highest

- Step 4. Set scale values

The cell values for each input raster in the analysis are assigned values from the evaluation scale. This makes it possible to perform arithmetic operations on rasters that originally held dissimilar types of values. You can change the default values assigned to each cell according to importance or suitability.

For instance, a land-use raster that is added has values representing the land-use type. To find suitable locations, assign scale values depending on which land-use types are more suitable. For example, with an evaluation scale set at 1 to 9 by 1, you might assign the following scale values: Forest = 3, Water = Restricted, Barren land = 9, Scrub land = 7.

➢ Step 5. Assign weights to input rasters

To each input raster a percentage influence is assigned, based on its importance. **The total influence for all rasters must equal 100 %**. Each of the criteria in the weighted overlay analysis may not be equal in importance. You can weight the important criteria more than the other criteria or some criterias may have equal importance in terms of creation potential for PED implementation.

Weights of each macro/micro scale inputs (PED analytical components water resources, geomorphological structure, land use, buildings etc.) are determined by considering local/regional/national contexts such as laws and regulations, technical and technological aspects, etc.

➢ Step 6. Run the Weighted Overlay Tool

As a result, the layers are combined and the overlay layer is obtained. Modifying the suitability values or the influence percentages will produce different results for output suitability raster.

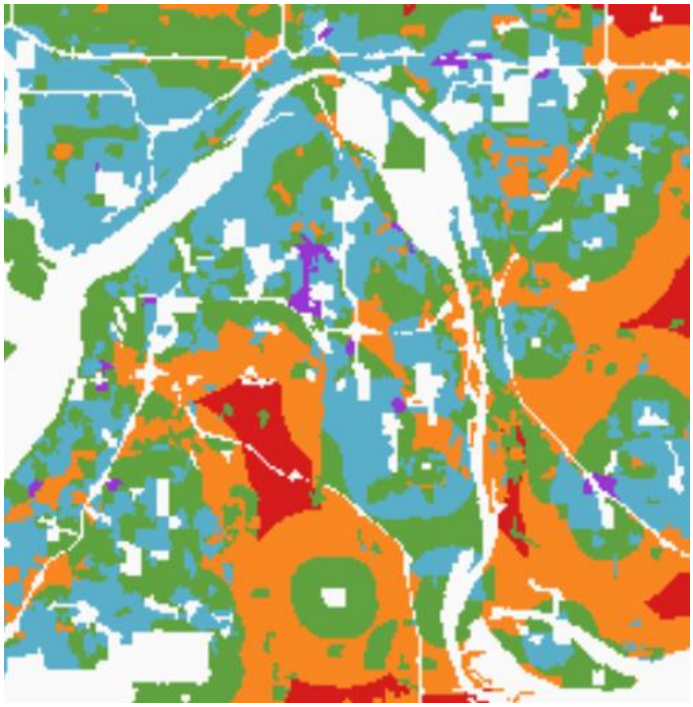


Figure 7: Overlay result example in ArcGIS

Kadiköy, León, Lublin and Trencin have been analysed following ArcGIS steps. The process to obtain the scale and weighing values and the overlay results are presented in section 6, section 7, section 8 and section 9 respectively.

QGIS overlay analysis: process in 4 steps

By means of this process, various layers are overlaid and assigned a weight with various parameters in each one of them, which are scored from 1 to 9, obtaining a final layer with a weighted score for each point of it.

- **Step 1. Layers treatment**

The first step is to collect, clean and adapt all the layers that are going to be included in the analysis. The layers can be obtained from a wide variety of sources, and so that, the parameters that are going to be evaluated are adapted and grouped to the needs of the analysis.

- **Step 2. Set scale values**

After the parameters have been grouped into the required categories, values from 1 to 9 are assigned to each of them.

Initial use	Predefined categories	Scale
Use1	Commercial areas	7
Use2	Active Green / Open Parking Lot.	9
Use3	Social / Cultural/Educational/Sport Areas.	3
…	Residential & Mixed Use Areas	6
UseN	…	…

Figure 8: Value scaling example in QGIS

In case that buffers have to be created, for instance, for the case of solar PV installations, the proximity to the installation will be the predefined categories and, the closest zones will have the highest scale (9).

- **Step 3. Conversion to rasters**

Once the layers have the scores assigned, they are transformed into raster files. An important consideration here is that all rasters must be of the same extent, so they have to be cut to the boundary size.

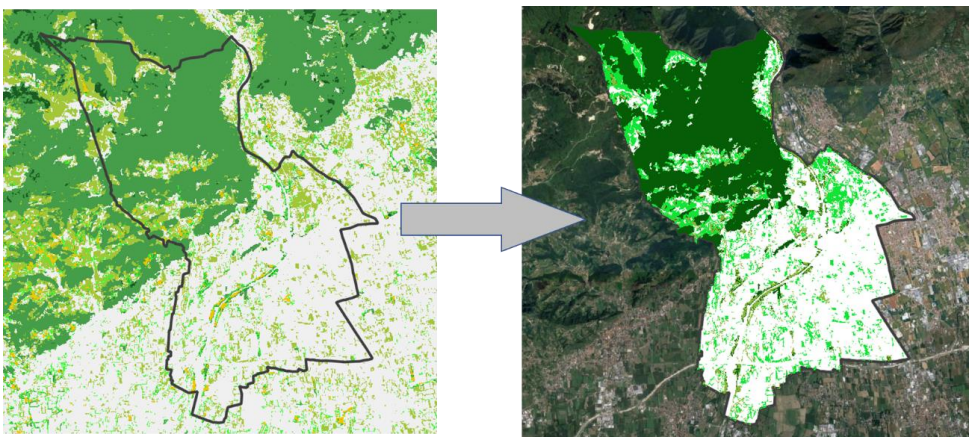
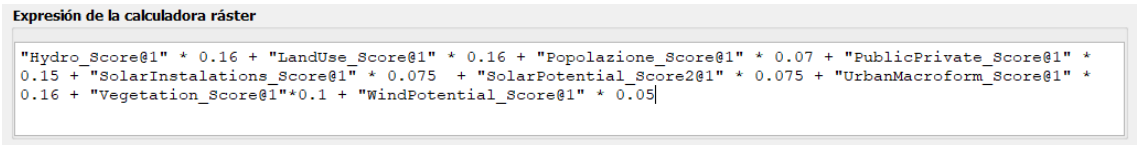


Figure 9: Conversion to raster example in QGIS

➢ Step 4. Run the Weighted Overlay

Finally, all the layers are added taking into account the weight given to each of them, obtaining the final overlay layer.



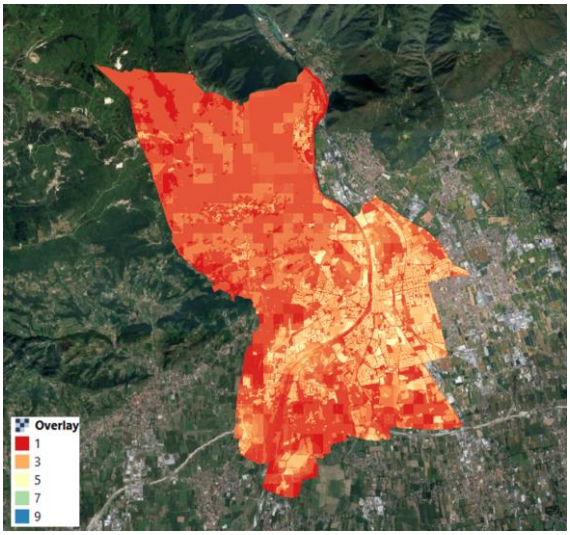


Figure 10: Overlay example in QGIS

Bassano del Grappa and Vidin have been analysed following QGIS steps. The process to obtain the scale and weighing values and the overlay results are presented in section 5 and section 10 respectively.

5 Selection of PED areas in FWC: Bassano del Grappa

Bassano del Grappa is a city and "commune", in the Vicenza province, in the region Veneto in northern Italy, **at the foot of the Alps where the Brenta river come out from the Valsugana valley**. According to a census in 2018, the population of Bassano del Grappa city is approximately 43.500. The city is located at an altitude of 129 metres above sea level and covers an area of 46,79 km^2, with a density of 920 inhabitants per km^2.

Figure 11: Bassano del Grappa main characteristics (Source: D1.2 – City Diagnosis)

According to Bassano del Grappa Action Plan for Sustainable Energy (PAES, 2014), the current energy consumption of the municipality area is equal to 804,842MWh with a result of 211,465 tons of CO_2. The city mainly uses renewable energy generated from biogas plants, solar power and hydropower in addition to the fossil fuel sources as it is shown in Table 10.

Solid Fossil fuels	Natural Gas	Oil and petroleum	Renewables and biofuels	Electricity from the grid
1,52	7,35	4,22	2,29	3,70

Table 10: Primary energy sources (MWh/cap)– Bassano del Grappa

Main characteristics of renewable resources in Bassano del Grappa are summarized in Table 11.

Average solar radiation (kWh/m²year)	Average Wind power density (W/m²)	Geothermal potential conductivity (W/mk)	River
1.334	37	1	Brenta

Table 11: Renewable resources main characteristics – Bassano del Grappa

5.1 State of Play / Analyses of City Characteristics and Priorities

Bassano del Grappa characteristics and priorities for areas with potential to become positive have been defined according to the MCDA questionnaire. Spatial references selected and prioritization values of each of them are summarized in Table 12 to Table 17. The whole MCDA assessment is included in the annex (page 115).

Regarding resource availability, Bassano del Grappa is suitable for solar energy with an average radiation of 1.334 kWh/m^{2}year. Nowadays there is and installed power of 9.086kW of photovoltaic panels at residential and administrative buildings[4] and it has a high social acceptability that promotes the expansion of it. Bassano del Grappa is suitable for wind energy generation too, however, the main potential it is outside the city boundaries. Regarding hydropower, there are 3 hydroelectric plants installed on the Brenta River that produced 8,76 GWh in 2018. Bassano del Grappa has interest both in biomass and waste heat recovery and want to develop specific studies in each area. However, in a preliminary analysis it seems that there are no industries with heat energy recovery potential next to the city. At this stage there is no interest in geothermal energy.

Resource Availability		
Category	Spatial reference	Value
Solar Efficient zones	Existing solar energy investment zones	6
	Potential solar energy investment zones	9
Wind Efficient zones	Existing wind energy investment zones	5
	Potential wind energy investment zones	4
Water resources	Potential surface water resources for energy generation. Hydropower.	9
Biomass	Potential energy generation areas by biomass.	8
Waste heat potential	Waste heat Potential	#NA

Table 12: Spatial references preselected for resource availability – Bassano del Grappa

Bassano del Grappa selected all the urban macroform components considered relevant for identifying the areas with potential to become positive. Selected values respond to a suitable legal framework that

[4] Source: https://atla.gse.it/atlaimpianti/project/Atlaimpianti_Internet.html

promotes PED implementation and economic resources availability. It is important to note that the Italian government has enacted in the last months a law to stimulate the economy in the post-covid period that provides for tax incentives equal to 110% of the sums spent on building interventions. There are few requirements to take advantage of this incentives that implies that all buildings in the city of Bassano built before 1990 may be affected. On the other hand, neither these interventions nor ISUDS areas have been defined yet.

Urban Macroform		
Category	Spatial reference	Value
New Development Areas	New Development Zones	9
Retrofitting Areas	Old Building Stock areas	6
Infill Areas.	Redevelopment or land recycling areas	6
Transformation / Reuse Areas	Urban Transformation Areas	9

Table 13: Spatial references preselected for urban macroform – Bassano del Grappa

Regarding land use context, the differences in defined priorities for Bassano del Grappa have been defined according to the existence of investment plans. Legal framework is suitable and social acceptability is well seen in this context.

Land usage context		
Category	Spatial reference	Value
Land Cover in Zonings / Islands	Residential & Mixed Use Areas	9
	Commercial Areas	7
	Active Green / Open Parking Lot. Active green	6
	Public Administration Areas	9
	Social / Cultural/Educational/Sport Areas.	9

Table 14: Spatial references preselected for land usage context – Bassano del Grappa

There is a lot of interest from Bassano del Grappa municipality in energy and e-mobility structure and components. However nowadays power infrastructure exists only in private industrial areas and there

is no heat network yet. On the other hand, there are some experimental areas regarding electric vehicle chargers and citizens are investing in hybrid and electric cars. However, e-mobility was considered out of the scope of the assessment as implies more electric demand and obstructs the conversion to positive.

Energy / E-mobility structure		
Category	Spatial reference	Value
Power Infrastructure	High / Low voltage power grid and its impact area	#NA
Heat Network	Natural gas pipeline network	#NA
Mobility Infrastucture	Existing EV chargers and impact areas	#NA

Table 15: Spatial references preselected for Energy / E-mobility structure – Bassano del Grappa

Regarding the micro grid applications, nowadays there is no existence of them in Bassano del Grappa but the city considers it interesting for the future and the regulatory framework is suitable for the implementation.

Energy service availability		
Category	Spatial reference	Value
Micro Grid Applications	Impact areas of micro-grids/ islands	4

Table 16: Spatial references preselected for Energy service availability – Bassano del Grappa

Bassano del Grappa wants to prioritize high density zones with solvent income level. These zones play a key role for being participative and implementing PEDs economically and socially. Including the energy communities and other related cooperatives and associations seems to be interesting, however, there is no spatial data available to include it in the GIS assessment.

Social structure		
Category	Spatial reference	Value
Current and Projected Population	Population Density identified in Spatial Data	9
Energy Organisations	Impact and organizational areas of energy Communities / cooperatives / housing associations.	#NA

Table 17: Spatial references preselected for Social structure – Bassano del Grappa

According to Bassano del Grappa selection of the spatial references, GIS layers to be included in the study were identified. Considering the availability of Bassano del Grappa information in GIS format and information available at open sources, the nine GIS layers summarized in the Figure 12 were considered in the analysis.

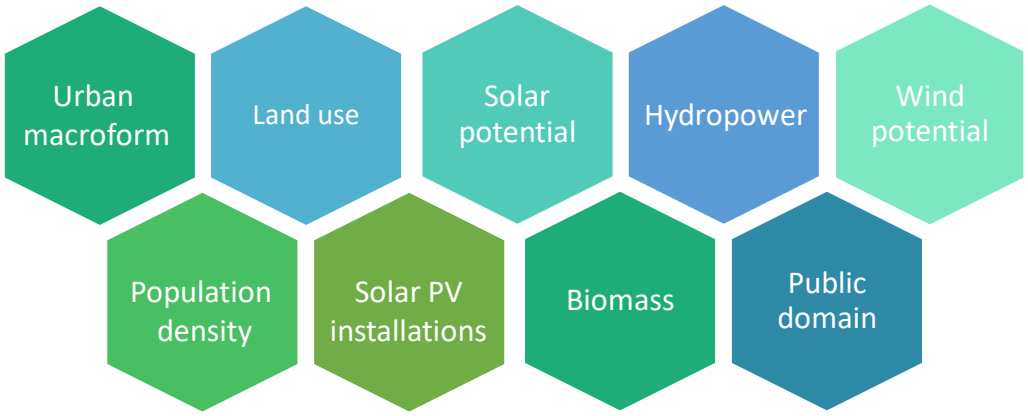


Figure 12: GIS layers considered in the analysis – Bassano del Grappa

In order to be included in the analysis properly, each of this layer needed specific data treatment for reclassification purposes. The approach followed is summarized in Table 18 and more information is given in the annex (page 150). Prioritization percentages given to each GIS layer for overlay purposes are also given in Table 18.

GIS layer		Approach	Prioritization for overlay
Urban macroform		Based on the combination of GIS layers (new development and reuse areas) sent by the city and the identification of buildings built before 1990. Selected spatial references were included according to Table 13.	16%
Land use		Based on the GIS layer land use sent by the city. Selected spatial references were included according to Table 14.	16%
Solar	Potential	New layer has been created based on the ratio between the building roof surface and the total built surface. Grids of 250x250 with values closest to 1 are considered the most suitable.	15%
	PV installations	Based on data from Atlaimpianti[5] for existing installations and power identification. Areas that can be supplied with existing installations are considered the most suitable.	

[5] https://atla.gse.it/atlaimpianti/project/Atlaimpianti_Internet.html

GIS layer	Approach	Prioritization for overlay
Hydropower	Based on the location of hydroelectric plants sent by the city. Closest areas to the hydroelectric plants have been considered the most suitable.	16%
Wind	Based on wind power density data from Global Wind Atlas[6].	5%
Population density	Based on the GIS layer population density sent by the city. Highest population density was considered the most suitable for the purpose of the analysis.	7%
Biomass	Based on the vegetation map of Corine land cover[7]. Forest areas are the most suitable as biomass source.	10%
Public domain	Based on GIS layer public administration areas and cultural, social and educational areas from the land use layer sent by the city. All these areas are considered more suitable to become positive.	15%

Table 18: GIS analysis approach and prioritization scores – Bassano del Grappa

5.2 Definition of already chosen areas

At proposal stage Bassano del Grappa identified three districts with potential to become PED. Each of them has different characteristics that distinguish it from one to another on territory and the possibility of production and use of renewable energy:

- Sant'Eusebio (0,76km^2) is mainly residential with small detached houses. It is located in the north west of the ancient centre of BdG at the end of the Valsugana valley and flanked by the Brenta river to the east and by the hills and mountains to the west. It has 1.286 inhabitants (2014) divided into 563 families.
- Merlo (1,81km^2) is a district with many industrial buildings and shopping centres built with mostly unused flat roofs. It is located in the southern part of the city and has 1.811 inhabitants (2014) divided into 894 families living for the most part in single or semi-detached houses. Many of the owners have benefited in recent years from the tax incentives for the construction of photovoltaic systems of about 3-6 kwatt placed on the south side of roofs.
- San Vito (1,02km^2) is located to the east of the historical centre, with 5000 inhabitants divided into 2771 families, it is the most populated district of Bassano. Initiated in 1911 thanks to the establishment of a metallurgical industry and developed mainly in the post second world war years, it is undergoing a phase of urban revisions and real estate transformation.

[6] https://globalwindatlas.info/
[7] https://land.copernicus.eu/pan-european/high-resolution-layers/

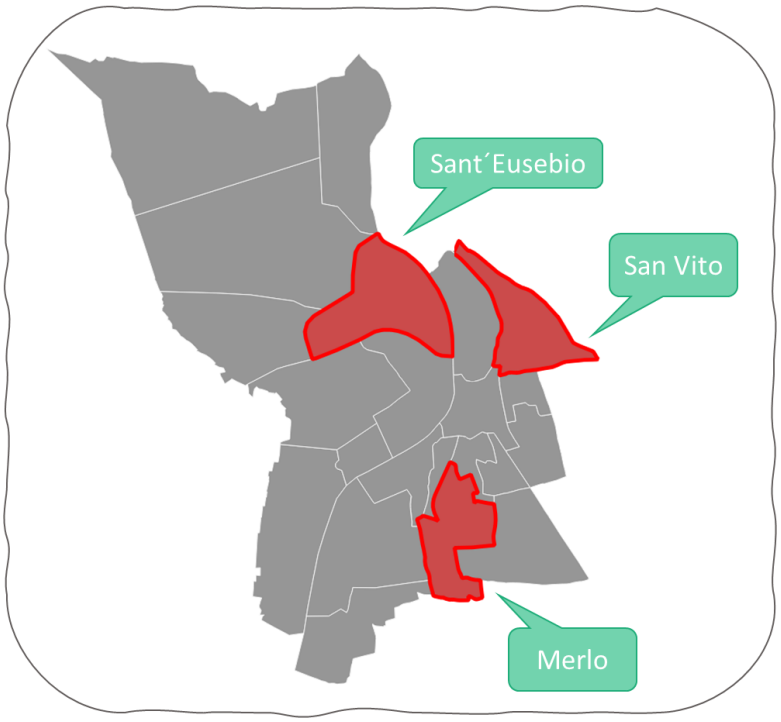


Figure 13: Bassano del Grappa preselected areas

Following chapter presents the results of the GIS overlay analysis to identify Bassano del Grappa suitable areas to become positive and puts in common this result with preselected areas.

5.3 Candidate areas to become a PED

Renewable resources availability, innovative atmosphere and a suitable legal framework confer Bassano del Grappa favourable characteristics to become positive in many areas of the city. This is reflected in the overlay result shown in Figure 14: Bassano del Grappa candidate areas to become positive.

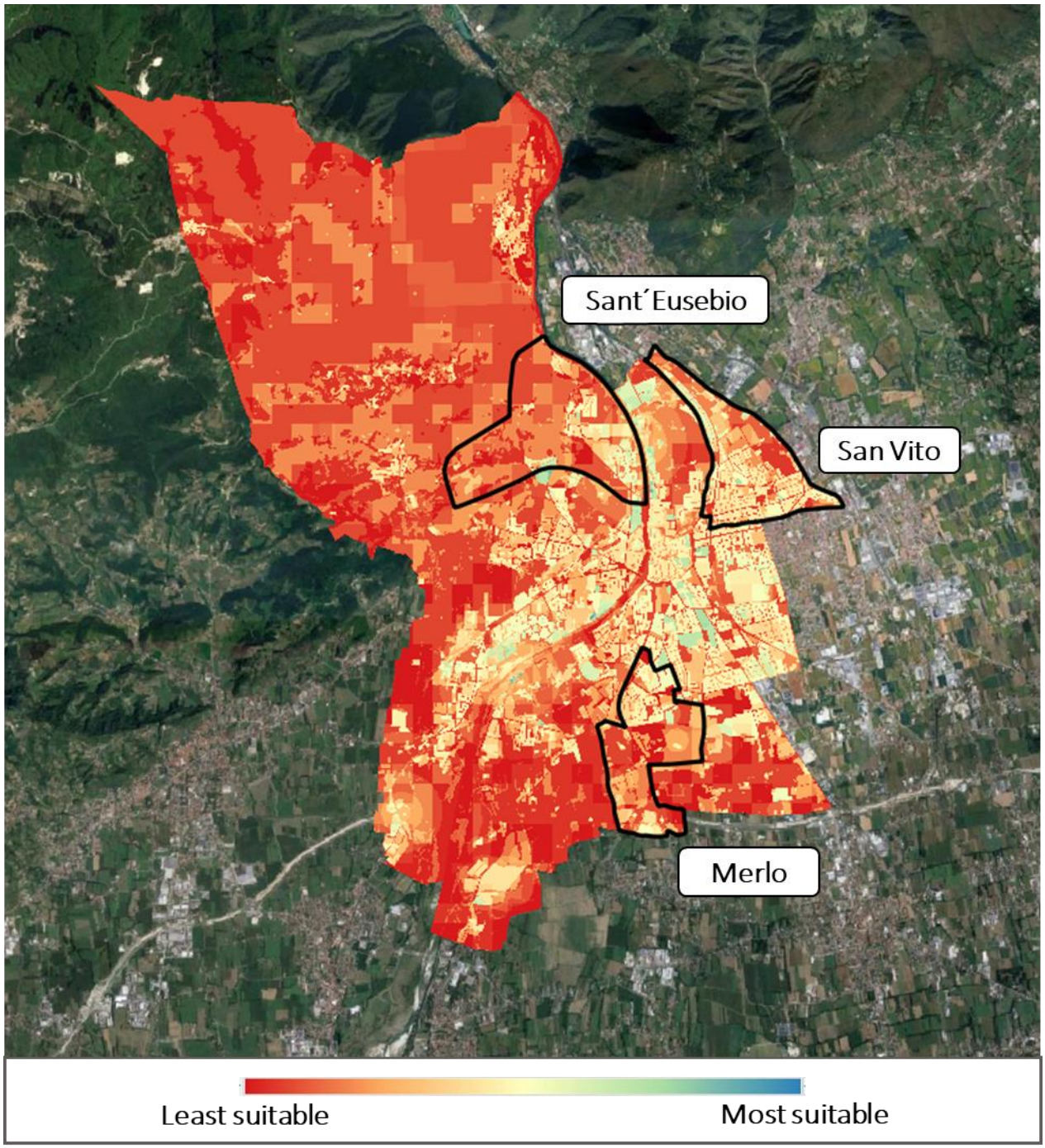


Figure 14: Bassano del Grappa candidate areas to become positive

Bassano del Grappa is taking advantage of the Brenta river through the installation of hydroelectric plants. The bet of the municipality in this sense is an opportunity to the city that is well reflected in the results. The combination of this issue together with the new development/reuse and public areas is even more remarkable. Moreover, the opportunity given by the Italian government in terms of tax incentives to retrofit buildings seems promising to help the conversion of areas of the city to positive.

It is important to note that the location with the most suitable results has a value of 6,75/9.

Regarding the districts preselected by the city, Table 19 summarises the most relevant values obtained for them. These districts include some areas with suitable potential to become positive, while others will need higher efforts to convert them in positive.

Preselected District	Mean value	Maximum value
Sant´Eusebio	2,43	6,00
San Vito	2,96	5,30
Merlo	2,53	5,20

Table 19: Overlay values of preselected areas – Bassano del Grappa

The exact size of the areas to be included in the micro-analysis will be done in the next steps of the WP4 and it does not necessarily coincide with the official limits of existing district. Moreover, further analysis will be done in next steps of WP4 in terms of technological solutions for the conversion.

6 Selection of PED areas in FWC: Kadiköy

Kadiköy is one of the central districts of the metropolitan city of Istanbul. Located on the southwest of Anatolian part of the city, it's surrounded by Marmara Sea on the west and south. Consisting of 21 neighbourhoods, Kadiköy has 25,2 km^2 land area, located at an altitude of 120m, and its population is 458,638 according to latest data of TurkStat. There are 29,486 buildings (including both residential and tertiary) and building density is 12 stock/area in ha. With its cosmopolitan structure and central location, Kadiköy is very attractive for the national and foreign population.

Figure 15: Kadiköy main characteristics (Source: D1.2 – City Diagnosis)

According to Kadiköy Action Plan for Sustainable Energy (PAES, 2016)[8], average energy consumption per year 77,32kWh/m^2 for residential buildings and 168,76kWh/m^2 for tertiary buildings. Table 20 summarizes the primary energy sources of Kadiköy.

Solid Fossil fuels	Natural Gas	Oil and petroleum	Renewables and biofuels	Electricity from the grid
0,00	0,67	0,00	0,06	2,68

Table 20: Primary energy sources (MWh/cap)– Kadiköy

Main characteristics of renewable resources potential in Kadiköy are summarized in Table 21.

Average solar radiation (kWh/m²year)	Average Wind power density (W/m²)	Geothermal potential conductivity (W/mk)	Water bodies
1.507,66	36,44	#NA	Mármara sea

Table 21: Renewable resources main characteristics – Kadiköy

[8] Kadiköy SEAP (2016) Final Consumptions and Kadiköy GIS Spatial Infrastructure from Kadiköy GIS shape file

6.1 State of Play / Analyses of City Characteristics and Priorities

The study for identifying PED concept boundaries in Kadiköy was developed by collecting digital data accompanied with gathering the city's results for MCDA questionnaire. The classification of the GIS data required to identify the PED area has been made by considering the macro scale requirements.

From Kadiköy city GIS database, potential solar efficient zones (indicated as mostly open market, carpark areas), geomorphological structure for assessing thermal storage potential, surface water resources, retrofitting and transformation areas (identified in Spatial Strategic Plan[9] of Kadiköy), land-usage maps, e-mobility infrastructure and population density are gathered. The analyses are operated with ARCGIS software. All layers converted into rasters for the reclassification stage. The procedure followed for grouping process of the values in the layers are explained in detail in methodology Section 4.3 – step 2 from technical expertise point of view. The final stage is realized by evaluating the results from the MCDA and the reclassified groups together. As mentioned before, a multi-criteria analysis together with spatial and technical analysis are followed for analyzing FWCs' context, to state their needs and priorities and to superimpose energy and urban strategic planning. The MCDA questionnaire filled by Kadiköy city, not only by considering the spatial information that exists, but also the potential of the city in terms of economic, social, legal aspects without GIS data. The result of Kadiköy city questionnaire was obtained according to the expert opinions of the city and the results are presented in ANNEX I.

The score values collected from the MCDA questionnaire and the reclassification stage are presented in Table 22 to Table 27 for all categories. The remap value in the analysis was chosen between 1-9 value to be consistent with MCDA method.

Potential solar energy zones are mostly green areas and parking lots. The geomorphological structure of Kadiköy presents that there are potential areas for aquifer technologies especially areas with clay and sand types of soil. Available zones exist for drilling and there is no legal barrier for public drilling.

There are some streams and rivers but without relevant energy generation or evaporative potential since they are mostly rehabilitated and closed with land transport purposes.

Resource Availability				
Category	Spatial reference	MCDA Value	Reclassification Groups	Remap Value
Solar Efficient zones	Potential solar energy investment zones	6	All zones	9
Ground Coupling	Extensive ground coupling potential for cooling and heating purposes	9	Sandstone, loamy stone, conglomerate, shale	3

[9] Spatial Strategic Plan – Existing Structure Report, Center Kadiköy - https://webgis.kadikoy.bel.tr/keos/img/PDF/MSPMDR.PDF

			Clay, Thin Sand, Micaceous shale, Calcite	9
			Calcite, Sandstone, Shale, Argillaceous limestone, reef limestone	7
			Argillaceous limestone, lyddite, lumpy limestone, shale	3
			Alluvial deposit	1
			Land Reclamation	1
Water resources	Potential surface water resources for energy generation. Hydropower.	0	250 m	1
			500m	1
			750m	1
			1000m	1
	Water surfaces with evaporative potential	0	#N/A	#N/A

Table 22: Spatial references preselected for resource availability – Kadiköy

Kadiköy provided GIS layers for transformation and retrofitting areas that are considered relevant for identifying the areas with potential to become positive. Selected values respond to a suitable legal framework that promotes PED implementation and economic resources availability. Kadiköy has already published the "Urban Transformation Strategy Report"[10], areas are identified to be demolished and reconstructed regarding sismic and energy efficiency concerns. In Turkey buildings before 2008 were not subject to insulation regulations, after 2008 buildings were subject to be insulated according to TS825 standard.

Urban Macroform				
Category	Spatial reference	MCDA Value	Reclassification Groups	Remap Value
Retrofitting Areas	Old Building Stock areas	4	before 2008	1
			after 2008	4

[10] Kadiköy Urban Transformation Strategy document, 2019

Transformation / Reuse Areas	Urban Transformation Areas	9	Ongoing transformation areas	9
			Prospective transformation areas	5

Table 23: Spatial references preselected for urban macroform – Kadiköy

Regarding land use context, the differences in defined priorities for Kadiköy are scored according to the existence of investment plans. Legal framework is suitable and social acceptability for PED implementations are mostly promoted in public administration areas.

Land usage context				
Category	Spatial reference	MCDA Value	Reclassification Groups	Remap Value
Land Cover in Zonings / Islands	Residential & Mixed-Use Areas	5	Residential and mixed-use areas	5
	Commercial Areas	1	Commercial, industrial and office areas	1
	Active Green / Open Parking Lot. Active green Areas	7	Active green and open parking lots	7
	Public Administration Areas	9	Public administration areas	9
	Social / Cultural/Educational/Sport Areas.	9	Social, cultural,	9
			educational and sport areas	4

Table 24: Spatial references preselected for land usage context – Kadiköy

There is a lot of interest from Kadiköy e-mobility structure. There are existing charging stations but also planned station in near future. New market models are under discussion for sharing energy from public-owned ones.

Technical / Physical Infrastructure				
Category	Spatial reference	MCDA Value	Reclassification Groups	Remap Value

e- Mobility Infrastructure	Existing EV chargers and impact areas	6	0-250m	6
			250-500m	6
			500-750m	1
			750-1000m	1

Table 25: Spatial references preselected for Physical Infrastructure – Kadiköy

Regarding the micro grid applications, nowadays there is no existence of them in Kadiköy but the city considers it interesting for the future and the regulatory framework is under evaluation for the implementations.

Virtual Structure		
Category	Spatial reference	MCDA Value
Micro Grid Applications	Impact areas of micro-grids/ islands	#N/A

Table 26: Spatial references preselected for Virtual Infrastructure – Kadiköy

High density zones play a key role for being participative and implementing PEDs economically and socially. Including the energy communities and other related cooperatives and associations seems to be interesting, however, there is no spatial data available to include it in the GIS assessment. There is one energy cooperative but the impact area of the organization has not been identified yet, that's why it is not included in the assessment.

Social structure				
Category	Spatial reference	MCDA Value	Reclassification Groups	Remap Value
Current and Projected Population	Population Density identified in Spatial Data	8	-3	2
			-2	3
			-1	4
			0	5
			1	6
			2	7
			3	8
Energy Organisations	Impact and organizational areas of energy Communities /	0	#N/A	#N/A

	cooperatives / housing associations.			
Socio-Cultural Economic Behaviour	Cultural Human Behaviour	6	#N/A	#N/A
	Vulnerable Communities	0	#N/A	#N/A

Table 27: Spatial references preselected for Social structure – Kadiköy

According to Kadiköy selection of the spatial references, GIS layers to be included in the study area identified. Considering the availability of Kadiköy information in GIS format, the six GIS layers summarized in the Figure 16 are considered in the analysis.

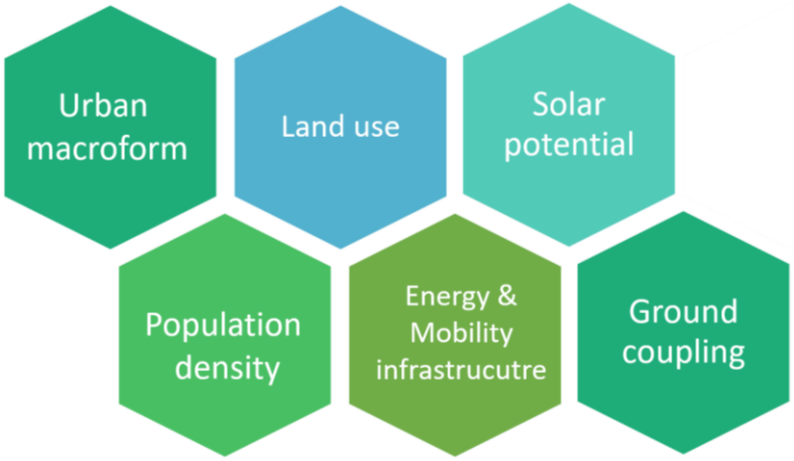


Figure 16: GIS layers considered in the analysis – Kadiköy

In order to be included in the analysis properly, each of these layers needs specific data treatment for reclassification purposes. Based on the results obtained from MCDA, the influence values and remap values of all layers are calculated in the weighted overlay tool. The total value of influence percentage was arranged to % 100 (Table 28). After the table values are prepared, all layers that we reclassified were added to the weighted overlay analysing tool in ArcGIS software.

Spatial reference	Approach	Prioritization for overlay (Influence)
Potential solar energy investment zones	Based on the GIS layer land use sent by the city.	8%
Extensive ground coupling potential for cooling and heating purposes	Based on the GIS layer land use sent by the city.	12%
Retrofitting Area	Based on the GIS layer land use sent by the city and TS825 standards.	5%

Spatial reference	Approach	Prioritization for overlay (Influence)
Transformation / Reuse Areas	Based on the GIS layer land use sent by the city and Kadiköy Urban Transformation Strategy Report.	12%
Residential & Mixed-Use Areas	Based on the GIS layer land use sent by the city.	7%
Commercial Areas	Based on the GIS layer land use sent by the city.	1%
Active Green / Open Parking Lo	Based on the GIS layer land use sent by the city.	10%
Public Administration Areas	Based on the GIS layer land use sent by the city.	12%
Social / Cultural/Educational/Sport Areas	Based on the GIS layer land use sent by the city.	12%
E-Mobility Infrastructure	Based on the GIS layer land use sent by the city.	8%
Population Density	Based on the GIS layer land use sent by the city and expert comments on economic viability.	11%

Table 28: GIS analysis approach and prioritization scores – Kadiköy

6.2 Definition of already chosen areas

At proposal stage Kadiköy identified two districts with potential to become PED: Hasanpasa and Caferaga. Table below summarized the justification of the city while selecting these areas.

QUESTIONS to the City	Concerns of the City
What were the main conditions (in economic, political, social and technical point of view) when identifying the PED area in the city?	· being a transport hub, · to involve different types of building that used individual and common, · to involve buildings that have different uses (public, commercial, private, etc.), · to be an urban area that will be planned to transform soon or likely, · to have more energy consumption such as a wedding hall or Municipality building, · integrability of the between the different type of building and its uses.
What was the first consideration on deciding the resources for energy generation in the city?	Reducing GHG emissions, and energy efficiency implementations are involved in the SECAP of Kadiköy. plan. These proposes are point out to generate and use natural and sustainable energy. Resources of energy generation were determined in the line with the goals of SECAP and also in Kadiköy Municipality Strategic Plan.

QUESTIONS to the City	Concerns of the City
What are the main city needs and priorities for lowering energy demand and improving energy efficiency in the city?	Building stock energy and carbon concentrations are the largest components of Kadiköy greenhouse gas inventory. The growing population with changing consumption habits should be steered towards low carbon routes in terms of either structural characteristics or consumption habits, the energy efficiency of building stock should be improved, and new buildings should be constructed in a pattern that requires much lower energy.
What was the scale of the PED area?	Caferağa Neighbourhood is about 11 hectares, and Hasanpaşa is about 2.8 hectares.
Did the PED area include different building uses? Was land-use planning and strategic planning considered while defining the boundaries?	The total construction area of Hasanpaşa Neighborhood is nearly 130.000 m^2 with 166 buildings. 17% of the area is a public use, among which there is also the present headquarters of Kadıköy Municipality. There is a large public car park which is about 12.000 m2. Besides, there is a Cartoon House and wedding hall. Caferağa Neigborhood where 600 people reside, is closer to the port area and to the old center of town. It is a mixed-use area with a large cultural-sport complex in the middle and a large number of commercial outlets and shops. 1.5% of the total area is a public use. 2.8% buildings are heritage structures.

Each PED area has different characteristics that distinguish it from one to another on territory and the possibility of production and use of renewable energy:

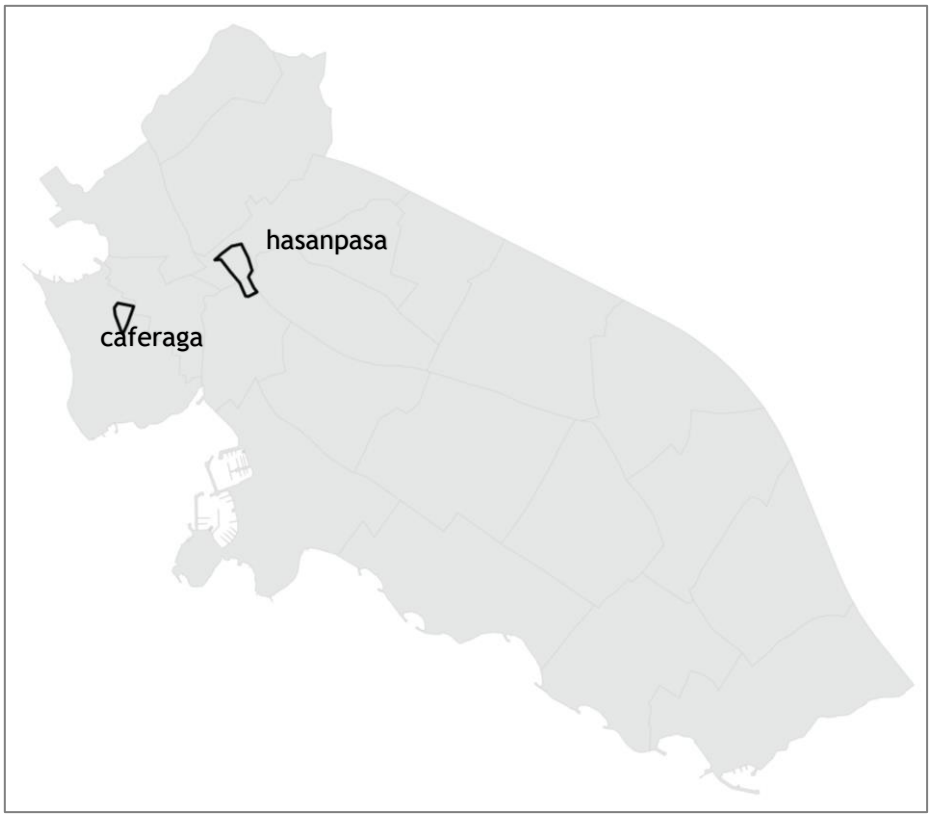


Figure 17 : Kadiköy **preselected areas**

Following chapter presents the results of the GIS overlay analysis to identify Kadiköy suitable areas to become positive and puts in common this result with preselected areas.

6.3 Candidate areas to become a PED

Through this process of validating the methodology for defining PED concept boundaries in cities, Kadiköy represents high potential in solar energy generation, political framework for urban transformation areas supported by energy efficiency purposes and economic viability for investing in energy mostly from public administration areas. There is also potential for bottom-up approaches that are being motivated by energy communities.

As a result of Kadiköy macro scale analysis, most suitable candidate PED area has been marked with dark green colour. The least suitable areas are going through red colour (Figure 18).

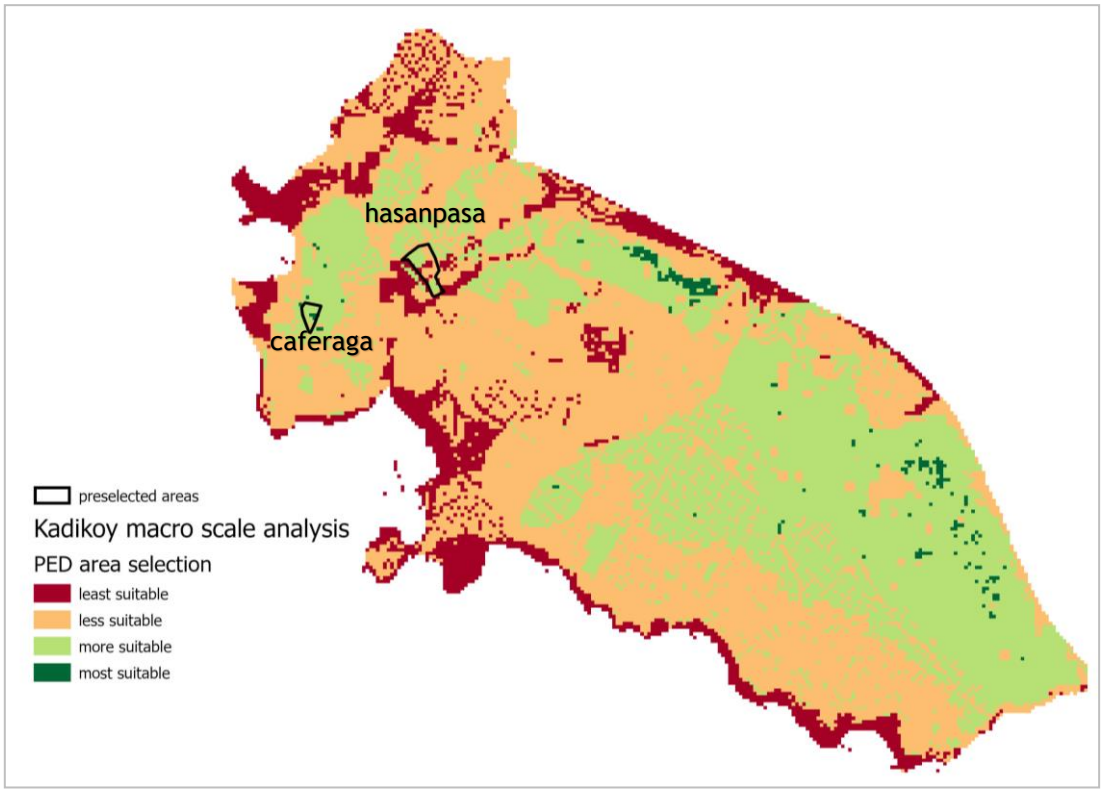


Figure 18: Kadiköy **preselected and candidate areas to become positive**

It is important to note that the location with the most suitable results has a value of 4/9.

From preselected areas, Caferaga seems to have more potential to become energy positive.

7 Selection of PED areas in FWC: León

The city of León is one of the main provincial capitals in Castilla y León, a Spanish objective in the European Union.

In demographic terms, León is the fourth city of the region. It is a medium-sized city with a population of 124.722 inhabitants in 2018, boasting a significant expansion throughout the 20th century. The municipality of León displays a complex structure in which the urban area together with minor suburban developments amount to a small agglomeration of almost 200,000 inhabitants for which the Local Authority must cater in terms of all services.

The municipality has an extension of 39,2 km^2 and its density is 3.182 inhabitants/km^2. The housing density for León is 20,08 dwellings/hectare compared to 2,84 dwellings/hectare of the Urban Area.

Figure 19: León main characteristics (Source: D1.2 – City Diagnosis)

Table 29 summarizes the primary energy sources of León.

Solid Fossil fuels	Natural Gas	Oil and petroleum	Renewables and biofuels	Electricity from the grid
0,00	7,23	13,16	0,05	5,22

Table 29: Primary energy sources (MWh/cap)– León

Main characteristics of renewable resources potential in León are summarized in Table 30.

Average solar radiation (kWh/m²year)	Average Wind power density (W/m²)	Geothermal potential conductivity (W/mk)	Water bodies
1.643,56	43,45	1 – 1,1	Bernesga and Torío rivers

Table 30: Renewable resources main characteristics – León

7.1 State of Play / Analyses of City Characteristics and Priorities

The study for identifying PED concept boundaries in León is developed by collecting digital data accompanied with gathering the city's results for MCDA questionnaire. The classification of the GIS data required to identify the PED area has been made by considering the macro scale requirements.

From the León city GIS database, existing and potential solar efficient zones, geomorphological structure for assessing thermal storage potential, surface water resources for hydro generation, biomass impact areas, New Development, Retrofitting, Infill, Transformation / Reuse areas, Land-usage, E-Mobility Infrastructure and Population Density are gathered. The analyses are operated with ARCGIS software. All layers were converted into rasters for the reclassification stage. The procedure followed for grouping process of the values in the layers are explained in detail in methodology Section 4.3 – step 2 from technical expertise point of view. The final stage is realized by evaluating the results from the MCDA and the reclassified groups together. As mentioned before, a multi-criteria analysis together with spatial and technical analysis were followed for analyzing FWCs' context, to state their needs and priorities and to superimpose energy and urban strategic planning. The MCDA questionnaire filled in by León city considers not only the spatial information that exists, but also the potential of the city in terms of economic, social, legal aspects without GIS data. The result of León city questionnaire was obtained according to the expert opinions of the city and the results are presented in ANNEX I.

The score values collected from the MCDA questionnaire and the reclassification stage are presented in Table 37-42 for all categories. The remap value in the analysis was chosen between 1-9 value to be consistent with MCDA method.

Potential solar energy zones are mostly green areas and parking lots. The geomorphological structure of Kadiköy presents that there are potential areas for aquifer technologies especially areas with clay and sand types of soil. Available zones exist for drilling and there is no legal barrier for public drilling.

There are some streams and rivers but without relevant energy generation or evaporative potential since they are mostly rehabilitated and closed with land transport purposes.

There is a privately owned solar park around the city. Potential solar energy zones are mostly parking lots and abandoned areas that are municipally owned. roof area of publicly owned congress centre (public) is ~16000m^2 can be given as a potential area for solar installations, as well.

There is medium ground temperature for ground coupling potential for cooling and heating purposes. Available zones exist for drilling and there is no legal barrier for public drilling. There are some streams and two rivers but without relevant potential. There are two old ponds (5.000 m^2) from the water supply infrastructure (currently empty and with no use) located in the upper level of the city.

Social acceptability of biomass is medium-high. There are many installed heating systems. But there is very low acceptability of biomass central generation plants. Pruning residues are not currently used as fuel, but both municipal services (waste and gardening) what to used them as fuel, and there is a technical study already done about it.

Industries with heat energy recovery potential (i.e. cement manufacture, steel working) exist and there is relevant heat demand in the city.

Resource Availability				
Category	Spatial reference	MCDA Value	Reclassification Groups	Remap Value
Solar Efficient zones	Existing solar energy investment zones	9	0-250m	9
			250-500m	9
			500-750m	1
			750-1000m	1
	Potential solar energy investment zones	9	All zones	9
Ground Coupling	Extensive ground coupling potential for cooling and heating purposes	8	Silts	1
			Siliceous-medium	2
			Siliceous-low	3
			Sands	8
			Polymictic	2
Water resources	Potential surface water resources for energy generation. Hydropower.	2	250-500m	2
			750-1000m	1
	Water surfaces with evaporative potential	7	100m	7
			200m	5
			300m	3
			400m	1
			500m	1
Biomass	Potential energy generation areas by biomass.	7	All zones	7
Waste heat potential	Waste heat Potential	0	existing	1
			potential	1

Table 31: Spatial references preselected for resource availability – León

León selected all the urban macroform components considered relevant for identifying the areas with potential to become positive. Selected values respond to a suitable legal framework that promotes PED implementation and economic resources availability. Although León is a shrinking city, there are new

development zones planned. Currently new building regulation has high requirements for renewable use of energy and efficiency, and DH is included. Every year the tax deduction is reviewed and sometimes there are specific deduction for renewable implementation or improvements in energy efficiency, but it varies every year. There is a legal framework for self-production and consumption and sharing mechanisms. There is no legal framework for DH infrastructure (pipes).

Urban Macroform				
Category	Spatial reference	MCDA Value	Reclassification Groups	Remap Value
New Development Areas	New Development Zones	6	All zones	6
Retrofitting Areas	Old Building Stock areas	9	All zones	9
Infill Areas.	Redevelopment or land recycling areas	7	All zones	7
Transformation / Reuse Areas	Urban Transformation Areas	6	All zones	6

Table 32: Spatial references preselected for urban macroform – León

Regarding land use context, the differences in defined priorities for León have been defined according to the existence of investment plans. The legal framework is suitable and social acceptability is well seen in this context.

Land usage context				
Category	Spatial reference	MCDA Value	Reclassification Groups	Remap Value
Land Cover in Zonings / Islands	Residential & Mixed-Use Areas	5	Residential and mixed-use areas	5
	Commercial Areas	4	Commercial, industrial and office areas	4
	Active Green / Open Parking Lot. Active green	8	Active green and open parking lots	8
	Public Administration Areas	9	Public administration areas	9
	Social / Cultural/Educational/Sport Areas.	9	Social, cultural, educational and sport areas	9

Table 33: Spatial references preselected for land usage context – León

There is a lot of interest from León municipality in energy and e-mobility structure and components. Outside the municipality, there would be the High Voltage Network, of Spanish Electricity Network "Red Eléctrica Española", which is public. In low voltage, within the municipality, the networks are private property, (owned by companies), but the network is considered a public service, and therefore can be arranged along public roads. The city assumes that citizens are open to sharing networks.

Technical / Physical Structure				
Category	Spatial reference	MCDA Value	Reclassification Groups	Remap Value
Power Infrastructure	High / Low voltage power grid and its impact area	9	#N/A	#N/A
Heat Network	Natural gas pipeline network	5	#N/A	#N/A
Mobility Infrastructure	Existing EV chargers and impact areas	9	0-250m	7
			250-500m	5
			500-750m	3
			750-1000m	1

Table 34: Spatial references preselected for Energy / E-mobility structure – León

Regarding the micro grid applications, nowadays there is no application in León but the city considers it interesting for the future and the regulatory framework is suitable for the implementation.

Virtual Structure		
Category	Spatial reference	MCDA Value
Micro Grid Applications	Impact areas of micro-grids/ islands	0

Table 35: Spatial references preselected for Energy service availability – León

High density zones play a key role for being participative and implementing PEDs economically and socially. Including the energy communities and other related cooperatives and associations seems to be interesting, however, there is no spatial data available to include it in the GIS assessment.

Social structure				
Category	Spatial reference	MCDA Value	Reclassification Groups	Remap Value
			0-500	2

Current and Projected Population	Population Density identified in Spatial Data	7	501-1000	3
			1001-1500	4
			1501-2000	5
			2001-2500	6
			>2501	7
	Population Projections for new development zones	8	#N/A	#N/A
Energy Organisations	Impact and organizational areas of energy Communities / cooperatives / housing associations.	6	#N/A	#N/A
Socio-Cultural Economic Behaviour	Cultural Human Behaviour	4	#N/A	#N/A
	Vulnerable Communities	7	#N/A	#N/A

Table 36: Spatial references preselected for Social structure – León

According to León selection of the spatial references, GIS layers to be included in the study are identified. Considering the availability of León information in GIS format, the nine GIS layers summarized in the Figure 20 are considered in the analysis.

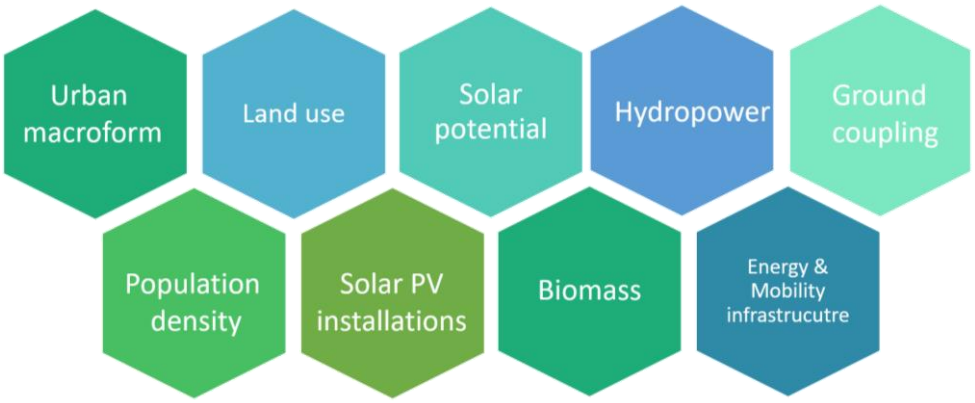


Figure 20: GIS layers considered in the analysis – León

In order to be included in the analysis properly, each of these layers needs specific data treatment for reclassification purposes. Based on the results obtained from MCDA, the influence values and remap values of all layers are calculated in the weighted overlay tool. The total value of influence percentage was arranged to % 100 (Table 37: GIS analysis approach and prioritization scores – León). After the table values are prepared, all layers that we reclassified were added to the weighted overlay analysing tool in ArcGIS software.

Spatial reference	Approach	Prioritization for overlay (Influence)
Existing solar energy investment zones	Based on the GIS layer land use sent by the city.	7%
Potential solar energy investment zones	Based on the GIS layer land use sent by the city.	7%
Extensive ground coupling potential for cooling and heating purposes	Based on the GIS layer land use sent by the city.	6%
Potential surface water resources for energy generation.	Based on the GIS layer land use sent by the city.	2%
Water surfaces with evaporative potential	Based on the GIS layer land use sent by the city.	6%
Potential energy generation areas by biomass	Based on the GIS layer land use sent by the city.	6%
New Development Areas	Based on the GIS layer land use sent by the city.	5%
Retrofitting Area	Based on the GIS layer land use sent by the city.	7%
Infill Areas	Based on the GIS layer land use sent by the city.	6%
Transformation / Reuse Areas	Based on the GIS layer land use sent by the city.	5%
Residential & Mixed-Use Areas	Based on the GIS layer land use sent by the city.	6%
Commercial Areas	Based on the GIS layer land use sent by the city.	3%
Active Green / Open Parking Lo	Based on the GIS layer land use sent by the city.	6%
Public Administration Areas	Based on the GIS layer land use sent by the city.	7%
Social / Cultural/Educational/Sport Areas	Based on the GIS layer land use sent by the city.	7%
E-Mobility Infrastructure	Based on the GIS layer land use sent by the city.	7%
Population Density	Based on the GIS layer land use sent by the city.	6%

Table 37: GIS analysis approach and prioritization scores – León

7.2 Definition of already chosen areas

At proposal stage León identified one district with potential to become PED mainly because it is an EDUSI area. EDUSI is the Spanish acronym for ISUDS (Integrated Sustainable Urban Development Strategies) and gives a great opportunity to this area to develop solutions to become PED. Table below summarized the justification of the city while selecting this area.

QUESTIONS to the City	Concerns of the City
What were the main conditions (in economic, political, social and technical point of view) when identifying the PED area in the city?	· Execution of a large investment of ERDF funds has been programmed in the selected area. · PED is an opportunity to solve city problems. it gives the ability to manoeuvre. · In the area are the most populated and popular neighbourhoods of the city, with the presence of vulnerable groups in a situation of inequality and social fracture. Social balance. · The housing stock is quite old and run down. · PED is an area with enormous potential for improvement where we understand that actions will be well received.
What was the first consideration on deciding the resoruces for energy generation in the city?	Considering resources of the city and not only renewable sources as "the sun" (that contributes to reduce the country's enormous external energy dependence) but also considering available technologies as well as workforce, management structures and know-how, etc. The sources for energy generation have not been decided yet for the selected PED area. A district heating project with a biomass central of energy was under study in the previous years but there were a strong social rejection and finally it is on stand-by.
What are the main city needs and priorities for lowering energy demand and improving energy efficiency in the city?	· Changing social behaviour is fundamental. Monitoring and control systems contribute to changing people's habits along with awareness campaigns. · Increase the use of renewables. · Improve efficiency · Improve the behaviour of the thermal envelope and heating systems of the existing building stock (with a high percentage of dwellings over 25 years old) · Reduce the use of private vehicles and renew the fleet of vehicles that use fossil fuels
What was the scale of the PED area?	It is a macro area. For the time being, we have a very extensive area, 2.26 km2, which is 5.8% of the city of León, but it is home to 21.2% of the population of León. However, we need to reduce it to a viable, more manageable and realistic area.
Did the PED area include different building uses? Was land-use planning and strategic planning considered while defining the boundaries?	Inside the EDUSI boundary there is all kind of buildings (residential, tertiary, and even a small industrial area). This area has been delimited to develop an "EDUSI" (Estrategia de Desarrollo Urbano Sostenible Integrada): Sustainable and Integrated Urban Development Strategy, and it comprises almost all kind of Spanish types of land-use planning (Urban Consolidated Areas, New Development Areas, Rustic Areas, Regeneration Areas and Cultural Heritage Protected Areas).

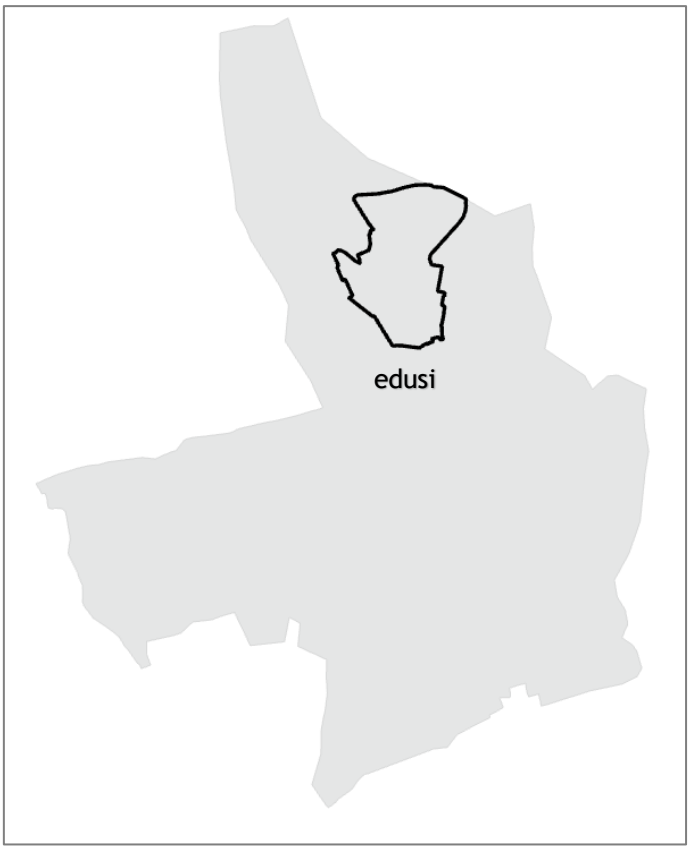


Figure 21: León preselected area

Following chapter presents the results of the GIS overlay analysis to identify León suitable areas to become positive and puts in common this result with preselected areas.

7.3 Candidate areas to become a PED

Through this process of validating the methodology for defining PED concept boundaries in cities, León represents high potential in solar energy generation, political framework for urban transformation areas supported by energy efficiency purposes and economic viability for investing in energy mostly from public administration areas. There is also potential for bottom-up approaches that are being motivated by energy communities.

As a result of León macro scale analysis, the most suitable candidate PED area has been marked with a dark green colour. The least suitable areas are indicated with a red colour (Figure 22).

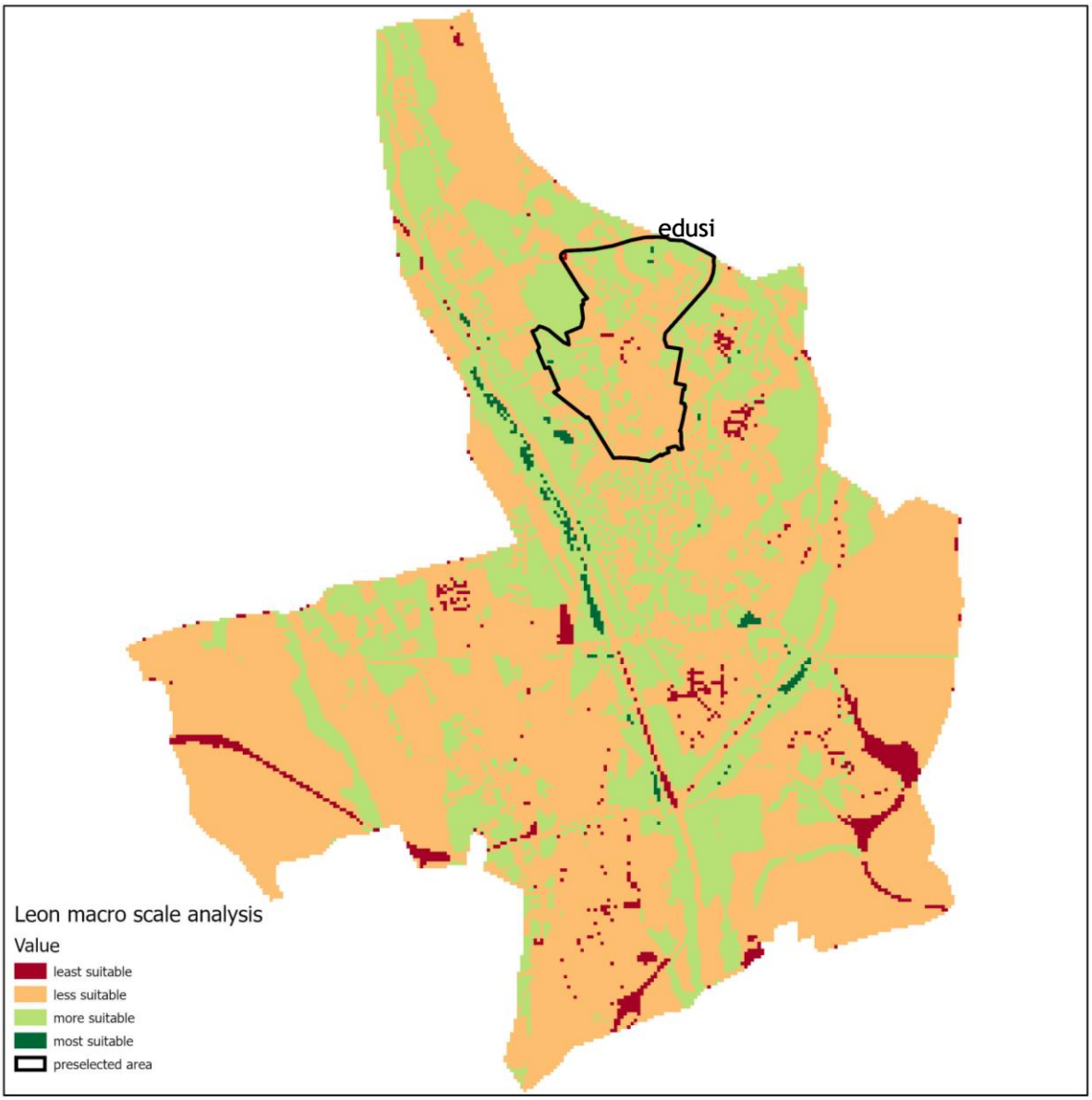


Figure 22: León preselected and candidate areas to become positive

It is important to note that the location with the most suitable results has a value of 4/9.

Regarding the preselected areas, there is a huge range of both positive and negative potentialities. It seems that expanding the area to cover more suitable zones could help in the conversion. Micro analysis to be done in next steps of WP4 will analyse this possibility.

8 Selection of PED areas in FWC: Lublin

Lublin is located in eastern Poland in the geographical macro-region Wyżyna Lubelska. Lublin, with a population of 339,7 thousand inhabitants[11], is the largest economic and academic centre in Eastern Poland, as well as the capital of the Lublin province. Occupying an area of 14.747 ha, it is on the 9th place in terms of area in the country. Lublin is the only city in the macro-region with a metropolitan profile, covering the Lublin Metropolitan Area. According to the division of urban centres included in the National Spatial Development Concept 2030 Lublin was included in the group of centres of primary importance for the settlement system of the country and its economy.

Figure 23: Lublin main characteristics (Source: D1.2 – City Diagnosis)

Table 38 summarizes the primary energy sources of Lublin.

Solid Fossil fuels	Natural Gas	Oil and petroleum	Renewables and biofuels	Electricity from the grid
0,53	3,67	0,02	4,25	3,30

Table 38: Primary energy sources (MWh/cap)– Lublin

Main characteristics of renewable resources potential in Lublin are summarized in Table 39.

Average solar radiation (kWh/m²year)	Average Wind power density (W/m²)	Geothermal potential conductivity (W/mk)	Water bodies
1.128,47	61,99	1	Bystrzyca River

Table 39: Renewable resources main characteristics – Lublin

[11] Central Statistical Office, Local Data Bank, Population by age and gender groups, data as at 31st of December 2018.

8.1 State of Play / Analyses of City Characteristics and Priorities

The study for identifying PED concept boundaries in Lublin was developed by collecting digital data accompanied with gathering the city's results for MCDA questionnaire. The classification of the GIS data required to identify the PED area has been made by considering the macro scale requirements.

From Lublin city GIS database, surface water resources for hydro generation, biomass impact areas, waste heat potential, New Development, Retrofitting, Land-usage, Heat grid and E-Mobility Infrastructure are gathered. The analyses were operated with ARCGIS software. All layers converted into rasters for the reclassification stage. The procedure followed for grouping process of the values in the layers are explained in detail in methodology Section 4.3 – step 2 from technical expertise point of view. The final stage was realized by evaluating the results from the MCDA and the reclassified groups together. As mentioned before, a multi-criteria analysis together with spatial and technical analysis were followed for analysing FWCs' context, to state their needs and priorities and to superimpose energy and urban strategic planning. The MCDA questionnaire filled by Lublin city, not only by considering the spatial information that exists, but also the potential of the city in terms of economic, social, legal aspects without GIS data. The result of Lublin city questionnaire was obtained according to the expert opinions of the city and the results are presented in ANNEX I.

The score values collected from the MCDA questionnaire and the reclassification stage are presented in Table 46-51 for all categories. The remap value in the analysis was chosen between 1-9 value to be consistent with MCDA method.

In Poland, each house has an individual PV, and the surplus of energy produced is fed into the grid. Owner buys it in the period of lower sunlight (winter) at a lower price (discount). It is not popular to build PV farms for purposes such as housing estates. One "PV farm" = 1 building.

On the other hand, the installation using energy from biogas is located in the Hajdów sewage treatment plant, belonging to Miejskie Przedsiębiorstwo Wodociągów i Kanalizacji w Lublinie Sp. z o.o. This plant is located in the eastern part of the city and treats domestic and industrial sewage from Lublin, Świdnik, Wólka, Głuska and Konopnica."

Resource Availability				
Category	Spatial reference	MCDA Value	Reclassification Groups	Remap Value
Water resources	Potential surface water resources for energy generation. Hydropower.	6	250-500m	6
			750-1000m	1
	Water surfaces with evaporative potential	0	50m	1
			100m	1
			150m	1
			200m	1

Biomass	Potential energy generation areas by biogas.	6	Sewage Plant polygon	6
Waste heat potential	Industrial zones with waste heat potential	7	Existing industries	7

Table 40: Spatial references preselected for resource availability – Lublin

Lublin's urban macroform components considered are relevant for identifying the areas with potential to become positive. According to EPD Regulations in Poland, buildings before 2002 are estimated as not insulated.
The spatial development plan of Lublin indicates single family, multifamily housing and mixed-use development areas as new development areas which are mostly located at the borders of the city.

Urban Macroform				
Category	Spatial reference	MCDA Value	Reclassification Groups	Remap Value
New Development Areas	New Development Zones	6	1)single family housing 2) multifamily housing 3) mixed use development	1) 6 2) 6 3) 6
Retrofitting Areas	Old Building Stock areas		1) Before 2002 2) After 2002	

Table 41: Spatial references preselected for urban macroform – Lublin

According to the land use context, the legal mechanism is promoting energy efficiency retrofitting and/or renewables implementations for residential, commercial, and public administration areas. Private and/or public investment plans and incentives are available for active areas to implement renewables.

Land usage context				
Category	Spatial reference	MCDA Value	Reclassification Groups	Remap Value
Land Cover in Zonings / Islands	Residential & Mixed-Use Areas	8	residential areas	8
	Commercial Areas	9	commercial sales areas within spatial development plan	9
	Active Green / Open Parking Lot. Active green	5	1)green areas 2)recreation-leisure areas	5

			3)parking lots	
	Public Administration Areas	9	public_service_area_spatial_plan	9

Table 42: Spatial references preselected for land usage context – Lublin

There is a lot of interest from Lublin municipality in integrating the existing district heating grid for connecting and sharing energy or integration of a technology such as "heat pumps" that would promote a potential PED.

The district heating system is based on the heat produced by power plants. The Lublin heating system consists of a district heating network managed by the municipal company Lubelskie Przedsiębiorstwo Energetyki Cieplnej S.A. and two combined heat and power plants: PGE Energia Ciepła S.A. Branch Elektrociepłownia in Lublin Wrotków and Elektrociepłownia MEGATEM EC-Lublin Sp. z o.o.

Energy / E-mobility structure				
Category	Spatial reference	MCDA Value	Reclassification Groups	Remap Value
Heat Grid	District Heating / Cooling grid and its impact areas	7	Polygons for heat grid impact area	7
Mobility Infrastructure	Existing EV chargers and impact areas	9	0-250m	9
			250-500m	9
			500-750m	1
			750-1000m	1

Table 43: Spatial references preselected for Energy / E-mobility structure – Lublin

Regulatory framework is suitable for micro grid applications in Lublin. But there is no spatial data confirmed for impact areas that's why this cannot be evaluated for PED area selection weighted overlay analysis.

Energy service availability		
Category	Spatial reference	MCDA Value
Micro Grid Applications	Impact areas of micro-grids/ islands	#N/A

Table 44: Spatial references preselected for Energy service availability – Lublin

High density zones play a key role for being participative and implementing PEDs economically and socially. Including the energy communities and other related cooperatives and associations seems to be interesting, however, there is no spatial data available to include it in the GIS assessment for social structure components.

Social structure				
Category	Spatial reference	MCDA Value	Reclassification Groups	Remap Value
Current and Projected Population	Population Density identified in Spatial Data	9	#N/A	#N/A
	Population Projections for new development zones	8	#N/A	#N/A
Self-sufficient districts / neighbourhoods	Impact and organizational areas of energy Communities / cooperatives / housing associations.	4	#N/A	#N/A
Socio-Cultural Economic Behaviour	Cultural Human Behaviour	7	#N/A	#N/A
	Vulnerable Communities	3	#N/A	#N/A

Table 45: Spatial references preselected for Social structure – Lublin

According to Lublin selection of the spatial references, GIS layers to be included in the study are identified. Considering the availability of Lublin information in GIS format and information available at open sources, the six GIS layers summarized in Figure 24 were considered in the analysis.

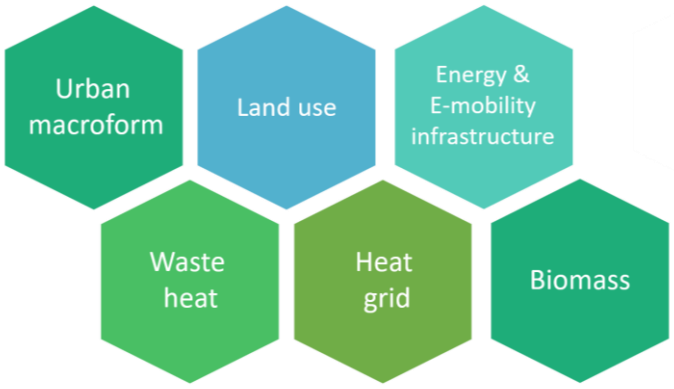


Figure 24: GIS layers considered in the analysis – Lublin

In order to be included in the analysis properly, each of this layer needed specific data treatment for reclassification purposes. Based on the results obtained from MCDA, the influence values and remap values of all layers were calculated in the tool. The total value of influence percentage was arranged to % 100 (Table 46). After the table values were prepared, all layers that we reclassified were added to the weighted overlay analysing tool in ArcGIS software.

Spatial reference	Approach	Prioritization for overlay (Influence)
Potential surface water resources for energy generation.	Based on the GIS layer land use sent by the city.	% 8
Water surfaces with evaporative potential	Based on the GIS layer land use sent by the city.	% 0
Potential energy generation areas by biomass	Based on the GIS layer land use sent by the city.	% 8
Waste heat Potential	Based on the GIS layer land use sent by the city.	% 9
New Development Areas	Based on the GIS layer land use sent by the city.	% 8
Retrofitting Area	Based on the GIS layer land use sent by the city.	% 6
Residential & Mixed-Use Areas	Based on the GIS layer land use sent by the city.	% 10
Commercial Areas	Based on the GIS layer land use sent by the city.	% 12
Active Green / Open Parking Lot	Based on the GIS layer land use sent by the city.	% 9
Public Administration Areas	Based on the GIS layer land use sent by the city.	% 12
Heat Grid	Based on the GIS layer land use sent by the city.	% 9
E-Mobility Infrastructure	Based on the GIS layer land use sent by the city.	% 12

Table 46: GIS analysis approach and prioritization scores – Lublin

8.2 Definition of already chosen areas

At proposal stage Lublin identified 2 districts with potential to become PED.

QUESTIONS to the City	Concerns of the City
What were the main conditions (in economic, political, social and technical point of view) when identifying the PED area in the city?	There are areas in Lublin that are characterized by energy poverty, but as a result, poverty and degradation of the area. The division of the property owner to enable co-financing of the investment and to have many business stakeholders at the implementation stage is targetted. The proposed PED is equipped with both gas and heating network. In terms of demographics, this area is highly diversified. There is a contrast between students who rent flats and mainly elderly people who live there.

QUESTIONS to the City	Concerns of the City
What was the first consideration on deciding the resources for energy generation in the city?	Buildings not connected to the heating network use gas or have their own coal heating. Renewable energy sources are also used, but on a much smaller scale. There have been no plans to close mines and thus reduce production, but the authorities are slowly starting to shape the policy towards decarbonisation by 2050.
What are the main city needs and priorities for lowering energy demand and improving energy efficiency in the city?	· The district heating network is intensively developed and more and more buildings may be connected to it. · Improvement of the heating efficiency itself - thermal modernization of buildings · When it comes to street lighting, a good solution would be to introduce an intelligent system, which, thanks to its functionality, would affect both the comfort of the residents and the energy savings and economy. · When it comes to the use of electricity in private households, apart from educational campaigns on how to accumulate savings, the city cannot do much - unless heat and power plants from Lublin, some of the rest of the country, give up coal for another source · Another issue concerns urban mobility. Steps should be taken to reduce the emission of harmful gases.
What was the scale of the PED area?	The PED area is 2,2km^2
Did the PED area include different building uses? Was land-use planning and strategic planning considered while defining the boundaries?	The area intertwined with many different but complementary functions: Educational (schools, universities, libraries), service (shops, small service establishments), residential (multi-family residential buildings, dormitories), churches, recreational areas.

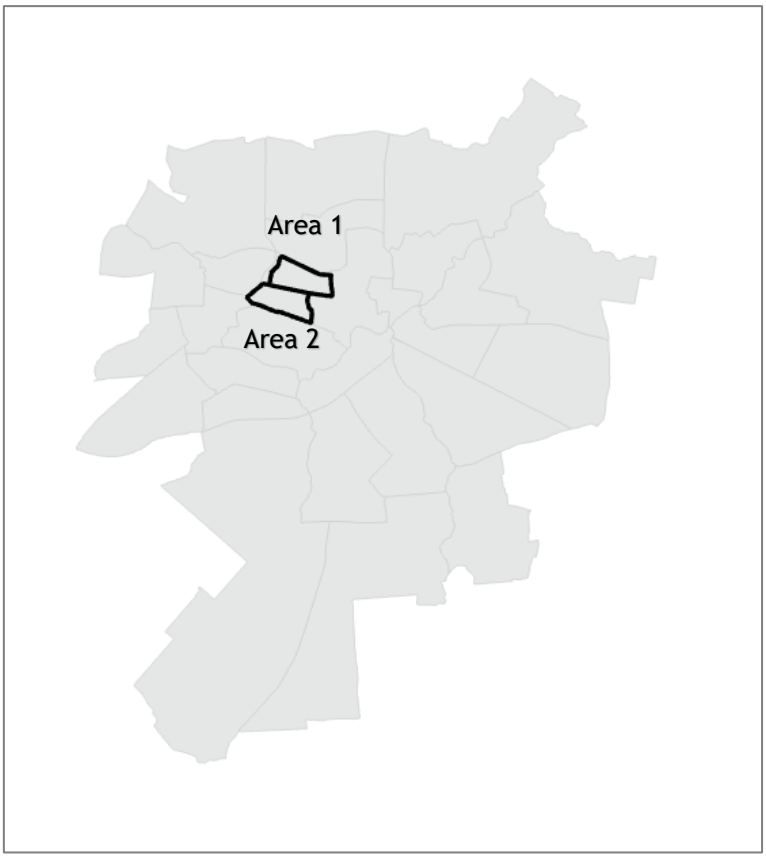


Figure 25: Lublin preselected areas

Following chapter presents the results of the GIS overlay analysis to identify Lublin suitable areas to become positive and puts in common this result with preselected areas.

8.3 Candidate areas to become a PED

Through this process of validating the methodology for defining PED concept boundaries in cities, Lublin represents high potential in waste heat from industries, biogas from sewage treatment plants and hydrogeneration from water resources, political framework is available for promoting the energy efficiency and/or renewables implementations in public administration, residential and commercial areas. The district heating grid plays a key role for areas nearby for connecting and sharing energy or integration of a technology such as "heat pumps" that would be a potential PED. It provides storage or integration different types of renewable technologies and legal mechanisms exist for the promotion of the implementation of renewables and the substitution of boilers or other outdated technology.

As a result of Lublin macro scale analysis, most suitable candidate PED area has been marked with a dark green colour. The least suitable areas are indicated with a red colour. (Figure 26)

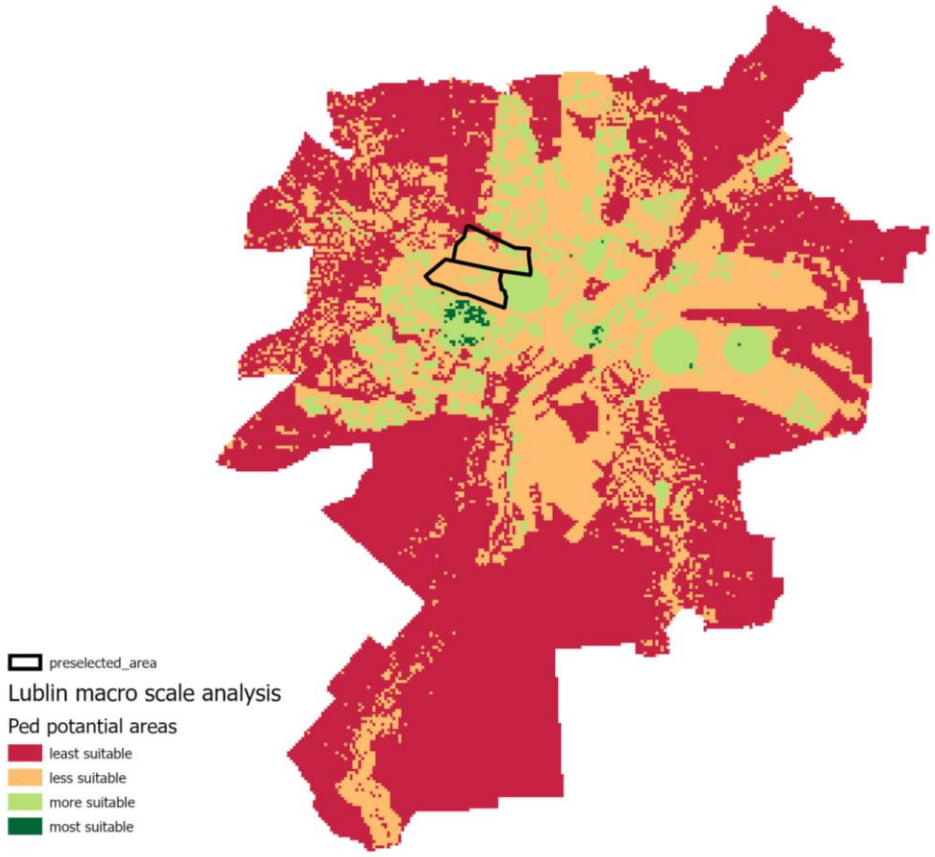


Figure 26: Lublin preselected and candidate areas to become positive

It is important to note that the location with the most suitable results has a value of 4/9.

Going in deep to the results obtained for the preselected areas is needed. Results show that next to preselected areas there are zones with a higher potential to become energy positive.

9 Selection of PED areas in FWC: Trenčín

Trenčín is a city in western Slovakia lying in the valley of the river Vah about 120 kilometres north of the Slovak capital city Bratislava. Trenčín is an old historical city with population about 54.919 inhabitants (Dec 2018). Trenčín consist of 10 cadastral areas: Hanzlíková, Istebník, Kubra, Kubrica, Orechové, Opatová, Trenčianske Biskupice, Záblatie and Zlatovce. Trenčín with 81,99km^2 and a density of 669 inhabitants/km^2 could be characterized as the city with middle level of urban density because of the presence of large green areas.

SLOVAKIA	81,99 km^2	54.916 inhabitants	669,79 people/km^2	EUROPEAN CONTINENTAL CLIMATE

Figure 27: Trenčín main characteristics (Source: D1.2 – City Diagnosis)

Table 47 summarizes the primary energy sources of Trenčín.

Solid Fossil fuels	Natural Gas	Oil and petroleum	Renewables and biofuels	Electricity from the grid
3,85	4,62	4,24	2,12	4,43

Table 47: Primary energy sources (MWh/cap)– Trenčín

Main characteristics of renewable resources potential in Trenčín are summarized in Table 48.

Average solar radiation (kWh/m^{2}year)	Average Wind power density (W/m^2)	Geothermal potential conductivity (W/mk)	Water bodies
1.182,15	50,55	1	Vah river

Table 48: Renewable resources main characteristics – Trenčín

9.1 State of Play / Analyses of City Characteristics and Priorities

The study for identifying PED concept boundaries in Trenčín was developed by collecting digital data accompanied with gathering the city's results for MCDA questionnaire. The classification of the GIS data required to identify the PED area has been made by considering the macro scale requirements.

From Trenčín city GIS database, surface water resources for hydro generation, biomass impact areas, waste heat potential, New Development, Retrofitting, Land-usage, Heat grid and E-Mobility Infrastructure are gathered. The analyses are operated with ARCGIS software. All layers were converted into rasters for the reclassification stage. The procedure followed for grouping process of the values in the layers are explained in detail in Annex III GIS intermediate results of Trenčín. The final stage was realized by evaluating the results from the MCDA and the reclassified groups together. As mentioned before, a multi-criteria analysis together with spatial and technical analysis are followed for analysing FWCs' context, to state their needs and priorities and to superimpose energy and urban strategic planning. The MCDA questionnaire filled by Trenčín city, not only by considering the spatial information that exists, but also the potential of the city in terms of economic, social, legal aspects without GIS data. The result of Trenčín city questionnaire was obtained according to the expert opinions of the city and the results are presented in ANNEX I.

The score values collected from the MCDA questionnaire and the reclassification stage are presented in Table 49 to Table 54 for all categories. The remap value in the analysis was chosen between 1-9 value to be consistent with MCDA method.

There are zones with medium geothermal potential in the city. Legal framework allows the implementation of geothermal, but some restrictions exist. Social acceptability of the geothermal energy is assessed as high-medium. There is current sea, lakes, streams, creeks in the city with high energy generation potential. Legal framework allows the use of water resources for energy generation, but some restrictions exist. There is biomass available close to the city.

Resource Availability				
Category	Spatial reference	MCDA Value	Reclassification Groups	Remap Value
Solar Efficient zones	Existing solar energy investment zones	3	#NA	#NA
	Potential solar energy investment zones	5	#NA	#NA
Ground Coupling	Extensive ground coupling potential for cooling and heating purposes		Cambisols	4
			Fluvisols	1
			Haplic Luvisols	2

		4	Mollic Fluvisols and Mollic Gleysols	1
			Rendzic Leptosols	3
			Calcaric Cambisols	2
Geothermal Water	Existing geothermal water resources	3	6 groups	3
Water resources	Potential surface water resources for energy generation. Hydropower.	9	250-500m	9
			750-1000m	1
	Water surfaces with evaporative potential	0	100m	7
			200m	5
			300m	3
			400m	1
			500m	1
	Potential water resources utilized for heat source for heating / cooling purposes	5	#NA	#NA
Biomass	Potential energy generation areas by biomass.	4	All zones	4
Waste heat potential	Waste heat Potential	0	existing	#NA

Table 49: Spatial references preselected for resource availability – Trenčín

Trenčín selected all the urban macroform components considered relevant for identifying the areas with potential to become positive. Selected values respond to a suitable legal framework that promotes PED implementation and economic resources availability.

Selected areas for retrofitting exist and funding mechanism are already approved. There are infill areas and are mentioned in strategic plan, incentives or any regulations through energy efficiency for new building stock, for PED implementation. Legal framework is suitable for the implementation of PED in infill areas. Strategy of urban regeneration allows the implementation of PED also in transformation/reuse areas.

Urban Macroform				
Category	Spatial reference	MCDA Value	Reclassification Groups	Remap Value
New Development Areas	New Development Zones	9	#NA	#NA
Retrofitting Areas	Old Building Stock areas	6	All zones	6
Infill Areas.	Redevelopment or land recycling areas	7	All zones	7
Transformation / Reuse Areas	Urban Transformation Areas	5	All zones	5

Table 50: Spatial references preselected for urban macroform – Trenčín

Regarding land use context, the differences in defined priorities for Trenčín have been defined according to the existence of investment plans. Legal framework is suitable and social acceptability is well seen in this context.

Land usage context				
Category	Spatial reference	MCDA Value	Reclassification Groups	Remap Value
Land Cover in Zonings / Islands	Residential & Mixed-Use Areas	9	Residential and mixed-use areas	9
	Commercial Areas	9	Commercial, industrial and office areas	9
	Active Green / Open Parking Lot. Active green	8	Active green and open parking lots	8
	Public Administration Areas	9	#NA	#NA
	Social / Cultural/Educational/Sport Areas.	9	Social, cultural, educational and sport areas	9

Table 51: Spatial references preselected for land usage context – Trenčín

There is a lot of interest from Trenčín Municipality in power infrastructure, heat network and e-mobility infrastructure. However, it was no possible including all this information in the assessment. Heat density is medium in relation to the climate. Legal Infrastructure permits trading in public charging stations

Energy / E-mobility structure				
Category	Spatial reference	MCDA Value	Reclassification Groups	Remap Value
Power Infrastructure	High / Low voltage power grid and its impact area	9	#NA	#NA
Heat Network	Natural gas pipeline network	5	#NA	5
Mobility Infrastructure	Existing EV chargers and impact areas	9	#NA	#NA

Table 52: Spatial references preselected for Energy / E-mobility structure – Trenčín

Regarding the micro grid applications, nowadays there is no existence of them in Trenčín but the city considers it interesting for the future and the regulatory framework is suitable for the implementation. Regulatory framework is suitable for micro grid applications implementation.

Energy service availability		
Category	Spatial reference	MCDA Value
Micro Grid Applications	Impact areas of micro-grids/ islands	3

Table 53: Spatial references preselected for Energy service availability – Trenčín

High density zones play a key role for being participative and implementing PEDs economically and socially. Including the energy communities and other related cooperatives and associations seems to be interesting, however, there is no spatial data available to include it in the GIS assessment.

Social structure				
Category	Spatial reference	MCDA Value	Reclassification Groups	Remap Value
Current and Projected Population	Population Density identified in Spatial Data	6	0-100	3
			>100	6
	Population Projections for new development zones	8	#NA	#NA
Energy Organisations	Impact and organizational areas of energy Communities /	0	#NA	#NA

	cooperatives / housing associations.			
Socio-Cultural Economic Behaviour	Cultural Human Behaviour	6	#NA	#NA
	Vulnerable Communities	7	#NA	#NA

Table 54: Spatial references preselected for Social structure – Trenčín

According to the Trenčín selection of the spatial references, GIS layers to be included in the study were identified. Considering the availability of Trenčín information in GIS format and information available at open sources, the seven GIS layers summarized in the Figure 28 were considered in the analysis.

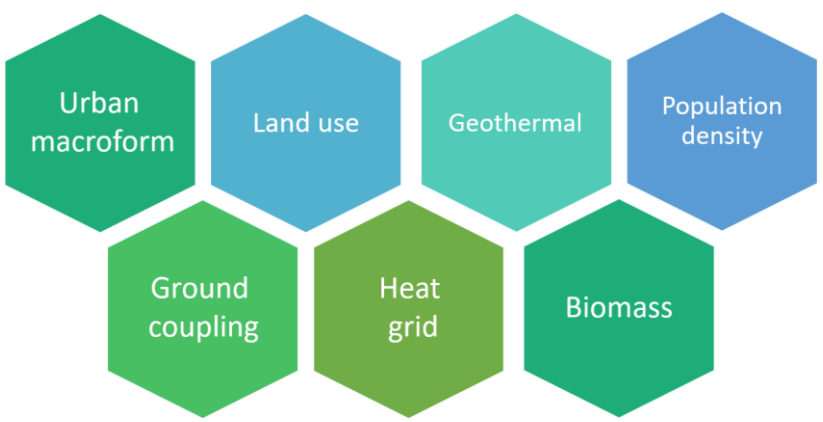


Figure 28: GIS layers considered in the analysis – Trenčín

In order to be included in the analysis properly, each of this layer needed specific data treatment for reclassification purposes. Based on the results obtained from MCDA, the influence values and remap values of all layers were calculated in the tool. The total value of influence percentage was arranged to % 100 (Table 55). After the table values were prepared, all layers that we reclassified were added to the weighted overlay analysing tool in ArcGIS software.

Spatial reference	Approach	Prioritization for overlay (Influence)
Existing solar energy investment zones	Based on the GIS layer land use sent by the city.	7%
Potential solar energy investment zones	Based on the GIS layer land use sent by the city.	7%
Existing wind energy investment zones	#NA	0%
Potential wind energy investment zones	#NA	0%
Extensive ground coupling potential for cooling and heating purposes	Based on the GIS layer land use sent by the city.	5%

Spatial reference	Approach	Prioritization for overlay (Influence)
Geothermal water impact area. (and * Potential Geothermal Water Investment zones)	Based on the GIS layer land use sent by the city.	4%
Potential surface water resources for energy generation.	Based on the GIS layer land use sent by the city.	11%
Potential energy generation areas by biomass	Based on the GIS layer land use sent by the city.	5%
Retrofitting Area	Based on the GIS layer land use sent by the city.	7%
Infill Areas	Based on the GIS layer land use sent by the city.	8%
Transformation / Reuse Areas	Based on the GIS layer land use sent by the city.	6%
Residential & Mixed-Use Areas	Based on the GIS layer land use sent by the city.	11%
Commercial Areas	Based on the GIS layer land use sent by the city.	11%
Active Green / Open Parking Lo	Based on the GIS layer land use sent by the city.	10%
Social / Cultural/Educational/Sport Areas	Based on the GIS layer land use sent by the city.	11%
Heat Grid	Based on the GIS layer land use sent by the city.	6%
Population Density	Based on the GIS layer land use sent by the city.	7%

Table 55: GIS analysis approach and prioritization scores – Trenčín

9.2 Definition of already chosen areas

At proposal stage Trenčín identified districts with potential to become PED were selected according to the information summarized in the following table.

QUESTIONS to the City	Concerns of the City
What were the main conditions (in economic, political, social and technical	There are all types of buildings from the 50s to the present. Various building constructions and various building materials are used. In terms of housing in the selected area of PED, there are family houses as well as residential blocks.

QUESTIONS to the City	Concerns of the City
point of view) when identifying the PED area in the city?	In the PED locality, there are also energy-intensive buildings which are owned by the city of Trenčín. There is a new central urban zone on the riverside close to the historical City centre. There is also a functional railway station with a complete electrical infrastructure in the PED area. The boundary of the PED locality is also formed by a river that flows through the territory. There is also a functional hydroelectric power plant with an output of 16 MW nearby. The whole territory of the PED has the character of an independent town.
What was the first consideration on deciding the resources for energy generation in the city?	· The Slovak Republic has committed itself to carbon neutrality by 2050. · The climate changes already affect Trenčín. · Increasing energy independence. · During 2018 and 2019, the European Union adopted a package of legislative documents, also called the Winter Energy Package. According to this the City wants to be an aggregator of flexibility and wants to support the building of energy communities.
What are the main city needs and priorities for lowering energy demand and improving energy efficiency in the city?	· Low carbon strategy · Climate change mitigation · Transition to electromobility - increasing electrical energy consumption · Energy demand can be managed by increasing energy efficiency of public buildings, etc. · The City of Trenčín plans to use a new financial instrument for the energy recovery of buildings using the guaranteed EPC (Energy performance contracting) energy service. · Increasing public awareness in this topic and the implementation of soft measures supporting social innovations in the behaviour of the citizens.
What was the scale of the PED area?	· 20% of the whole City territory · Diversity of buildings, structures · The selected area for a potential PED is a compact neighbourhood with comprehensive energetics and independent infrastructure
Did the PED area include different building uses? Was land-use planning and strategic planning considered while defining the boundaries?	When defining the boundaries, City strategic documents and Spatial Plan, the City Development Program and the Low Carbon Strategy are considered. There is housing (different kind of housing structures), small areas of industry, greenfield for new development, sports and leisure infrastructure, public institutions (schools etc.). In the process of PED defining the current state of the City Master plan and existing Programme of Social and Economic development of the city of Trenčín for years 2016 - 2022 with a vision to 2040 (the main socio-economic strategic plan of the city) were reflected and our proposed PED area is fully in accordance with them.

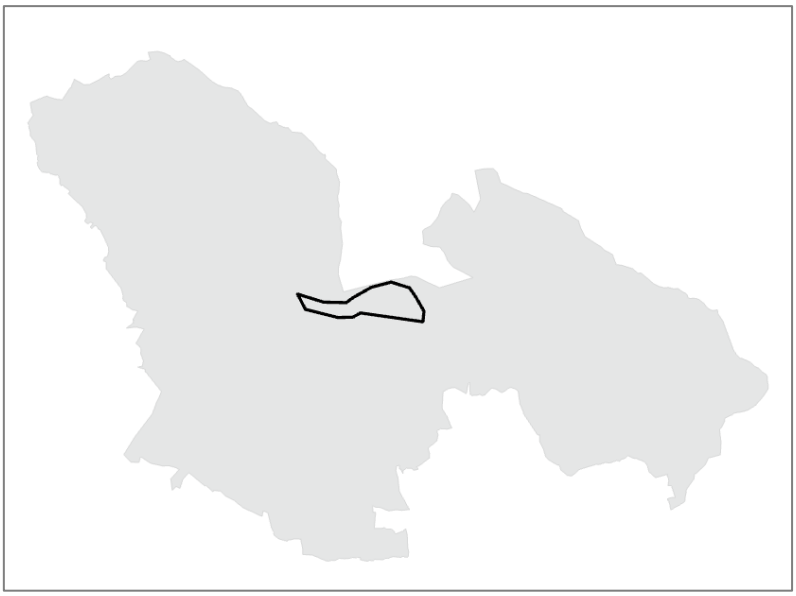


Table 56: Trenčín preselected areas

Following chapter presents the results of the GIS overlay analysis to identify Trenčín suitable areas to become positive and puts in common this result with preselected areas.

9.3 Candidate areas to become a PED

As a result of Trencin macro scale analysis, most suitable candidate PED area has been marked with dark green colour. The least suitable areas are going through red colour.

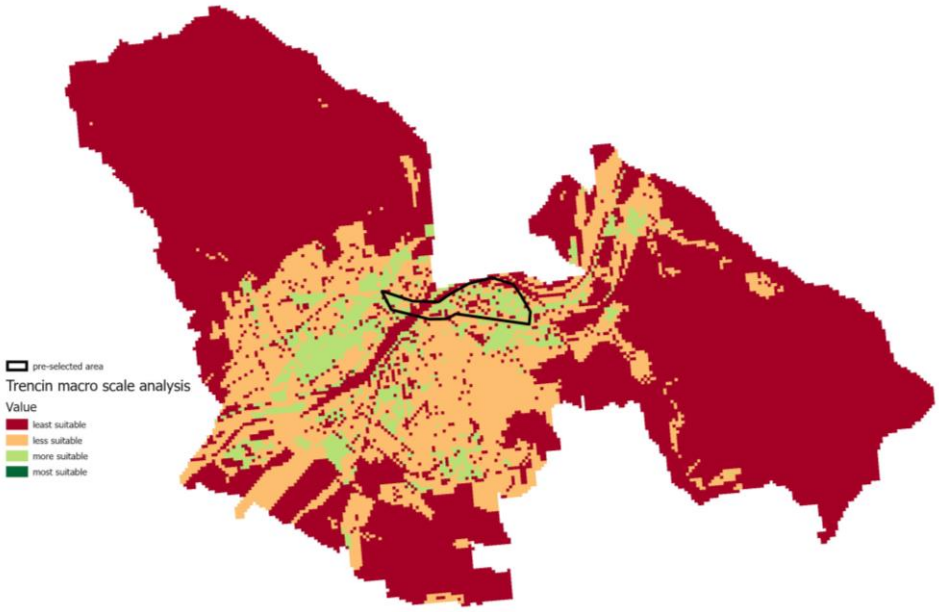


Table 57: Trenčín preselected and candidate areas to become positive

10Selection of PED areas in FWC: Vidin

The municipality of Vidin is a mid-size Bulgarian municipality located in the north-west part of the country, on the Danube river, close to the Romanian and Serbian borders. The municipality of Vidin is a major crossroad to Romania and Serbia via a bridge to the Romanian city Kalafat and major highways to Serbian cities. It is the centre of the Vidin region covering 63,22km^2.

The city of Vidin has a rich history as a cultural and touristic site, and has had a major role in the production industries on national level; however, in the last years the city has suffered recession and companies have retrieved from the region which has also led to migration of the young population. The number of residents of the city reached its peak between 1988 and 1991 when the population exceeded 65.000. As of 2011, the town had a population of 48.071 inhabitants.

BULGARIA	63,22 km²	41.583 inhabitants	657,77 people/km²	CONTINENTAL CLIMATE

Figure 29: Vidin main characteristics (Source: D1.2 – City Diagnosis)

Vidin municipality has a leading role in the region´s economy. Among the most developed economic sectors in the municipality are manufacturing and trade (Vidin is a port city). Agriculture is an important sector, with agricultural areas accounting for about 75% of its entire territory. In the service sector, there is a well-established network of businesses with diverse activities.

Regarding infrastructures, there is no district heating in Vidin and most of the residential buildings are heated by local boiler installations and wood stoves. Due to poor thermal performance of buildings and inefficient heating installations, the consumption of liquid and solid fuel for heating, which has a negative impact on the environment and climate, is increasing.

There is no natural gas supply infrastructure in the municipality. The use of renewable energy sources is also lacking. No deviations of the Republican gas pipeline pass through the district. There are no public, residential or other buildings that are gas supplied. There is no specific gasification project for the territory.

Solid Fossil fuels (MWh/cap)	Natural Gas (MWh/cap)	Oil and petroleum (MWh/cap)	Renewables and biofuels (MWh/cap)	Electricity from the grid (MWh/cap)
1.51	0.10	1.76	1.55	6.08

Table 58: Primary energy sources – Vidin

Average solar radiation (kWh/m²year)	Average Wind power density (W/m²)	Geothermal potential conductivity (W/mk	River
1.450	50	1	Danube

Table 59: Renewable resources main characteristics – Vidin

10.1 State of Play / Analyses of City Characteristics and Priorities

Vidin characteristics and priorities for areas with potential to become positive have been defined according to the MCDA questionnaire. Spatial references selected and prioritization values of each of them are summarized in Table 60 to Table 65. The whole MCDA assessment is included in the annex (page 144).

Regarding resource availability, Vidin is suitable for solar energy with an average radiation of 1.450 kWh/m^{2}year and it has a high social acceptability. However, legal framework is not suitable for this kind of installations, having as a result no solar photovoltaic panels installed in the city. On the other hand, the city is interested in both geothermal and hydrothermal energy. There is no information regarding private installations, but the municipality has made several drilling tests that reflects that the city is suitable for this kind of installations. Vidin has interest in biomass too. The city will study in the future waste heat recovery and hydropower. There is no interest in wind energy.

Resource Availability		
Category	Spatial reference	Value
Solar Efficient zones	Existing solar energy investment zones	8
	Potential solar energy investment zones	7
Ground coupling	Extensive ground coupling potential for cooling and heating purposes	8
Geothermal water	Geothermal water impact area	6

Water resources	Potential surface water resources for energy generation. Hydropower.	9
Biomass	Potential energy generation areas by biomass.	6

Table 60: Spatial references preselected for resource availability – Vidin

Regarding urban macroform, new development areas and retrofitting areas have been selected to include in the analysis. Most buildings need in-depth renovation, self-sufficient production capacities or presuming capacities, intelligent energy monitoring and management.

Urban Macroform		
Category	Spatial reference	Value
New Development Areas	New Development Zones	6
Retrofitting Areas	Old Building Stock areas	9

Table 61: Spatial references preselected for urban macroform – Vidin

Regarding land use context, it is important to note that legal mechanisms promoting energy efficiency retrofitting and/or renewables implementation exist. Citizens medium acceptability to the interventions in residential areas is the only barrier identified in this context. On the other hand, a major target for the city is to reduce the energy demands in the public buildings through energy renovation and RES integration. It is also important to note that within the Municipal Programme and Action Plan for Energy Efficiency a roadmap for 2025 with a vision for 2030 was developed to achieve the energy savings targets for all sectors in Vidin Municipality. The Residential Buildings sector is the most relevant to achieve the energy consumption reduction objectives. Some actions to support the achievement of this objective include the implementation of the National Programme for the Redevelopment of Housing, the replacement of inefficient heating systems, and the implementation of behavioural measures and replacement of old appliances.

Land usage context		
Category	Spatial reference	Value
Land Cover in Zonings / Islands	Residential & Mixed Use Areas	8
	Commercial Areas	9
	Active Green / Open Parking Lot. Active green	9
	Public Administration Areas	9

	Social / Cultural/Educational/Sport Areas.	9

Table 62: Spatial references preselected for land usage context – Vidin

The city is interested in revitalizing its existing infrastructure and developing attractive image for potential investors. Therefore, there is a lot of interest from Vidin municipality in technical and physical energy infrastructure and components. For example, there is interest in small district heating for some neighbourhoods. There are also expected actions to improve lighting in the whole municipality. However, there is no district heating nor natural gas pipeline in the city.

Energy / E-mobility structure		
Category	Spatial reference	Value
Power Infrastructure	High / Low voltage power grid and its impact area	#NA
Heat Network	Natural gas pipeline network	#NA
Mobility Infrastucture	Existing EV chargers and impact areas	#NA

Table 63: Spatial references preselected for Energy / E-mobility structure – Vidin

Regarding the micro grid applications same comments made for energy and e-mobility apply.

Energy service availability		
Category	Spatial reference	Value
Micro Grid Applications	Impact areas of micro-grids/ islands	#NA

Table 64: Spatial references preselected for Energy service availability – Vidin

Vidin wants to prioritize high density zones. These zones play a key role for being participative and implementing PEDs economically and socially. Including the energy communities and other related cooperatives and associations seems to be interesting, however, there is no spatial data available to include it in the GIS assessment.

Social structure		
Category	Spatial reference	Value

Current and Projected Population	Population Density identified in Spatial Data	7
Energy Organisations	Impact and organizational areas of energy Communities / cooperatives / housing associations.	6

Table 65: Spatial references preselected for Social structure – Vidin

According to Vidin selection of the spatial references, GIS layers to be included in the study were identified. Considering the availability of Vidin information in GIS format and information available at open sources, the eight GIS layers summarized in the Figure 30 were considered in the analysis.

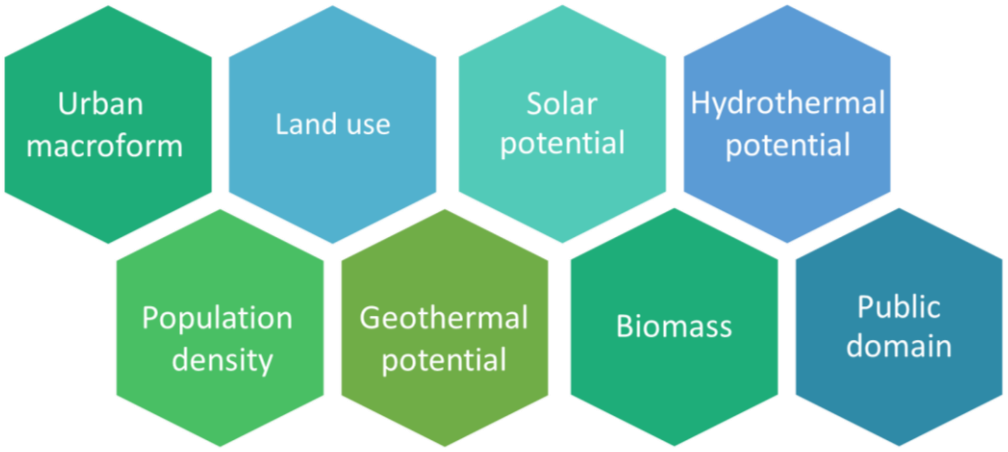


Figure 30: GIS layers considered in the analysis – Vidin

In order to be included in the analysis properly, each of this layer needed specific data treatment for reclassification purposes. The approach followed is summarized in Table 66 and more information is given in the annex (page 194). Prioritization percentages given to each GIS layer for overlay purposes are also given in Table 66.

GIS layer	Approach	Prioritization for overlay
Urban macroform	Based on the combination of new development areas identified in land use GIS file sent by the city and including manually the buildings expected to be retrofitted. Selected spatial references were included according to Table 61.	16%
Land use	Based on the GIS layer land use sent by the city. Selected spatial references were included according to Table 62.	16%
Solar Potential	New layer has been created based on the ratio between the building roof	14%

GIS layer	Approach	Prioritization for overlay
	surface and the total built surface. Grids of 250x250 with values closest to 1 are considered the most suitable.	
Geothermal Potential	Based on the proximity to areas where installations can be made (grassland and active green) and are located more than 1000m far from the Danube.	14%
Hydrothermal potential	Based on the proximity to areas where installations can be made (grassland and active green) and are located at less than 1000m far from the Danube.	10%
Population density	Based on public source information[12]. Highest population density was considered the most suitable for the purpose of the analysis.	5%
Biomass	Based on the vegetation map of Corine land cover[13]. Forest areas are the most suitable as biomass source.	10%
Public domain	Based on GIS land use layer sent by the city. Public areas are considered most suitable to become positive.	16%

Table 66: GIS analysis approach and prioritization scores – Vidin

10.2 Definition of already chosen areas

Before the analysis done in task 4.2, Vidin municipality identified two areas with potential to become positive. These districts were selected because they have a concentration of both – public buildings (mainly schools and kindergartens) and residential buildings.

- Himik: consists of buildings with higher readiness to accommodate advanced energy efficiency and renewable energy solutions.
- Bononia: consists of building with lower readiness and in need of identification, design and planning of EE and RES measures and actions to achieve high-energy performance characteristics.

[12] https://ghsl.jrc.ec.europa.eu/download.php?ds=pop
[13] https://land.copernicus.eu/pan-european/high-resolution-layers/

Figure 31: Vidin preselected areas

The city integrated infrastructural and investment plan has foreseen actions and measures to be realised in the preselected districts buildings in the coming years. These measures have been defined according to the current perspectives for the city development, but could be updated and improved to accommodate advanced energy measures. Financial resources envisaged and allocated for these buildings come from municipal budget, national operational programmes, European initiatives and projects, EEA grants, Interreg Programme, etc.

10.3 Candidate areas to become a PED

The Danube river, solar radiation, both geothermal and hydrothermal potential, highlight several areas from Vidin with potential to become positive. It is important to note that most of the assessment was made based on the potential of different renewable resources and not in existing installations. Private geothermal installations exist but the information was not available at macroscale.

It is remarkable the innovative vision of the municipality of Vidin that sees the promotion of energy efficiency measures as a great strategy to get the attention of potential investors. Therefore, the economic activity will be promoted.

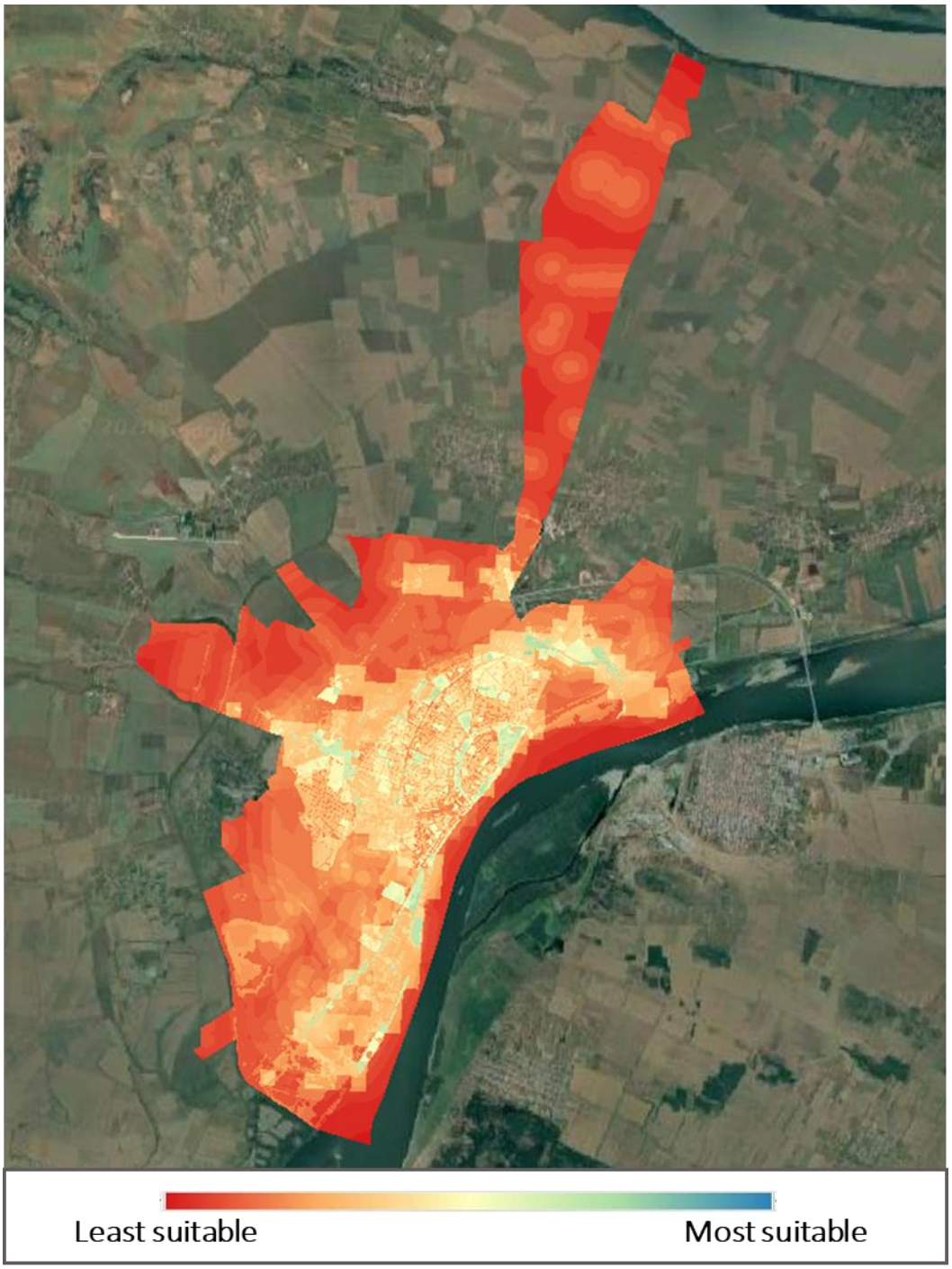


Figure 32: Vidin candidate areas to become positive

It is important to note that the location with the most suitable results has a value of 7,31/9.

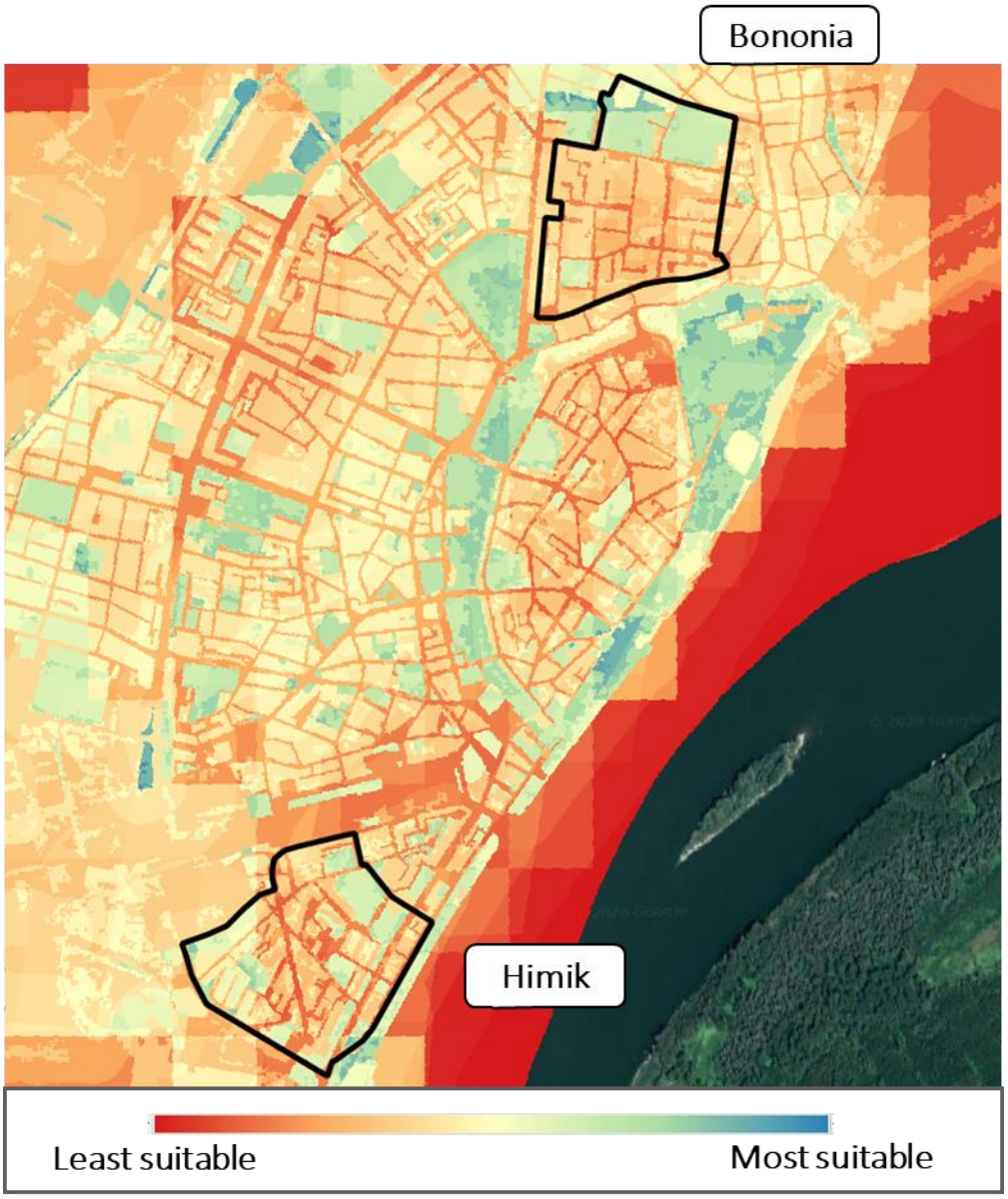


Figure 33: Vidin preselected and candidate areas to become positive

Regarding the districts preselected by the city, Table 67 summarises the most relevant values obtained for them. These districts include some areas with suitable potential to become positive, while others will need higher efforts to convert them in positive.

Preselected District	Mean value	Maximum value
Himik	3,81	6,57
Bononia	3,87	6,85

Table 67: Overlay values of preselected areas – Vidin

The exact size of the areas to be included in the micro-analysis will be done in the next steps of the WP4 and it does not necessarily coincide with the official limits of existing district.

The main difficulties and barriers to the implementation of energy efficiency actions in Vidin are:

- Lack of gasification in Vidin District;
- Lack of district heating in the settlements of the district;
- Insufficient consumer awareness of existing new technologies and opportunities to reduce consumption.

Further analysis will be done in next steps of WP4 in terms of technological solutions for the conversion.

11 Next steps

This chapter summarises the next steps that are going to be given based on the work presented in this deliverable.

SECOND Approach; Micro-scale analysis will be conducted within the identified potential PED zones that are calculated from macro-scale analysis. PED Analytical compontents that will be collected in building scale from selected zones are as follows: Resources, Land Usage, Socio-economic and Legal Data and Building Based Energy Demand Maps coming from WP1 analysis. As this stage will be more detailed in M36 for D4.4 while desiging PEDs, more information regarding the components will be examined next year of the project. All data at this stage will be gathered in building scale an will **integrate the energy demand** of the cities calculated in WP1.

One area of improvement of the MCDA questionnaire is to clearly **identify the data that should be variable** depending on the context of the city. This variable data will help in adapting the analysis to the specific characteristics of a city. For example, depending on the legal framework of a city regarding self-consumption, the buffer surrounding the solar PV installations can be defined. This work has been done manually and case-by-case in the cities studied in this deliverable, but could be predefined.

Regarding the solutions, a preliminary **connection of the GIS PED analytical components with the technical solutions** included in the PESTEL board has been done in the context of Task 4.2. Preliminary results are shown in the table below.

Note that acronyms stand to: Resource availability (RA), Urban Macroform (UM), Land use (LU), Technical-Physical infrastructure (TPI), Virtual infrastructure (VI) and Social structure (SS).

PED ANALYTICAL COMPONENTS	Related technology
RA1. Existing solar energy investment zones Investment + Zones with high solar potential + Size of the zones	S0.1b Solar orientation strategies S9a Neighbourhood electro storage facility S14a PV in roofs and parking lot S14b Building Integrated PV (on the façade) S14c Floating Solar pontoons S14d Solaroad
RA2. Potential solar energy investment zones	S0.1b Solar orientation strategies S9a Neighbourhood electro storage facility S14a PV in roofs and parking lot S14b Building Integrated PV (on the façade) S14c Floating Solar pontoons S14d Solaroad
RA3. Existing wind energy investment zones	S19a Wind Turbines
RA4. Potential wind energy investment zones	S19a Wind Turbines
RA5. Extensive ground coupling potential for cooling and heating purposes	S0.1d Ground coupling strategies S10b Seasonal storage S10c Thermal Storage S16a Geothermal energy S16a Near to surface Geothermal energy S16b Geothermal District Heating (aquifer)
RA6. Geothermal water impact area.	S0.1c Water resources strategies S16b Geothermal District Heating
RA9. Water surfaces with evaporative potential.	S0.2b Evaporative cooling
RA10. Potential energy generation areas by biomass.	Biomass Boiler (not in MC)

PED ANALYTICAL COMPONENTS	Related technology
RA11. Waste heat Potential	S10c Thermal Storage S17a Heat recovery system from AC and sewage water S17b Heat recovery system from return pipeline to DHW S17c High pressure wastewater digester
UM1. New Development Areas	S2a New High-Performance Building (residential) S4a New High-Performance Building (Shopping Mall) S4b New High-Performance Building (Academy Building) S4c New High-Performance Building (Sport Complex)
UM2. Retrofitting Areas	S1a Residential (High Rise) retrofitting S1b Residential (Private House) retrofitting S3a Retrofitting of tertiary buildings
UM3. Infill Areas	S2a New High-Performance Building (residential) S4a New High-Performance Building (Shopping Mall) S4b New High-Performance Building (Academy Building) S4c New High-Performance Building (Sport Complex)
UM4. Transformation / Reuse Areas	S2a New High-Performance Building (residential) S4a New High-Performance Building (Shopping Mall) S4b New High-Performance Building (Academy Building) S4c New High-Performance Building (Sport Complex)
LU1. Residential & Mixed-Use Areas	S1a Residential (High Rise) retrofitting S1b Residential (Private House) retrofitting S2a New High-Performance Building (residential)
LU2. Commercial Areas	S3a Retrofitting of tertiary buildings S4a New High-Performance Building (Shopping Mall)
LU3. Active Green / Open Parking Lot.	S14a Solar PV on roofs and parking lot
LU4. Social / Cultural/Educational/Sport Areas.	S4b New High-Performance Building (Academy Building) S4c New High Performance Building (Sport Complex)
TPI1. Heat Grid	S11a Low Temp regional transfer pipeline S11b Adjust geothermal district heating for using low temperature S11c Connection to the low temperature district heat
TPI4. E-Mobility Infrastructure.	S20a E-car charging points S20b Connection of the charging stations to the local demand response system
VI1. Smart Grid Applications	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 A47 Blockchain
SS3. Impact and organizational areas of energy Communities / cooperatives	A45: Innovative business models development for PED
SS5. Cultural Human Behaviour	S5b Visualization Units to study human behaviour regarding the energy consumption

This study will be further analysed in next steps of WP4 in order to properly define the technological solutions according to the PED potential identified in this deliverable.

12Conclusions

The methodology developed for macro-scale analysis of cities to identify zones with potential to become energy positive, combines both the potential of multi-criteria analysis and overlay analysis of GIS software. This combination provides a robust assessment and very visual results that can be easily understood in a quick view.

The multicriteria questionnaire ensures the consideration of all the relevant criteria that can affect the correct implementation of a PED. Therefore, it allows the consideration of not only the **renewable resource potential** of a specific location, but also the **economic opportunities**, the **legal framework** enablers and barriers, the **social context** and, of course, the existing and future modifications of the **urban spatial form and planning** and the existence or interest in creating **infrastructure** that can support the conversion to energy positive. **Environmental** issues are also considered giving a deep overview of the whole city context.

The **methodology defined standardises the process** in the sense that same criteria are evaluated in every case study, but it is also **flexible enough to be adapted to each city's context** in the sense that different choices can be made regarding each criteria. In the process of fulfilling the questionnaire in meetings with experts from the cities, it was well understood what was being considered the "most suitable" situation and the status of the city in each of the criteria. Therefore, follower cities that participated in the process see themselves well-reflected in the results. On the other hand, it is recommended filling in the questionnaire with experts from different fields of knowledge.

Regarding the potentialities of **open and private GIS software tools**, both allow the application of the macro-scale methodology to its full extent and obtaining quality results as well. Open GIS sources allow the municipality and other stakeholders to modify the results and adapt the overlay analysis to new city needs without additional cost or new investments. However, it is important to note that some extra work has to be done manually in case of open sources, and this will require advance knowledge of the use of the GIS software.

Regarding the overlay results, it must be noted that **the maximum value obtained as a result of the overlay depends on the number of layers considered**. In other words, introducing more spatial components makes more difficult reaching the most suitable circumstances. This does not necessarily mean that the city has less areas with potential to become PED, but more detailed analysis of the results will be needed to understand properly which criteria and/or combination of criteria are conditioning the results and if they are relevant for the assessment. For example, it could be more interesting focusing on several technologies and in the renewable resources that support them than in trying to find a place with high potential in all the resources.

Results presented in this deliverable provide a **prioritization of the areas from the 6 fellow cities of MAKING-CITY with highest potential to become energy positive**. Moreover, it provides information about the suitability of preselected areas by the municipality for this purpose. Results given will guide the definition of the PED boundaries in which the micro-analysis will be focused. According to the resource availability analysis and the preliminary connection to the technology, work presented in this deliverable provides a first approach to understand the solutions suitable for the conversion of the selected areas in PED.

Annex I: MCDA questionnaire (template)

RA. Existing solar energy investment zones					
If the existing solar energy investment zones are owned by the community or the public administration, the area could have a high score to define PED boundary near this area. * Existing solar energy investment zones are zones were solar investment has been made or is planned to be made.					
ECONOMIC		**TECHNICAL**		**SPATIAL**	
1) Solar energy investment zones owned by the community, by a private sector involved in the project or the public administration exist	2	1) Zones with high solar potential exist radiation higher than 1.500 kWh/m2year	3	1) There are zones with high solar potential higher than 20.000m2	4
2) Solar energy investment zones owned by the private sector (with their own business model) exists	1	2) Zones with medium solar potential exist radiation between 1.000-1.500 kWh/m2year	2	2) There are zones with high solar potential with a size between 10.000 and 20.000m2	3
3) There are no solar energy investment zones	0	3) There are no solar energy zones fulfilling previous criteria	0	3) There are zones with medium solar potential higher than 10.000m2	1
				4) There are no zones that fulfil the previous criteria.	0

Table 68: Existing solar energy investment zones criteria

Potential solar energy investment zones									
Potential solar energy investment zones play a key role in PED area identification since an area nearby a potential investment zone may get advantage of solar energy generation and define in its boundary. Other criteria with potential interest: Existency of investment opportunities from the private sector. Desired payback, the efficiency (the topography, the height of nearby buildings..etc) (micro?)									
ECONOMIC		**SOCIAL**		**TECHNICAL**		**LEGAL**		**SPATIAL**	
1) Potential solar energy investment zones owned by the community, by a private sector involved in the project or the public administration exist	2	1) High-medium social acceptability of the solar energy	1	1) Zones with high solar potential exist: radiation higher than 1.500 kWh/m2year	2	1) Regulatory framework is suitable for solar energy implementation (Self-consumption is allowed, NET balance,…)	1	1) There are zones with high solar potential higher than 20.000m2	3
2) Solar energy investment zones owned by the private sector (with their own business model) exist	1	2) Low social acceptability of the solar energy	0	2) Zones with medium solar potential exist: radiation between 1.000-1.500 kWh/m2year	1	2) Regulatory framework is not suitable for solar energy implementation	0	2) There are zones with high solar potential with a size between 10.000 and 20.000m2	2
3) There are no solar energy investment zones	0			3) There are no solar energy zones fulfiling previous criteria	0			3) There are zones with medium solar potential owned by the community or the public administration	1

								highers than 10.000m2	
								4) There are no zones that fulfil the previous criteria	0

Table 69: Potentital solar energy investment zones criteria

RA. Existing wind energy investment zones					
If the existing wind energy investment zones are owned by the community or the public administration, the area could have a high score to define PED boundary near this area.					
ECONOMIC		TECHNICAL		SPATIAL	
1) Wind energy investment zones owned by the community, by a private sector involved in the project or the public administration exist	3	1) Zones with a high wind energy potential exist: generation potential higher than 200W/m2year	3	1) There are zones with high wind potential higher than 20.000m2	3
2) Wind energy investment zones owned by the private sector (with their own business model) exist	2	2) Zones with a medium wind energy potential exist: generation potential between 150-200W/m2year	2	2) There are zones with high wind potential with a size between 10.000 and 20.000m2	2
3) There are no wind energy investment zones	0	3) There are no zones fulfilling previous criteria	0	3) There are zones with medium wind potential highers than 10.000m2	0

Table 70: Existing wind energy investment zones criteria

Potential wind energy investment zones							
If the existing wind energy investment zones are owned by the community or the public administration, the area could have a high score to define PED boundary near this area							
ECONOMIC		SOCIAL		TECHNICAL		SPATIAL	
1) Wind energy investment zones owned by the community or the public administration exist	3	1) High-medium social acceptability of the wind energy	1	1) Zones with a high wind energy potential exist: generation potential higher than 200W/m2year	2	1) There are zones with high wind potential higher than 20.000m2	3
2) Wind energy investment zones owned by the private sector (with their own business model) exist	2	2) Low social acceptability of the wind energy	0	2) Zones with a medium wind energy potential exist: generation potential between 150-200W/m2year	1	2) There are zones with high wind potential with a size between 10.000 and 20.000m2	2
3) There are no wind energy investment zones	0			3) There are no zones fulfiling previous criteria	0	3) There are zones with medium wind potential highers than 10.000m2	0

Table 71: Potential wind energy investment zones criteria

RA. Extensive ground coupling potential							
Potential for the installation of geothermal heat pump systems and ground-coupled heat exchanger systems (Which also avoid heat island effect by placing the "cooling towers" underground). Landfill and alluvial deposit land would get less score when compared to clay soil in terms of thermal energy storage.							
ECONOMIC		TECHNICAL		LEGAL		SPATIAL	
1) There is drilling and geothermal technology available at affordable price	2	1) There are zones with high geothermal potential	2	1) Legal Framework allows drilling boreholes (environmental restrictions, community restrictions - too close to other boreholes,etc.).	2	1) There are zones available to make drilling boreholes. Public zones available for this purpose	3
2) Drilling and geothermal technology can be find.	1	2) There are zones with medium geothermal potential.	1	3) Previous criteria is not fulfilled	0	2) There are zones available to make drilling boreholes. Private zones available for this purpose	2
3) Previous criteria is not fulfilled	0	3) Previous criteria is not fulfilled	0			3) Previous criteria is not fulfilled	0

Table 72: Extensive ground coupling potential criteria

RA. Geothermal water impact area					
Existing geothermal water resources and their impact areas by locating existing wells, heat centers. Etc. Wells may be potential areas to be connnected by the potential PED area. If there are already conducted new areas for new geothermal wells, they would be potential PED areas					
SOCIAL		TECHNICAL		LEGAL	
1) High-medium social acceptability of the geothermal energy	2	1) There are existing geothermal water resources and their impact areas by locating existing wells, heat centers. Etc. (Wells may be potential areas to be connnected by the potential PED area)	4	1) Legal framework allows the implementation of geothermal (no restrictions to the use of ground water)	3
2) Low social acceptability of the geothermal energy	1	2) There are some geothermal water resources	2	2) Legal framework allows the implementation of geothermal but restrictions exist	2
3) Previous criteria is not fulfilled	0	3) Previous criteria is not fulfilled	0	3) Legal framework does not allow the implementation of geothermal	0

Table 73: Geothermal water impact area criteria

RA. Potential surface water resources for energy generation					
Current sea, lakes, streams, creeks in the city with energy generation potential.					
ECONOMIC		TECHNICAL		LEGAL	
1) Public Investment provides feasible installation	3	1) There are Current sea, lakes, streams, creeks in the city with high energy generation potential.	3	1) Legal framework allows the use of water resources for energy generation.	3

2) Large Private Investments is feasible.	1	2) There are Current sea, lakes, streams, creeks in the city with energy generation potential.	2	1) Legal framework allows the use of water resources for energy generation but some restrictions exist.	2
3) Small private / Individual Invesmtents	0	3) Previous criteria is not fulfilled	0	3) Previous criteria is not fulfilled	0

Table 74: Potential surface water resources for energy generation criteria

RA. Potential water resources utilized as heat source for heating / cooling purposes					
Potential water resources [pits/PTES (artificial pools with storage capacity)] utilized as heat source for heating / cooling purposes heat exchangers					
ECONOMIC		TECHNICAL		LEGAL	
1) There is drilling and heat exchanger available at affordable price	3	1) There are seas, rivers etc. with high potential by constant temperature.	3	1) Legal Framework allows building heat exhanger rooms on the coast	3
2) Drilling and heat echanger technology can be found	1	2) There are zones with medium potential.	2	3) Previous criteria is not fulfilled	0
3) Previous criteria is not fulfilled	0	3) Previous criteria is not fulfilled	0		

Table 75: Potential water resources utilized as heat source for heating / cooling purposes criteria

RA. Water surfaces with evaporative potential.	
Impact areas affected by evaporative cooling from nearby natural or artificial water surfaces. This would affect low energy demand in PED boundary.	
SPATIAL	
1) Only for warm climate cities: There are zones with high percentage of water surface and next to a water surface (therefore the cooling demand will be lower)	9
2) Only for warm climate cities: There are zones with medium percentage of water surface and next to a water surface (therefore the cooling demand will be lower)	7
3) Previous criteria is not fulfilled	0

Table 76: Water surfaces with evaporative potential criteria

Potential energy generation areas by biomass							
Current intense green areas, waste collection areas with energy generation purpose.							
SOCIAL		TECHNICAL		ENVIRONMENTAL		SPATIAL	
1) Social acceptability of biomass is medium- high	1	1) There is biomass available within the city and infrastructure to collect it exists	4	1) Pruning residues are used as fuel	2	1) There are biomass resources available next to places (such us industry) with energy production potential	2
1) Social acceptability of biomass is low	0	2) There is biomass available close to the city	3	2) The rest fraction (separated plastics) is used as fuel	1	1) There are biomass resources available but to places (such us	1

						industry) with energy production potential are not very close	
		3) Previous criteria is not fulfilled	0	3) There is no separation for incineration	0	3) Previous criteria is not fulfilled	0

Table 77: Potential energy generation areas by biomass criteria

RA. Waste heat Potential			
Industrial Zones/data centers/supermarkets/sewege systems/thermal plants with waste heat energy generation potential - depending on legal data or any incentives in the city would define a more potential PED area and scoring			
TECHNICAL		SPATIAL	
1)There is waste heat energy recovery potential (i.e from cement manufacture, steelworking, supermarket, data center,…) exist and there is relevant heat demand in the city and/or existing DH.	7	1) There are zones next to this kind of industries	2
2)There is waste heat energy recovery potential (i.e from cement manufacture, steelworking, supermarket, data center,…) exist and there is heat demand in the city or existing DH	5	2) There are zones close to this kind of industries	1
3) Previous criteria is not fulfilled	0	3) Previous criteria is not fulfilled	0

Table 78: Waste heat Potential criteria

UM. New Development Areas			
If mentioned in a strategic plan, decisions through energy efficiency, energy production or low energy consumption, then new development zones could be potential areas for PED implementations			
TECHNICAL		SPATIAL	
1) New development areas exist and it is mentioned in a strategic plan, decisions through energy efficiency, energy production or low energy consumption.	6	1) There is a legal framework that promotes PED implementation (i.e: energy efficiency requirements)	3
2) New development areas exist and although it is not mentioned in a strategic plan, decisions through energy efficiency, energy production or low energy consumption, could be pontential areas for PED implementation.	4	2) There is a legal framework that allows the implementation of PED in this kind of areas	2
3) Previous criteria is not fulfilled	0	3) PED implementation is not allowed in new development zones	0

Table 79: New development areas criteria

UM. Retrofitting Areas		
If mentioned in strategic plan, incentives or any regulations through retrofitting the existing building stock, could be a opportunity for loweing energy consumption for PED implementations.		
ECONOMIC	LEGAL	SPATIAL

1) Selected areas for retrofitting exist and funding mechanism are already approved (i.e ISUDS: integrated sustainable urban development strategies)	5	1) Legal framework is suitable forNearly zero energy building retrofiting projects	1	1) It is an ISUDS (integrated sustainable urban development strategies) area	3
2) Selected areas for retrofitting exist and some fundings are expected	4	2) Previous criteria is not fulfilled	0	2) It is next to an ISUDS area	2
3) Previous criteria is not fulfilled	0			3) Previous criteria is not fulfilled	0

Table 80: Retrofitting Areas criteria

UM. Infill Areas					
If mentioned in strategic plan, incentives or any regulations through energy effiency for new building stock, could be a opportunity for PED implementations					
TECHNICAL		LEGAL		SPATIAL	
1) There are infill areas and are mentioned in strategic plan, incentives or any regulations through energy effiency for new building stock, for PED implementation	5	1) Legal framework is suitable forthe implementation of PED in infill areas	2	1) It is an infill area	2
2) There are infill areas not mentioned in strategic plan, incentives or any regulations through energy effiency for new building stock, but PED implementation is allowed	4	2) Previous criteria is not fulfilled	0	2) It is next to an infill area	1
3) Previous criteria is not fulfilled	0			3) Previous criteria is not fulfilled	0

Table 81: Infill Areas criteria

UM. Transformation / Reuse Areas					
If mentioned it a strategic plan, decisions through energy efficiency, energy production or low energy consumption, then transformation / reuse zones could be potential areas for PED implementations					
ECONOMIC		LEGAL		SPATIAL	
1) Selected areas for transformation/Reuse exist and funding mechanism are already approved	5	1) Strategy of urban regeneration promotes the implementation of PED in transformation/reuse areas	2	1) It is an transformation/Reuse area	2
2) Selected areas for transformation /Reuse exist and some fundings are expected	4	1) Strategy of urban regeneration allows the implementation of PED in transformation/reuse areas	1	2) It is next to a transformation/reuse area	1
3) Previous criteria is not fulfilled	0	3) Previous criteria is not fulfilled	0	3) Previous criteria is not fulfilled	0

Table 82: Transformation / Reuse Areas criteria

LU. Residential & Mixed Use Areas					
Any governmental or municipal plan offering investment plans, incentives for private integrated(mixed use areas) building stock, would be a key point for PED implementations					
ECONOMIC		SOCIAL		LEGAL	
1) Zones with expected investment plans and incentives for private building stock	3	1) Citizens have a high acceptability of new developments	3	1) Legal mechanism promoting energy efficiency retroffiting and/or renewables implementation exist	3
2) Zones with expected private investment plans and incentives for private building stock	2	2) Citizens have a medium acceptability of new developments	2	2) Legal mechanism allowing energy efficiency retroffiting and/or renewables implementation exist	2
3) Previous criteria is not fulfilled	0	3) Previous criteria is not fulfilled	0	3) Previous criteria is not fulfilled	0

Table 83: Residential & Mixed Use Areas criteria

LU. Commercial Areas			
Any governmental or municipal plan offering investment plans, incentives for private building stock, would be a key point for PED implementations			
ECONOMIC		LEGAL	
1) Zones with expected private and/or public investment plans and incentives for commercial areas	7	1) Legal mechanism promoting energy efficiency retroffiting and/or renewables implementation	2
2) Zones with expected public investment plans and incentives for commercial areas	5	2) Legal mechanism allowing energy efficiency retroffiting and/or renewables implementation	1
3) Previous criteria is not fulfilled	0		

Table 84: New development areas criteria

LU. Active Green / Open Parking Lot. Considering it as available urban areas							
Any governmental or municipal plan offering investment plans, incentives for public/private open spaces for energy generation, would be a key point for PED implementations							
ECONOMIC		TECHNICAL		ENVIRONMENTAL		LEGAL	
1) Zones with expected private and/or public investment plans and incentives for active green/open parking lot or long term storage	3	1) Long term energy storage (pits, batteries,etc.) is feasible	2	1) Active Green (forest, intense vegetation) has high positive impact on cooling loads in warm cities	1	1) Legal exigencies exist promoting the energy efficiency and/or renewables implementation in active green/open partking Lot. Included in urban planning	3
2) Zones with expected private and/or public investment plans or incentives for active green/open parking lot	2	2) Long term energy storage is not available	0	2) No forest or intense vegetation in city	0	2) Legal exigencies does not exist, but the energy efficiency and/or renewables implementation in active green/open partking Lot is promoted. Not	2

						Included in urban planning	
3) Previous criteria is not fulfilled	0					3) Previous criteria is not fulfilled	0

Table 85: Active Green / Open Parking Lot criteria

LU. Public Administration Areas			
Any governmental or municipal plan offering investment plans, incentives for public building stock, would be a key point for PED implementations			
ECONOMIC		LEGAL	
1) Zones with expected public investment plans and incentives for public administration areas. Budget expected to these kind of investment	6	1) Legal exigencies exist promoting the energy efficiency and/or renewables implementation	3
2) Zones with expected public investment plans or incentives for public administration areas. Budget still not expected to these kind of investment	4	2) Legal exigencies allow the energy efficiency and/or renewables implementation	2
3) Previous criteria is not fulfilled	0	3) Previous criteria is not fulfilled	0

Table 86: Public administration areas criteria

LU. Social / Cultural/Educational/Sport Areas			
Any governmental or municipal plan offering investment plans, incentives for public building stock, would be a key point for PED implementations			
ECONOMIC		LEGAL	
1) Zones with expected public investment plans and incentives for public administration areas. Budget expected to these kind of investment	6	1) Legal exigencies exist promoting the energy efficiency and/or renewables implementation	3
2) Zones with expected public investment plans or incentives for *Social / Cultural/Educational/Sport Areas. Budget still not expected to these kind of investment	4	2) Legal exigencies allow the energy efficiency and/or renewables implementation	2
3) Previous criteria is not fulfilled	0	3) Previous criteria is not fulfilled	0

Table 87: Social / Cultural/Educational/Sport Areas criteria

TPI. Heat Grid							
If any DH/C grid exists in the city, an area nearby for connecting and sharing energy or integration of atechnology such as "heat pumps" would be a potential PED							
ECONOMIC		TECHNICAL		ENVIRONMENTAL		LEGAL	
1) The grid is amortized and the share of renewables is high	2	1) The heat grid contains storage and integrates different types of renewable technologies	3	1) Legal mechanisms exist for the promotion of the implantation of renewables and the substitution of boilers or other outdated tehchonolgy	3	1) There is space available for the installation of the technologies	1

2) The grid is amortized but the share of renewables is low	1	1) The heat grid contains storage or integrates different types of renewable technologies	2	1) Legal mechanisms exist allowing the implantation of renewables and the substitution of boilers or other outdated tehchonolgy	2	2) Previous criteria is not fulfilled	0
3) Previous criteria is not fulfilled	0	3) Previous criteria is not fulfilled	0	3) Previous criteria is not fulfilled	0		

Table 88: Heat Grid criteria

TPI. Power Infrastructure					
If power infrastructure does not exist in an area, this would have a positive effect on investment or an opportunity for implementing PEDs off-grid.					
ECONOMIC		TECHNICAL		LEGAL	
1) There are approved investments to improve the power infrastructure	3	1) The network is strongly prepared for the introduction of distributed generation equipment (The protection measures are prepared for a bi-directional flow of energy, there are measures for the prevention of voltage spikes, filtering of harmonics in the network, etc.)	3	1) there are legal mechanism promoting the connection and ingection to the grid (for example in Spain the procedure for networks behind 10kW is very convenient and only requires notification)	3
2) There are expected investments to improve the power infrastructure	2	2) There are some parts of the network prepared	2	2) Legal mechanisms allow the connection and inyection to the grid	2
3) Previous criteria is not fulfilled	0	3) Previous criteria is not fulfilled	0	3) Previous criteria is not fulfilled	0

Table 89: Power Infrastructure criteria

TPI. Heat Network									
If heat infrastructure does not exist in an area, this would have a negative effect on investment or an opportunity for imlementing PEDs off-grid.									
ECONOMIC		SOCIAL		TECHNICAL		LEGAL		SPATIAL	
1) There is high investment approved for the infrastructure and business models promote the implementation	3	1) Citizens are open to share	1	1) Zones with high solar potential exist: radiation higher than 1.500 kWh/m2year	2	1) Urban planning promotes this kind of infrastructure	2	1) Heat density is high (related to climate and building density or population density) - in relation to the climate	2
2) There is investment expected for the infrastructure and business models promote the implementation	2	2) Previous criteria is not fulfilled		2) Zones with medium solar potential exist: radiation between 1.000-1.500 kWh/m2year	1	2) Urban planning allows this kind of infrastructure	1	2) Heat density is medium (related to climate and building density or population density) - in relation to the climate	1

3) Previous criteria is not fulfilled	0			3) There are no solar energy zones fulfilling previous criteria	0	3) Previous criteria is not fulfilled	0	3) Previous criteria is not fulfilled	0

Table 90: Heat Network criteria

TPI. Mobility Infrastucture			
Existing EV charging stations and their ownership data is reqiured in order to identify e-mobility loads in PED areas			
ECONOMIC		LEGAL	
1) Charging stations or H2 refuelling stations owned by the community or the public administrations	6	1) Legal Infrastructure permits trading in public charging stations	3
2) Charging stations or H2 refuelling stations owned by the private sector	4	2) Legal Infrastructure permits trading in private charging stations	2
3) There are no charging stations	0	3) No legal infrastructure permits trading	0

Table 91: Mobility Infrastucture criteria

VI. Smart Grid Applications							
Since this is a virtual data, the districts / negihbourhoods / islands that are conected to the facility, would be potential PEDs							
ECONOMIC		TECHNICAL		LEGAL		SPATIAL	
1) The micro grid exists and is amortized and the share of renewables is high	2	1) Existency of a micro grid and/or a virtual power plant facilitates PED implementation	4	1) Regulatory framework is suitable for micro grid applications implementation (Shared self-consumption is allowed, NET balance,…)	1	1) The micro grid is in the area	2
2) The micro grid is amortized but the share of renewables is low or the micro grid is not amortized but the share of renewables is high	1	2) It is expected to be created a micro grid and/or a virtual power plant	2	2) Regulatory framework is not suitable for micro grid applications implementation	0	2) Proximity to existing micro grid	1
3) The micro grid does not exist	0	3) The electric infrastructure is not ready for the implementation of micro grids (low-quality).	0				

Table 92: Smart Grid Applications criteria

SD. Population Density identified in Spatial Data	
Population Density in macro-scale plays a key role for being participative and implementing PEDs economically and socially	
ECONOMIC	SOCIAL

1) High density zones (they promote the economic activity)	3	1) Solvent income level	6
2) medium density zones	2	2) Not solvent income level but expected investments (for urban poor and disadvantegous communities)	4
3) low density zones	0	3) Previous criteria is not fulfilled	0

Table 93: Population Density criteria

SD. Population Projections for new development zones.					
Population Density in macro-scale plays a key role for being participative and implementing PEDs economically and socially					
ECONOMIC		SOCIAL		LEGAL	
1) High density zones (they promote the economic activity)	3	1) Solvent income level	4	1) The municipality has the capacity to make changes in new development zones.	2
2) medium density zones	2	2) Not solvent income level but expected investments (for urban poor and disadvantegous communities)	2	2) national governments have the capacity to make changes in new development zones	1
3) low density zones	1	3) Previous criteria is not fulfilled	0	3) Previous criteria is not fulfilled	0

Table 94: Population Projections criteria

SD. Co-designing and collectively organizing PEDs in areas where communities are effective					
Population Density in macro-scale plays a key role for being participative and implementing PEDs economically and socially					
ECONOMIC		SOCIAL		LEGAL	
1) Incentives or subsidies highly support energy communities	3	1) High engagement communities facilitate the effective implementation of PED. High cultural level of the population promote the implementation	4	1) Regulation exist for the energy Communities / cooperatives / housing associations	2
2) Incentives or subsidies support energy communities	2	2) Low engagement communities facilitate the effective implementation of PED.	1		
3) Previous criteria is not fulfilled	0	3) Previous criteria is not fulfilled	0		

Table 95: organizational areas criteria

SD. Self-sufficient districts / neighbourhoods or Ecovillages (with a more circular economy perspective)		
Self-sufficient districts, neighborhood would be pilot areas for implementing PEDs.		
ECONOMIC	TECHNICAL	SPATIAL

1) Share economy models support trading - economically feasible	2	Self-sufficient districts have a high potential to become PED	4	1) Zones next to PED could have more opportunities to become a PED - geographical or functional boundaries / enery trading	3
2) Previous criteria is not fulfilled	0			2) Zones connected to PED could have more opportunities to become a PED - virtual boundaries /energy trading	2
				3) Previous criteria is not fulfilled	0

Table 96: Self-sufficient districts / neighborhoods criteria

SD. Cultural Human Behavior			
If possible spatial data integrated with aging population, lifestyles, cultural backgrounds for estimating energy use.			
ECONOMIC		SOCIAL	
1)Population with higher possibility for private energy investments	5	1)raising energy efficiency and energy investment campaigns	4
2) Population withmedium possibility for private energy investments	3	2) youngters and professionals keen on behavioural change	3
3) Low incomelevel	1	3) Previous criteria is not fulfilled	0

Table 97: Cultural Human Behaviour criteria

SD. Vulnerable Communities / disadvantageous/ urban poor			
Population Density in macro-scale plays a key role for being participative and implementing PEDs economically and socially			
ECONOMIC		LEGAL	
1) Incentives or subsidies highly support reducing energy poverty	5	1) Municipalities support collaborative decision making	4
2) Incentives or subsidies support reducing energy poverty	3	2) Previous criteria is not fulfilled	0
3) Previous criteria is not fulfilled	0		

Table 98: Vulnerable Communities / disadvantageous/ urban poor criteria

MCDA questionnaire of Bassano de Grappa

RA. Existing solar energy investment zones					6
ECONOMIC		TECHNICAL		SPATIAL	
2) Solar energy investment zones owned by the private sector (with their own business model) exists	1	2) Zones with medium solar potential exist radiation between 1.000-1.500 kWh/m2year	2	2) There are zones with high solar potential with a size between 10.000 and 20.000m2	3

Table 99: Existing solar energy investment zones criteria – Bassano de Grappa

Potential solar energy investment zones									9
ECONOMIC		SOCIAL		TECHNICAL		LEGAL		SPATIAL	
1) Potential solar energy investment zones owned by the community, by a private sector involved in the project or the public administration exist	2	1) High-medium social acceptability of the solar energy	1	1) Zones with high solar potential exist: radiation higher than 1.500 kWh/m2year	2	1) Regulatory framework is suitable for solar energy implementation (Self-consumption is allowed, NET balance,…)	1	1) There are zones with high solar potential higher than 20.000m2	3

Table 100: Potential solar energy investment zones criteria – Bassano de Grappa

RA. Existing wind energy investment zones					5
ECONOMIC		TECHNICAL		SPATIAL	
3) There are no wind energy investment zones	0	2) Zones with a medium wind energy potential exist: generation potential between 150-200W/m2year	2	2) There are zones with high wind potential with a size between 10.000 and 20.000m2	3

Table 101: Existing wind energy investment zones criteria – Bassano de Grappa

RA. Potential wind energy investment zones							4
ECONOMIC		SOCIAL		TECHNICAL		SPATIAL	
3) There are no wind energy investment zones	0	1) High-medium social acceptability of the wind energy	1	2) Zones with a medium wind energy potential exist: generation potential between 150-200W/m2year	2	3) There are zones with medium wind potential highers than 10.000m2	**1**

Table 102: Potential wind energy investment zones criteria – Bassano de Grappa

RA. Extensive ground coupling potential				OS
ECONOMIC	TECHNICAL	LEGAL	SPATIAL	

Table 103: Extensive ground coupling potential criteria – Bassano de Grappa

RA. Geothermal water impact area						OS
SOCIAL		TECHNICAL		LEGAL		

Table 104: Geothermal water impact area criteria – Bassano de Grappa

RA. Potential surface water resources for energy generation						9
ECONOMIC		TECHNICAL		LEGAL		
1) Public Investment provides feasible installation	3	1) There are Current sea, lakes, streams, creeks in the city with high energy generation potential.	3	1) Legal framework allows the use of water resources for energy generation.	3	

Table 105: Potential surface water resources for energy generation criteria – Bassano de Grappa

RA. Potential water resources utilized as heat source for heating / cooling purposes						OS
ECONOMIC		TECHNICAL		LEGAL		

Table 106: Potential water resources utilized as heat source for heating / cooling purposes criteria – Bassano de Grappa

RA. Water surfaces with evaporative potential.						OS
SPATIAL						

Table 107: Water surfaces with evaporative potential criteria – Bassano de Grappa

Potential energy generation areas by biomass								8
SOCIAL		TECHNICAL		ENVIRONMENTAL		SPATIAL		
1) Social acceptability of biomass is medium- high	1	1) There is biomass available within the city and infrastructure to collect it exists	4	2) The rest fraction (separated plastics) is used as fuel	1	1) There are biomass resources available next to places (such us industry) with energy production potential	2	

Table 108: Potential energy generation areas by biomass criteria – Bassano de Grappa

RA. Waste heat Potential				0
TECHNICAL		SPATIAL		
3) Previous criteria is not fulfilled	0	3) Previous criteria is not fulfilled	0	

Table 109: Waste heat Potential criteria – Bassano de Grappa

UM. New Development Areas				9
TECHNICAL		SPATIAL		

1) New development areas exist and it is mentioned in a strategic plan, decisions through energy efficiency, energy production or low energy consumption.	6	1) There is a legal framework that promotes PED implementation (i.e: energy efficiency requirements)	3

Table 110: New development areas criteria – Bassano de Grappa

UM. Retrofitting Areas					6
ECONOMIC		LEGAL		SPATIAL	
1) Selected areas for retrofitting exist and funding mechanism are already approved (i.e ISUDS: integrated sustainable urban development strategies)	5	1) Legal framework is suitable forNearly zero energy building retrofiting projects	1	3) Previous criteria is not fulfilled	0

Table 111: Retrofitting Areas criteria – Bassano de Grappa

UM. Infill Areas			OS
TECHNICAL	LEGAL	SPATIAL	

Table 112 Infill Areas criteria – Bassano de Grappa

UM. Transformation / Reuse Areas					9
ECONOMIC		LEGAL		SPATIAL	
1) Selected areas for transformation/Reuse exist and funding mechanism are already approved	5	1) Strategy of urban regeneration promotes the implementation of PED in transformation/reuse areas	2	1) It is an transformation/Reuse area	2

Table 113: Transformation / Reuse Areas criteria – Bassano de Grappa

LU. Residential & Mixed Use Areas					9
ECONOMIC		SOCIAL		LEGAL	
1) Zones with expected investment plans and incentives for private building stock	3	1) Citizens have a high acceptability of new developments	3	1) Legal mechanism promoting energy efficiency retroffiting and/or renewables implementation exist	3

Table 114: Residential & Mixed Use Areas criteria – Bassano de Grappa

LU. Commercial Areas			7
ECONOMIC		LEGAL	
2) Zones with expected public investment plans and incentives for commercial areas	5	1) Legal mechanism promoting energy efficiency retroffiting and/or renewables implementation	2

Table 115: New development areas criteria – Bassano de Grappa

LU. Active Green / Open Parking Lot. Considering it as available urban areas							6
ECONOMIC		TECHNICAL		ENVIRONMENTAL		LEGAL	
1) Zones with expected private and/or public investment plans and incentives for active green/open parking lot or long term storage	3	1) Long term energy storage (pits, batteries,etc.) is feasible	2	2) No forest or intense vegetation in city	0	2) Legal exigencies does not exist, but the energy efficiency and/or renewables implementation in active green/open partking Lot is promoted. Not Included in urban planning	2

Table 116: Active Green / Open Parking Lot criteria – Bassano de Grappa

LU. Public Administration Areas				9
ECONOMIC		LEGAL		
1) Zones with expected public investment plans and incentives for public administration areas. Budget expected to these kind of investment	6	1) Legal exigencies exist promoting the energy efficiency and/or renewables implementation	3	

Table 117: Public administration areas criteria – Bassano de Grappa

LU. Social / Cultural/Educational/Sport Areas				9
ECONOMIC		LEGAL		
1) Zones with expected public investment plans and incentives for public administration areas. Budget expected to these kind of investment	6	1) Legal exigencies exist promoting the energy efficiency and/or renewables implementation	3	

Table 118: Social / Cultural/Educational/Sport Areas criteria – Bassano de Grappa

TPI. Heat Grid							OS
ECONOMIC		TECHNICAL		ENVIRONMENTAL		LEGAL	
1) The grid is amortized and the share of renewables is high	2	1) The heat grid contains storage and integrates different types of renewable technologies	3	1) Legal mechanisms exist for the promotion of the implantation of renewables and the substitution of boilers or other outdated tehchonolgy	3	1) There is space available for the installation of the technologies	1
2) The grid is amortized but the share of renewables is low	1	1) The heat grid contains storage or integrates different types of renewable technologies	2	1) Legal mechanisms exist allowing the implantation of renewables and the substitution of boilers or other outdated tehchonolgy	2	2) Previous criteria is not fulfilled	0

3) Previous criteria is not fulfilled	0	3) Previous criteria is not fulfilled	0	3) Previous criteria is not fulfilled	0		

Table 119: Heat Grid criteria – Bassano de Grappa

TPI. Power Infrastructure			OS
ECONOMIC	TECHNICAL	LEGAL	

Table 120: Power Infrastructure criteria – Bassano de Grappa

TPI. Heat Network					OS
ECONOMIC	SOCIAL	TECHNICAL	LEGAL	SPATIAL	

Table 121: Heat Network criteria – Bassano de Grappa

TPI. Mobility Infrastucture			9
ECONOMIC		LEGAL	
1) Charging stations or H2 refuelling stations owned by the community or the public administrations	6	1) Legal Infrastructure permits trading in public charging stations	3

Table 122: Mobility Infrastucture criteria – Bassano de Grappa

VI. Smart Grid Applications							
ECONOMIC		TECHNICAL		LEGAL		SPATIAL	
3) The micro grid does not exist	0	2) It is expected to be created a micro grid and/or a virtual power plant	2	1) Regulatory framework is suitable for micro grid applications implementation (Shared self-consumption is allowed, NET balance,…)	1	2) Proximity to existing micro grid	1

Table 123: Smart Grid Applications criteria – Bassano de Grappa

SD. Population Density identified in Spatial Data			9
ECONOMIC		SOCIAL	
1) High density zones (they promote the economic activity)	3	1) Solvent income level	6
2) medium density zones	2	2) Not solvent income level but expected investments (for urban poor and disadvantegous communities)	4
3) low density zones	0	3) Previous criteria is not fulfilled	0

Table 124: Population Density criteria – Bassano de Grappa

SD. Population Projections for new development zones.					9
ECONOMIC		SOCIAL		LEGAL	
1) High density zones (they promote the economic activity)	3	1) Solvent income level	4	1) The municipality has the capacity to make changes in new development zones.	2

Table 125: Population Projections criteria – Bassano de Grappa

SD. Co-designing and collectively organizing PEDs in areas where communities are effective					OS
ECONOMIC		SOCIAL		LEGAL	

Table 126: organizational areas criteria – Bassano de Grappa

SD. Self-sufficient districts / neighbourhoods or Ecovillages (with a more circular economy perspective)					2
ECONOMIC		TECHNICAL		SPATIAL	
1) Share economy models support trading - economically feasible	2	3) Previous criteria is not fulfilled	0	3) Previous criteria is not fulfilled	0

Table 127: Self-sufficient districts / neighbourhoods – Bassano de Grappa

SD. Cultural Human Behavior		OS
ECONOMIC	SOCIAL	

Table 128: Cultural Human Behaviour criteria – Bassano de Grappa

SD. Vulnerable Communities / disadvantageous/ urban poor		OS
ECONOMIC	LEGAL	

Table 129: Vulnerable Communities / disadvantageous/ urban poor criteria – Bassano de Grappa

MCDA questionnaire of Kadiköy

RA. Existing solar energy investment zones						0
ECONOMIC		TECHNICAL		SPATIAL		

Table 130: Existing solar energy investment zones criteria – Kadiköy

Potential solar energy investment zones								6
ECONOMIC		SOCIAL		TECHNICAL		LEGAL	SPATIAL	
1) Potential solar energy investment zones owned by the community or the public administration exist	2	1) High-medium social acceptability of the solar energy	1	2) Zones with medium solar potential exist: radiation between 1.000-1.500 kWh/m2year	1	1) Regulatory framework is suitable for solar energy implementation (Self-consumption is allowed, NET balance)	1	3) There are zones with medium solar potential owned by the community or the public administration highers than 10.000m2	1

Table 131: Potential solar energy investment zones criteria – Kadiköy

RA. Existing wind energy investment zones						0
ECONOMIC		TECHNICAL		SPATIAL		

Table 132: Existing wind energy investment zones criteria – Kadiköy

RA. Potential wind energy investment zones								0
ECONOMIC		SOCIAL		TECHNICAL		SPATIAL		

Table 133: Potential wind energy investment zones criteria – Kadiköy

RA. Extensive ground coupling potential								9
SOCIAL		TECHNICAL		ENVIRONMENTAL		SPATIAL		
1) There is drilling and geothermal technology available at affordable price	2	1) There are zones with high geothermal potential due to high ground temperature.	2	1) Legal Framework allows drilling boreholes.	2	1) There are zones available to make drilling boreholes. Public zones available for this purpose	3	

Table 134: Extensive ground coupling potential criteria – Kadiköy

RA. Geothermal water impact area						0
SOCIAL		TECHNICAL		LEGAL		

Table 135: Geothermal water impact area criteria – Kadiköy

RA. Potential surface water resources for energy generation					0
ECONOMIC		TECHNICAL		LEGAL	

Table 136: Potential surface water resources for energy generation criteria – Kadiköy

RA. Potential water resources utilized as heat source for heating / cooling purposes					0
ECONOMIC		TECHNICAL		LEGAL	

Table 137: Potential water resources utilized as heat source for heating / cooling purposes criteria – Kadiköy

RA. Water surfaces with evaporative potential.					0
SPATIAL					

Table 138: Water surfaces with evaporative potential criteria – Kadiköy

RA. Potential energy generation areas by biomass							0
SOCIAL		TECHNICAL		ENVIRONMENTAL		SPATIAL	

Table 139: Potential energy generation areas by biomass criteria – Kadiköy

RA. Waste heat Potential			0
TECHNICAL		SPATIAL	

Table 140: Waste heat Potential criteria – Kadiköy

UM. New Development Areas			0
TECHNICAL		SPATIAL	

Table 141: New development areas criteria – Kadiköy

UM. Retrofitting Areas					4
ECONOMIC		LEGAL		SPATIAL	
3) Previous criteria is not fulfilled	0	1) Legal framework is suitable for Nearly zero energy building retrofitting projects	1	1) It is an ISUDS (integrated sustainable urban development strategies) area	3

Table 142: Retrofitting Areas criteria – Kadiköy

UM. Infill Areas					0
TECHNICAL		LEGAL		SPATIAL	

Table 143: Infill Areas criteria – Kadiköy

UM. Transformation / Reuse Areas					9
ECONOMIC		LEGAL		SPATIAL	
1) Selected areas for transformation/Reuse exist and funding mechanism are already approved	5	1) Strategy of urban regeneration promotes the implementation of PED in transformation/reuse areas	2	1) It is a transformation/Reuse area	2

Table 144: Transformation / Reuse Areas criteria – Kadiköy

LU. Residential & Mixed Use Areas					5
ECONOMIC		SOCIAL		LEGAL	
3) Previous criteria is not fulfilled	0	1) Citizens have a high acceptability of new developments	3	2) Legal mechanism allowing energy efficiency retrofitting and/or renewables implementation exist	2

Table 145: Residential & Mixed Use Areas criteria – Kadiköy

LU. Commercial Areas			1
ECONOMIC		LEGAL	
3) Previous criteria is not fulfilled	0	2) Legal mechanism allowing energy efficiency retrofitting and/or renewables implementation	1

Table 146: New development areas criteria – Kadiköy

LU. Active Green / Open Parking Lot. Considering it as available urban areas							7
ECONOMIC		TECHNICAL		ENVIRONMENTAL		LEGAL	
1) Zones with expected private and/or public investment plans and incentives for active green/open parking lot	3	1) Long term energy storage (pits, batteries,etc.) is feasible	0	2) No forest or intense vegetation in city	0	1) Legal exigencies exist promoting the energy efficiency and/or renewables implementation in active green/open partking Lot. Included in urban planning	4

Table 147: Active Green / Open Parking Lot criteria – Kadiköy

LU. Public Administration Areas			9
ECONOMIC		LEGAL	

1) Zones with expected public investment plans and incentives for public administration areas. Budget expected to these kind of investment	6	1) Legal exigencies exist promoting the energy efficiency and/or renewables implementation	3

Table 148: Public administration areas criteria – Kadiköy

LU. Social / Cultural/Educational/Sport Areas			9
ECONOMIC		LEGAL	
1) Zones with expected public investment plans and incentives for public administration areas. Budget expected to these kind of investment	6	1) Legal exigencies exist promoting the energy efficiency and/or renewables implementation	3

Table 149: Social / Cultural/Educational/Sport Areas criteria – Kadiköy

TPI. Heat Grid				0
ECONOMIC	TECHNICAL	ENVIRONMENTAL	LEGAL	

Table 150: Heat Grid criteria – Kadiköy

TPI. Power Infrastructure			0
ECONOMIC	TECHNICAL	LEGAL	

Table 151: Power Infrastructure criteria – Kadiköy

TPI. Heat Network					0
ECONOMIC	SOCIAL	TECHNICAL	LEGAL	SPATIAL	

Table 152: Heat Network criteria – Kadiköy

TPI. Mobility Infrastructure			6
ECONOMIC		LEGAL	
1) Charging stations owned by the community or the public administrations	6	3) No legal infrastructure permits trading	0

Table 153: Mobility Infrastucture criteria – Kadiköy

VI. Smart Grid Applications				0
ECONOMIC	TECHNICAL	LEGAL	SPATIAL	

Table 154: Smart Grid Applications criteria – Kadiköy

SD. Population Density identified in Spatial Data		8
ECONOMIC	SOCIAL	

2) medium density zones	2	1) Solvent income level	6

Table 155: Population Density criteria – Kadiköy

SD. Population Projections for new development zones.					7
ECONOMIC		SOCIAL		LEGAL	
1) High density zones (they promote the economic activity)	3	1) Solvent income level	4	3) Previous criteria is not fulfilled	0

Table 156: Population Projections criteria – Kadiköy

SD. Co-designing and collectively organizing PEDs in areas where communities are effective			0
ECONOMIC	SOCIAL	LEGAL	

Table 157: Organizational areas criteria – Kadiköy

SD. Self-sufficient districts / neighbourhoods or Ecovillages (with a more circular economy perspective)			0
ECONOMIC	TECHNICAL	SPATIAL	

Table 158: Self-sufficient districts / neighbourhoods – Kadiköy

SD. Cultural Human Behavior			6
ECONOMIC		SOCIAL	
2) Medium income level	3	2) youngsters and professionals keen on behavioural change	3

Table 159: Cultural Human Behaviour criteria – Kadiköy

SD. Vulnerable Communities / disadvantageous/ urban poor		0
ECONOMIC	LEGAL	

Table 160: Vulnerable Communities / disadvantageous/ urban poor criteria – Kadiköy

MCDA questionnaire of León

RA. Existing solar energy investment zones								9
ECONOMIC		LEGAL		SPATIAL		EXTRA POINT		
1) Solar energy investment zones owned by the community or the public administration exist	2	1) Zones with high solar potential exist: radiation higher than 1.500 kWh/m2year	3	2) There are zones with high solar potential with a size between 10.000 and 20.000m2	3	2) Surrounding the city there are private zones with potential to become solar parks.	1	

Table 161: Existing solar energy investment zones criteria – León

RA. Potential solar energy investment zones										9
ECONOMIC		SOCIAL		TECHNICAL		LEGAL		SPATIAL		
1) Potential solar energy investment zones owned by the community or the public administration exist	2	1) High-medium social acceptability of the solar energy	1	1) Zones with high solar potential exist: radiation higher than 1.500 kWh/m2year	2	1) Regulatory framework is suitable for solar energy implementation (Self-consumption is allowed, NET balance)	1	1) There are zones with high solar potential higher than 20.000m2	3	

Table 162: Potential solar energy investment zones criteria – León

RA. Existing wind energy investment zones						0
ECONOMIC		TECHNICAL		SPATIAL		

Table 163: Existing wind energy investment zones criteria – León

RA. Potential wind energy investment zones								0
ECONOMIC		SOCIAL		TECHNICAL		SPATIAL		

Table 164: Potential wind energy investment zones criteria – León

RA. Extensive ground coupling potential								8
SOCIAL		TECHNICAL		ENVIRONMENTAL		SPATIAL		
1) There is drilling and geothermal technology available at affordable price	2	2) There are zones with medium geothermal potential.	1	1) Legal Framework allows drilling boreholes.	2	1) There are zones available to make drilling boreholes. Public zones available for this purpose	3	

Table 165: Extensive ground coupling potential criteria – León

RA. Geothermal water impact area					2
SOCIAL		TECHNICAL		LEGAL	
	0	3) Previous criteria is not fulfilled	0	2) Legal framework allows the implementation of geothermal but restrictions exist	2

Table 166: Geothermal water impact area criteria – León

RA. Potential surface water resources for energy generation					2
ECONOMIC		TECHNICAL		LEGAL	
3) Small private / Individual Investments	0	3) Previous criteria is not fulfilled	0	1) Legal framework allows the use of water resources for energy generation but some restrictions exist.	2

Table 167: Potential surface water resources for energy generation criteria – León

RA. Potential water resources utilized as heat source for heating / cooling purposes					0
ECONOMIC		TECHNICAL		LEGAL	

Table 168: Potential water resources utilized as heat source for heating / cooling purposes criteria – León

RA. Water surfaces with evaporative potential					7
ECONOMIC		TECHNICAL		LEGAL	
3) Small private / Individual Investments	0	3) Previous criteria is not fulfilled	0	1) Legal framework allows the use of water resources for energy generation but some restrictions exist.	2

Table 169: Water surfaces with evaporative potential criteria – León

RA. Potential energy generation areas by biomass							7
SOCIAL		TECHNICAL		ENVIRONMENTAL		SPATIAL	
1) Social acceptability of biomass is medium- high	1	2) There is biomass available close to the city	3	1) Pruning residues are used as fuel	2	1) There are biomass resources available but to places (such us industry) with energy production potential are not very close	1

Table 170: Potential energy generation areas by biomass criteria – León

RA. Waste heat Potential				0
TECHNICAL		SPATIAL		

Table 171: Waste heat Potential criteria – León

UM. New Development Areas				6
TECHNICAL		LEGAL		
2) New development areas exist and although it is not mentioned in a strategic plan, decisions through energy efficiency, energy production or low energy consumption, could be potential areas for PED implementation.	4	2) There is a legal framework that allows the implementation of PED in this kind of areas	2	

Table 172: New development areas criteria – León

UM. Retrofitting Areas						9
ECONOMIC		LEGAL		SPATIAL		
1) Selected areas for retrofitting exist and funding mechanism are already approved	5	1) Legal framework is suitable forNearly zero energy building retrofiting projects	1	1) It is an ISUDS (integrated sustainable urban development strategies) area	3	

Table 173: Retrofitting Areas criteria – León

UM. Infill Areas						7
TECHNICAL		LEGAL		SPATIAL		
2) There are infill areas not mentioned in strategic plan, incentives or any regulations through energy efficiency for new building stock	4	1) Legal framework is suitable for the implementation of PED in infill areas	2	2) It is next to an infill area	1	

Table 174 Infill Areas criteria – León

UM. Transformation / Reuse Areas						6
ECONOMIC		LEGAL		SPATIAL		
2) Selected areas for transformation /Reuse exist and some fundings are expected	4	1) Strategy of urban regeneration promotes the implementation of PED in transformation/reuse areas	1	2) It is next to a transformation/reuse area	1	

Table 175: Transformation / Reuse Areas criteria – León

LU. Residential & Mixed Use Areas						8
ECONOMIC		SOCIAL		LEGAL		
1) Zones with expected investment plans and incentives for private building stock	3	2) Citizens have a medium acceptability of new developments	2	1) Legal mechanism promoting energy efficiency retrofitting and/or renewables implementation exist	3	

Table 176: Residential & Mixed Use Areas criteria – León

LU. Commercial Areas					4
ECONOMIC		LEGAL		EXTRA POINT	
3) Previous criteria is not fulfilled	0	1) Legal mechanism promoting energy efficiency retroffiting and/or renewables implementation	2	1) Citizens recognition of green behaviour	2

Table 177: New development areas criteria – León

LU. Active Green / Open Parking Lot. Considering it as available urban areas							8
ECONOMIC		TECHNICAL		ENVIRONMENTAL		LEGAL	
2) Zones with expected private and/or public investment plans or incentives for active green/open parking lot	2		0	1) Active Green (forest, intense vegetation) has high positive impact on cooling loads in warm cities	2	1) Legal exigencies exist promoting the energy efficiency and/or renewables implementation in active green/open parking Lot. Included in urban planning	4

Table 178: Active Green / Open Parking Lot criteria – León

LU. Public Administration Areas				9
ECONOMIC		LEGAL		
1) Zones with expected public investment plans and incentives for public administration areas. Budget expected to these kind of investment	6	1) Legal exigencies exist promoting the energy efficiency and/or renewables implementation	3	

Table 179: Public administration areas criteria – León

LU. Social / Cultural/Educational/Sport Areas				9
ECONOMIC		LEGAL		
1) Zones with expected public investment plans and incentives for public administration areas. Budget expected to these kind of investment	6	1) Legal exigencies exist promoting the energy efficiency and/or renewables implementation	3	

Table 180: Social / Cultural/Educational/Sport Areas criteria – León

TPI. Heat Grid				0
ECONOMIC	TECHNICAL	ENVIRONMENTAL	LEGAL	

Table 181: Heat Grid criteria – León

TPI. Power Infrastructure				9
ECONOMIC	TECHNICAL	LEGAL	EXTRA POINT	

1) There are approved investments to improve the power infrastructure	3	2) There are some parts of the network prepared	2	1) there are legal mechanism promoting the connection and injection to the grid	3	1) The power infrastructure is of public domain	1

Table 182: Power Infrastructure criteria – León

TPI. Heat Network								5
ECONOMIC		SOCIAL		TECHNICAL		LEGAL		SPATIAL	
1) There is high investment approved for the infrastructure and business models promote the implementation	3	1) Citizens are open to share	1	1) Technically is feasible the implementation of a heat network (and economically feasible)	2		0		0

Table 183: Heat Network criteria – León

TPI. Mobility Infrastructure			9
ECONOMIC		LEGAL	
1) Charging stations owned by the community or the public administrations	6	1) Legal Infrastructure permits trading in public charging stations	3

Table 184: Mobility Infrastucture criteria – León

VI. Smart Grid Applications				0
ECONOMIC	TECHNICAL	LEGAL	SPATIAL	

Table 185: Smart Grid Applications criteria – León

SD. Population Density identified in Spatial Data			7
ECONOMIC		SOCIAL	
1) High density zones (they promote the economic activity)	3	2) Not solvent income level but expected investments	4

Table 186: Population Density criteria – León

SD. Population Projections for new development zones.				8
ECONOMIC		SOCIAL		LEGAL	
2) medium density zones	2	1) Solvent income level	4	1) The municipality has the capacity to make changes in new development zones.	2

Table 187: Population Projections criteria – León

SD. Co-designing and collectively organizing PEDs in areas where communities are effective					0
ECONOMIC		SOCIAL		LEGAL	

Table 188: organizational areas criteria – León

SD. Self-sufficient districts / neighbourhoods or Ecovillages (with a more circular economy perspective)					6
ECONOMIC		TECHNICAL		LEGAL	
3) Previous criteria is not fulfilled	0	1) High engagement communities facilitate the effective implementation of PED. High cultural level of the population promote the implementation	4	1) Regulation exist for the energy Communities / cooperatives / housing associations	2

Table 189: Self-sufficient districts / neighbourhoods – León

SD. Cultural Human Behavior					4
ECONOMIC		SOCIAL		MINUS POINT	
2) Medium income level	3	2) youngsters and professionals keen on behavioural change	3	Hard to change energy use behaviour e.g. Aging population	-2

Table 190: Cultural Human Behaviour criteria – León

SD. Vulnerable Communities / disadvantageous/ urban poor				7
ECONOMIC		LEGAL		
2) Incentives or subsidies support reducing energy poverty	3	1) Municipalities support collaborative decision making	4	

Table 191: Vulnerable Communities / disadvantageous/ urban poor criteria – León

MCDA questionnaire of Lublin

RA. Existing solar energy investment zones							7
ECONOMIC		LEGAL		SPATIAL		EXTRA POINT	
1) Solar energy investment zones owned by the community or the public administration exist	2	2) Zones with medium solar potential exist: radiation between 1.000-1.500 kWh/m2year	2	1) There are zones with high solar potential higher than 20.000m2	4	2) Surrounding the city there are private zones with potential to become solar parks.	1
						1) The most suitable zones for implementing solar energy are active green or agricultural areas	-2

Table 192: Existing solar energy investment zones criteria – Lublin

RA. Potential solar energy investment zones											4
ECONOMIC		SOCIAL		TECHNICAL		LEGAL		SPATIAL		EXTRA POINT	
1) Potential solar energy investment zones owned by the community or the public administration exist	2	1) High-medium social acceptability of the solar energy	1	2) Zones with medium solar potential exist: radiation between 1.000-1.500 kWh/m2year	1	1) Regulatory framework is suitable for solar energy implementation (Self-consumption is allowed, NET balance)	1	4) There are no zones that fulfil the previous criteria	0	2) Surrounding the city there are private zones with potential to become solar parks.	1
										1) The most suitable zones for implementing solar energy are active green or agricultural areas	-2

Table 193: Potential solar energy investment zones criteria – Lublin

RA. Existing wind energy investment zones			0
ECONOMIC	TECHNICAL	SPATIAL	

Table 194: Existing wind energy investment zones criteria – Lublin

RA. Potential wind energy investment zones				0
ECONOMIC	SOCIAL	TECHNICAL	SPATIAL	

Table 195: Potential wind energy investment zones criteria – Lublin

RA. Extensive ground coupling potential							2
SOCIAL		TECHNICAL		ENVIRONMENTAL		SPATIAL	
3) Previous criteria is not fulfilled	0	3) Previous criteria is not fulfilled	0	1) Legal Framework allows drilling boreholes.	2	3) Previous criteria is not fulfilled	0

Table 196: Extensive ground coupling potential criteria – Lublin

RA. Geothermal water impact area			0
SOCIAL	TECHNICAL	LEGAL	

Table 197: Geothermal water impact area criteria – Lublin

RA. Potential surface water resources for energy generation					6
ECONOMIC		TECHNICAL		LEGAL	
3) Small private / Individual Investments	0	2) There are Current sea, lakes, streams, creeks in the city with energy generation potential.	4	2) Legal framework allows the use of water resources for energy generation but some restrictions exist.	2

Table 198: Potential surface water resources for energy generation criteria – Lublin

RA. Potential water resources utilized as heat source for heating / cooling purposes			0
ECONOMIC	TECHNICAL	LEGAL	

Table 199: Potential water resources utilized as heat source for heating / cooling purposes criteria – Lublin

RA. Water surfaces with evaporative potential			0
ECONOMIC	TECHNICAL	LEGAL	

Table 200: Water surfaces with evaporative potential criteria – Lublin

RA. Potential energy generation areas by biomass							6
SOCIAL		TECHNICAL		ENVIRONMENTAL		SPATIAL	
1) Social acceptability of biomass is medium- high	0	2) There is biomass available close to the city	3	1) Pruning residues are used as fuel	2	2) There are biomass resources available but to places (such us industry) with energy production potential are not very close	1

Table 201: Potential energy generation areas by biomass criteria – Lublin

RA. Waste heat Potential		7
TECHNICAL		SPATIAL
1) Industries with heat energy recovery potential (i.e. cement manufacture, steel working exist and there is relevant heat demand in the city and/or existing DH	7	

Table 202: Waste heat Potential criteria – Lublin

UM. New Development Areas			6
TECHNICAL		LEGAL	
2) New development areas exist and although it is not mentioned in a strategic plan, decisions through energy efficiency, energy production or low energy consumption, could be potential areas for PED implementation.	4	2) There is a legal framework that allows the implementation of PED in this kind of areas	2

Table 203: New development areas criteria – Lublin

UM. Retrofitting Areas					5
ECONOMIC		LEGAL		SPATIAL	
2) Selected areas for retrofitting exist and some fundings are expected	4	1) Legal framework is suitable forNearly zero energy building retrofitting projects	1	3) Previous criteria is not fulfilled	0

Table 204: Retrofitting Areas criteria – Lublin

UM. Infill Areas					6
TECHNICAL		LEGAL		SPATIAL	
2) There are infill areas not mentioned in strategic plan, incentives or any regulations through energy efficiency for new building stock	4	1) Legal framework is suitable for the implementation of PED in infill areas	2	3) Previous criteria is not fulfilled	0

Table 205: Infill Areas criteria – Lublin

UM. Transformation / Reuse Areas					6
ECONOMIC		LEGAL		SPATIAL	
2) Selected areas for transformation /Reuse exist and some fundings are expected	4	1) Strategy of urban regeneration promotes the implementation of PED in transformation/reuse areas	2	3) Previous criteria is not fulfilled	0

Table 206: Transformation / Reuse Areas criteria – Lublin

LU. Residential & Mixed Use Areas						8
ECONOMIC		SOCIAL		LEGAL		
1) Zones with expected investment plans and incentives for private building stock	3	2) Citizens have a medium acceptability of new developments	2	1) Legal mechanism promoting energy efficiency retrofitting and/or renewables implementation exist	3	

Table 207: Residential & Mixed Use Areas criteria – Lublin

LU. Commercial Areas					9
ECONOMIC		LEGAL		EXTRA POINT	
1) Zones with expected private and/or public investment plans and incentives for commercial areas	7	1) Legal mechanism promoting energy efficiency retrofitting and/or renewables implementation	2	1) Citizens recognition of green behaviour	2

Table 208: New development areas criteria – Lublin

LU. Active Green / Open Parking Lot. Considering it as available urban areas							5
ECONOMIC		TECHNICAL		ENVIRONMENTAL		LEGAL	
1) Zones with expected private and/or public investment plans and incentives for active green/open parking lot	3			1) Active Green (forest, intense vegetation) has high positive impact on cooling loads in warm cities	2	3) Previous criteria is not fulfilled	0

Table 209: Active Green / Open Parking Lot criteria – Lublin

LU. Public Administration Areas				9
ECONOMIC		LEGAL		
1) Zones with expected public investment plans and incentives for public administration areas. Budget expected to these kind of investment	6	1) Legal exigencies exist promoting the energy efficiency and/or renewables implementation	3	

Table 210: Public administration areas criteria – Lublin

LU. Social / Cultural/Educational/Sport Areas				9
ECONOMIC		LEGAL		
1) Zones with expected public investment plans and incentives for public administration areas. Budget expected to these kind of investment	6	1) Legal exigencies exist promoting the energy efficiency and/or renewables implementation	3	

Table 211: Social / Cultural/Educational/Sport Areas criteria – Lublin

TPI. Heat Grid				7
ECONOMIC	TECHNICAL	LEGAL	SPATIAL	

2) The grid is amortized but the share of renewables is low	1	1) The heat grid contains storage or integrates different types of renewable technologies	2	1) Legal mechanisms exist for the promotion of the implantation of renewables and the substitution of boilers or other outdated technology	3	1) There is space available for the installation of the technologies	1

Table 212: Heat Grid criteria – Lublin

TPI. Power Infrastructure							8
ECONOMIC		TECHNICAL		LEGAL		EXTRA POINT	
3) Previous criteria is not fulfilled	0	1) The network is strongly prepared for the introduction of distributed generation equipment	3	1) there are legal mechanism promoting the connection and injection to the grid	3	1) The power infrastructure is of public domain	2

Table 213: Power Infrastructure criteria – Lublin

TPI. Heat Network									8
ECONOMIC		SOCIAL		TECHNICAL		LEGAL		SPATIAL	
1) There is high investment approved for the infrastructure and business models promote the implementation	3	1) Citizens are open to share	1	1) Technically is feasible the implementation of a heat network (and economically feasible)	1	1) Urban planning promotes this kind of infrastructure	2	2) Heat density is medium (related to climate and building density or population density) - in relation to the climate	1

Table 214: Heat Network criteria – Lublin

TPI. Mobility Infrastructure			9
ECONOMIC		LEGAL	
1) Charging stations owned by the community or the public administrations	6	1) Legal Infrastructure permits trading in public charging stations	3

Table 215: Mobility Infrastucture criteria – Lublin

VI. Smart Grid Applications					7
ECONOMIC		TECHNICAL		LEGAL	
1) The micro grid exists and is amortized and the share of renewables is high	2	1) Existence of a micro grid and/or a virtual power plant facilitates PED implementation	4	1) Regulatory framework is suitable for micro grid applications implementation	1

Table 216: Smart Grid Applications criteria – Lublin

SD. Population Density identified in Spatial Data			9
ECONOMIC		SOCIAL	
1) High density zones (they promote the economic activity)	3	1) Solvent income level	6

Table 217: Population Density criteria – Lublin

SD. Population Projections for new development zones.					8
ECONOMIC		SOCIAL		LEGAL	
1) High density zones (they promote the economic activity)	3	1) Solvent income level	4	2) national governments have the capacity to make changes in new development zones	1

Table 218: Population Projections criteria – Lublin

SD. Co-designing and collectively organizing PEDs in areas where communities are effective			0
ECONOMIC	SOCIAL	LEGAL	

Table 219: organizational areas criteria – Lublin

SD. Self-sufficient districts / neighborhoods or Ecovillages (with a more circular economy perspective)			4
ECONOMIC		TECHNICAL	
3) Previous criteria is not fulfilled	0	1) High engagement communities facilitate the effective implementation of PED. High cultural level of the population promotes the implementation	4

Table 220: Self-sufficient districts / neighbourhoods – Lublin

SD. Cultural Human Behavior			7
ECONOMIC		SOCIAL	
2) Medium income level	3	1)raising energy efficiency and energy investment campaign	4

Table 221: Cultural Human Behaviour criteria – Lublin

SD. Vulnerable Communities / disadvantageous/ urban poor			3
ECONOMIC		LEGAL	
2) Incentives or subsidies support reducing energy poverty	3	2) Previous criteria is not fulfilled	0

Table 222: Vulnerable Communities / disadvantageous/ urban poor criteria – Lublin

MCDA questionnaire of Trenčín

RA. Existing solar energy investment zones							9
ECONOMIC		LEGAL		SPATIAL		EXTRA POINT	
1) Solar energy investment zones owned by the community or the public administration exist	2	1) Zones with high solar potential exist: radiation higher than 1.500 kWh/m2year	3	2) There are zones with high solar potential with a size between 10.000 and 20.000m2	3	2) Surrounding the city there are private zones with potential to become solar parks.	1

Table 223: Existing solar energy investment zones criteria – Trenčín

RA. Potential solar energy investment zones									9
ECONOMIC		SOCIAL		TECHNICAL		LEGAL		SPATIAL	
1) Potential solar energy investment zones owned by the community or the public administration exist	2	1) High-medium social acceptability of the solar energy	1	2) Zones with medium solar potential exist: radiation between 1.000-1.500 kWh/m2year	1	1) Regulatory framework is suitable for solar energy implementation (Self-consumption is allowed, NET balance)	1	1) There are zones with high solar potential higher than 20.000m2	3

Table 224: Potential solar energy investment zones criteria – Trenčín

RA. Existing wind energy investment zones			0
ECONOMIC	TECHNICAL	SPATIAL	

Table 225: Existing wind energy investment zones criteria – Trenčín

RA. Potential wind energy investment zones				0
ECONOMIC	SOCIAL	TECHNICAL	SPATIAL	

Table 226: Potential wind energy investment zones criteria – Trenčín

RA. Extensive ground coupling potential					4
ECONOMIC		TECHNICAL		LEGAL	
2) Drilling and geothermal technology can be find.	1	2) There are zones with medium geothermal potential.	1	1) Legal Framework allows drilling boreholes.	2

Table 227: Extensive ground coupling potential criteria – Trenčín

RA. Geothermal water impact area				3
SOCIAL		LEGAL		
1) High-medium social acceptability of the geothermal energy	1	2) Legal framework allows the implementation of geothermal but restrictions exist		2

Table 228: Geothermal water impact area criteria – Trenčín

RA. Potential surface water resources for energy generation					9
ECONOMIC		TECHNICAL		LEGAL	
1) Public Investment provides feasible installation	2	1) There are Current sea, lakes, streams, creeks in the city with high energy generation potential.	5	1) Legal framework allows the use of water resources for energy generation but some restrictions exist.	2

Table 229: Potential surface water resources for energy generation criteria – Trenčín

RA. Potential water resources utilized as heat source for heating / cooling purposes					5
ECONOMIC		TECHNICAL		LEGAL	
2) Drilling and heat exchanger technology can be found	1	1) There are seas, rivers etc. with high potential by constant temperature.	2	1) Legal Framework allows building heat exchanger rooms on the coast	2

Table 230: Potential water resources utilized as heat source for heating / cooling purposes criteria – Trenčín

RA. Water surfaces with evaporative potential			0
ECONOMIC	TECHNICAL	SPATIAL	

Table 231: Water surfaces with evaporative potential criteria – Trenčín

RA. Potential energy generation areas by biomass							4
SOCIAL		TECHNICAL		ENVIRONMENTAL		SPATIAL	
1) Social acceptability of biomass is medium- high	1	2) There is biomass available close to the city	3	3) There is no separation for incineration	0	3) Previous criteria is not fulfilled	0

Table 232: Potential energy generation areas by biomass criteria – Trenčín

RA. Waste heat Potential		0
TECHNICAL	SPATIAL	

Table 233: Waste heat Potential criteria – Trenčín

UM. New Development Areas				9
TECHNICAL		LEGAL		
1) New development areas exist and it is mentioned in a strategic plan, decisions through energy efficiency, energy production or low energy consumption.	6	1) There is a legal framework that promotes PED implementation (i.e. energy efficiency requirements)	3	

Table 234: New development areas criteria – Trenčín

UM. Retrofitting Areas					6
ECONOMIC		LEGAL		SPATIAL	
1) Selected areas for retrofitting exist and funding mechanism are already approved	5	1) Legal framework is suitable forNearly zero energy building retrofitting projects	1	2) Previous criteria is not fulfilled	0

Table 235: Retrofitting Areas criteria – Trenčín

UM. Infill Areas			7
TECHNICAL		LEGAL	
1) There are infill areas and are mentioned in strategic plan, incentives or any regulations through energy efficiency for new building stock, for PED implementation	5	1) Legal framework is suitable for the implementation of PED in infill areas	2

Table 236: Infill Areas criteria – Trenčín

UM. Transformation / Reuse Areas			5
ECONOMIC		LEGAL	
2) Selected areas for transformation /Reuse exist and some fundings are expected	4	1) Strategy of urban regeneration allows the implementation of PED in transformation/reuse areas	1

Table 237: Transformation / Reuse Areas criteria – Trenčín

LU. Residential & Mixed Use Areas					9
ECONOMIC		SOCIAL		LEGAL	
1) Zones with expected investment plans and incentives for private building stock	3	1) Citizens have a high acceptability of new developments	3	1) Legal mechanism promoting energy efficiency retrofitting and/or renewables implementation exist	3

Table 238: Residential & Mixed Use Areas criteria – Trenčín

LU. Commercial Areas			9
ECONOMIC		LEGAL	
1) Zones with expected private and/or public investment plans and incentives for commercial areas	7	1) Legal mechanism promoting energy efficiency retrofitting and/or renewables implementation	2

Table 239: Commercial areas criteria – Trenčín

LU. Active Green / Open Parking Lot. Considering it as available urban areas					8
ECONOMIC		ENVIRONMENTAL		LEGAL	
2) Zones with expected private and/or public investment plans or incentives for active green/open parking lot	2	1) Active Green (forest, intense vegetation) has high positive impact on cooling loads in warm cities	2	2) Legal exigencies does not exist, but the energy efficiency and/or renewables implementation in active green/open parking Lot is promoted. Not Included in urban planning.	4

Table 240: Active Green / Open Parking Lot criteria – Trenčín

LU. Public Administration Areas			9
ECONOMIC		LEGAL	
1) Zones with expected public investment plans and incentives for public administration areas. Budget expected to these kind of investment	6	1) Legal exigencies exist promoting the energy efficiency and/or renewables implementation	3

Table 241: Public administration areas criteria – Trenčín

LU. Social / Cultural/Educational/Sport Areas			9
ECONOMIC		LEGAL	
1) Zones with expected public investment plans and incentives for public administration areas. Budget expected to these kind of investment	6	1) Legal exigencies exist promoting the energy efficiency and/or renewables implementation	3

Table 242: Social / Cultural/Educational/Sport Areas criteria – Trenčín

TPI. Heat Grid					5
ECONOMIC		TECHNICAL		LEGAL	
2) The grid is amortized but the share of renewables is low	1	1) The heat grid contains storage or integrates different types of renewable technologies	2	1) Legal mechanisms exist allowing the implantation of renewables and the substitution of boilers or other outdated technology	2

Table 243: Heat Grid criteria – Trenčín

TPI. Power Infrastructure					7
ECONOMIC		TECHNICAL		LEGAL	
2) There are expected investments to improve the power infrastructure	2	2) There are some parts of the network prepared	2	1) there are legal mechanism promoting the connection and injection to the grid	3

Table 244: Power Infrastructure criteria – Trenčín

TPI. Heat Network			
LEGAL		SPATIAL	
2) Urban planning allows this kind of infrastructure	1	2) Heat density is medium (related to climate and building density or population density) - in relation to the climate	1

Table 245: Heat Network criteria – Trenčín

TPI. Mobility Infrastructure			7
ECONOMIC		LEGAL	
2) Charging stations owned by the private sector	4	1) Legal Infrastructure permits trading in public charging stations	3

Table 246: Mobility Infrastucture criteria – Trenčín

VI. Smart Grid Applications			3
TECHNICAL		LEGAL	
2) It is expected to be created a micro grid and/or a virtual power plant	2	1) Regulatory framework is suitable for micro grid applications implementation (Shared self-consumption is allowed, NET balance)	1

Table 247: Smart Grid Applications criteria – Trenčín

SD. Population Density identified in Spatial Data			6
ECONOMIC		SOCIAL	
2) medium density zones	2	2) Not solvent income level but expected investments	4

Table 248: Population Density criteria – Trenčín

SD. Population Projections for new development zones.					8
ECONOMIC		SOCIAL		LEGAL	
2) medium density zones	2	1) Solvent income level	4	1) The municipality has the capacity to make changes in new development zones.	2

Table 249: Population Projections criteria – Trenčín

SD. Co-designing and collectively organizing PEDs in areas where communities are effective			0
ECONOMIC	SOCIAL	LEGAL	

Table 250: organizational areas criteria – Trenčín

SD. Self-sufficient districts / neighbourhoods or Ecovillages (with a more circular economy perspective)			0
ECONOMIC	TECHNICAL	LEGAL	

Table 251: Self-sufficient districts / neighbourhoods – Trenčín

SD. Cultural Human Behavior			6
ECONOMIC		SOCIAL	
2) Medium income level	3	2) youngsters and professionals keen on behavioural change	3

Table 252: Cultural Human Behaviour criteria – Trenčín

SD. Vulnerable Communities / disadvantageous/ urban poor			7
ECONOMIC		LEGAL	
2) Incentives or subsidies support reducing energy poverty	3	1) Municipalities support collaborative decision making	4

Table 253: Vulnerable Communities / disadvantageous/ urban poor criteria – Trenčín

MCDA questionnaire of Vidin

RA. Existing solar energy investment zones						8*
ECONOMIC		TECHNICAL		SPATIAL		
2) Solar energy investment zones owned by the private sector (with their own business model) exists	1	1) Zones with high solar potential exist: radiation higher than 1.500 kWh/m2year	3	2) There are zones with high solar potential with a size between 10.000 and 20.000m2	3	

Table 254: Existing solar energy investment zones criteria – Vidin

*Note: one extra point was given because Surrounding the city there are private zones with potential to become solar parks.

Potential solar energy investment zones									7
ECONOMIC		SOCIAL		TECHNICAL		LEGAL		SPATIAL	
1) Potential solar energy investment zones owned by the community, by a private sector involved in the project or the public administration exist	2	1) High-medium social acceptability of the solar energy	1	1) Zones with high solar potential exist: radiation higher than 1.500 kWh/m2year	2	2) Regulatory framework is not suitable for solar energy implementation	0	2) There are zones with high solar potential with a size between 10.000 and 20.000m2	2

Table 255: Potential solar energy investment zones criteria – Vidin

RA. Existing wind energy investment zones			OS
ECONOMIC	TECHNICAL	SPATIAL	

Table 256: Existing wind energy investment zones criteria – Vidin

Potential wind energy investment zones				OS
ECONOMIC	SOCIAL	TECHNICAL	SPATIAL	

Table 257: Potential solar energy investment zones criteria – Vidin

RA. Extensive ground coupling potential						8
ECONOMIC		TECHNICAL		LEGAL	SPATIAL	
1) There is drilling and geothermal technology available at affordable price	2	1) There are zones with high geothermal potential	2	1) Legal Framework allows drilling boreholes (environmental restrictions, community restrictions - too close to other boreholes,etc.).	2	2) There are zones available to make drilling boreholes. Private zones available for this purpose	2

Table 258: Extensive ground coupling potential criteria – Vidin

RA. Geothermal water impact area					6
SOCIAL		TECHNICAL		LEGAL	
1) High-medium social acceptability of the geothermal energy	2	2) There are some geothermal water resources	2	2) Legal framework allows the implementation of geothermal but restrictions exist	2

Table 259: Geothermal water impact area criteria - Vidin

RA. Potential surface water resources for energy generation		OS
ECONOMIC	TECHNICAL	LEGAL

Table 260: Potential surface water resources for energy generation criteria – Vidin

RA. Potential water resources utilized as heat source for heating / cooling purposes		OS
ECONOMIC	TECHNICAL	LEGAL

Table 261: Potential water resources utilized as heat source for heating / cooling purposes criteria – Vidin

RA. Water surfaces with evaporative potential.	OS
SPATIAL	

Table 262: Water surfaces with evaporative potential criteria – Vidin

Potential energy generation areas by biomass							6
SOCIAL		TECHNICAL		ENVIRONMENTAL		SPATIAL	
1) Social acceptability of biomass is medium- high.	1	2) There is biomass available close to the city (private pellets suppliers)	3	3) There is not separation for incineration.	0	1) There are biomass resources available next to places (such us industry) with energy production potential	2

Table 263: Potential energy generation areas by biomass criteria – Vidin

RA. Waste heat Potential		OS
TECHNICAL	SPATIAL	

Table 264: Waste heat Potential criteria – Bassano de Grappa

UM. New Development Areas			6
TECHNICAL		SPATIAL	
2) New development areas exist and although it is not mentioned in a strategic plan, decisions through energy efficiency, energy production or low energy consumption, could be pontential areas for PED implementation.	4	2) There is a legal framework that allows the implementation of PED in this kind of areas	2

Table 265: New development areas criteria – Vidin

UM. Retrofitting Areas					9
ECONOMIC		LEGAL		SPATIAL	
1) Selected areas for retrofitting exist and funding mechanism are already approved (i.e ISUDS: integrated sustainable urban development strategies)	5	1) Legal framework is suitable forNearly zero energy building retrofiting projects	1	1) It is an ISUDS (integrated sustainable urban development strategies) area	3

Table 266: Retrofitting Areas criteria – Vidin

UM. Infill Areas		OS
TECHNICAL	LEGAL	SPATIAL

Table 267: Infill Areas criteria – Vidin

UM. Transformation / Reuse Areas					8
ECONOMIC		LEGAL		SPATIAL	
2) Selected areas for transformation /Reuse exist and some fundings are expected	4	1) Strategy of urban regeneration promotes the implementation of PED in transformation/reuse areas	2	1) It is an transformation/Reuse area	2

Table 268: Transformation / Reuse Areas criteria – Vidin

LU. Residential & Mixed Use Areas					9
ECONOMIC		SOCIAL		LEGAL	
1) Zones with expected investment plans and incentives for private building stock	3	2) Citizens have a medium acceptability of new developments	2	1) Legal mechanism promoting energy efficiency retroffiting and/or renewables implementation exist	3

Table 269: Residential & Mixed Use Areas criteria – Vidin

LU. Commercial Areas			9*
ECONOMIC		LEGAL	
2) Zones with expected public investment plans and incentives for commercial areas	5	1) Legal mechanism promoting energy efficiency retroffiting and/or renewables implementation	2

Table 270: New development areas criteria – Vidin

*Note that two extra points were given according to 1) Citizens recognition of green behaviour.

LU. Active Green / Open Parking Lot. Considering it as available urban areas							9
ECONOMIC		TECHNICAL		ENVIRONMENTAL		LEGAL	
1) Zones with expected private and/or public investment plans and incentives for active green/open parking lot or long term storage	3	1) Long term energy storage (pits, batteries,etc.) is feasible	2	1) Active Green (forest, intense vegetation) has high positive impact on cooling loads in warm cities	1	2) Legal exigencies does not exist, but the energy efficiency and/or renewables implementation in active green/open partking Lot is promoted. Not Included in urban planning	2

Table 271: Active Green / Open Parking Lot criteria – Vidin

LU. Public Administration Areas			9
ECONOMIC		LEGAL	
1) Zones with expected public investment plans and incentives for public administration areas. Budget expected to these kind of investment	6	1) Legal exigencies exist promoting the energy efficiency and/or renewables implementation	3

Table 272: Public administration areas criteria – Vidin

LU. Social / Cultural/Educational/Sport Areas			9
ECONOMIC		LEGAL	
1) Zones with expected public investment plans and incentives for public administration areas. Budget expected to these kind of investment	6	1) Legal exigencies exist promoting the energy efficiency and/or renewables implementation	3

Table 273: Social / Cultural/Educational/Sport Areas criteria – Vidin

TPI. Heat Grid				OS
ECONOMIC	TECHNICAL	ENVIRONMENTAL	LEGAL	

Table 274: Heat Grid criteria – Vidin

TPI. Power Infrastructure			OS
ECONOMIC	TECHNICAL	LEGAL	

Table 275: Power Infrastructure criteria – Vidin

TPI. Heat Network					OS
ECONOMIC	SOCIAL	TECHNICAL	LEGAL	SPATIAL	

Table 276: Heat Network criteria – Vidin

TPI. Mobility Infrastucture				OS
ECONOMIC		LEGAL		

Table 277: Mobility Infrastucture criteria – Vidin

VI. Smart Grid Applications				OS
ECONOMIC	TECHNICAL	LEGAL	SPATIAL	

Table 278: Smart Grid Applications criteria – Vidin

SD. Population Density identified in Spatial Data				7
ECONOMIC		SOCIAL		
1) High density zones (they promote the economic activity)	3	2) Not solvent income level but expected investments (for urban poor and disadvantegous communities)	4	

Table 279: Population Density criteria – Vidin

SD. Population Projections for new development zones.			OS
ECONOMIC	SOCIAL	LEGAL	

Table 280: Population Projections criteria – Vidin

SD. Co-designing and collectively organizing PEDs in areas where communities are effective					6
ECONOMIC		SOCIAL		LEGAL	
2) Incentives or subsidies support energy communities	2	1) High engagement communities facilitate the effective implementation of PED. High cultural level of the population promote the implementation	4	2) Previous criteria is not fulfilled	0

Table 281: organizational areas criteria – Vidin

SD. Self-sufficient districts / neighborhoods or Ecovillages (with a more circular economy perspective)			OS
ECONOMIC	TECHNICAL	SPATIAL	

Table 282: Self-sufficient districts / neighborhoods criteria – Vidin

SD. Cultural Human Behavior		OS
ECONOMIC	SOCIAL	

Table 283: Cultural Human Behaviour criteria – Vidin

SD. Vulnerable Communities / disadvantageous/ urban poor	OS
ECONOMIC	LEGAL

Table 284: Vulnerable Communities / disadvantageous/ urban poor criteria – Vidin

Annex II: Data sources for city components analysis

Data sources used for Bassano de Grappa components analysis

Provided by the city

- Land Use Divided in:
  - activeGreen.shp
  - cultural_area.shp
  - educational_area.shp
  - industrial_commercial_area.shp
  - parking.shp
  - residential_areas.shp
  - social_areas.shp
  - sport_areas.shp
  - pawer_industruial_areas.shp
- Urban Macroform
  - reuse_areas.shp
- Public/Private Areas
  - 12pubblic_adm_areas.shp
- Population Density
  - popolazione_quartieri_and_Quartieri.shp
- Location of existing hydroelectrics
  - hydroelectrics.shp
- EV Charging
  - charging_stations_EV.shp

From public sources

- Population density[14]: Number of inhabitants per grid cell (250x250m). Values transformed to inhabitants per km^2
- Vegetation map: Obtained from Corine land cover from 3 different maps
  - Forest[15]: Tree cover density, dominant leaf type and forest type products for reference year 2018 in 10 meter resolution.
  - Grassland[16]: Grassland status product for reference year 2018 in 10m resolution.
  - Small Woody Features[17]: Small patchy and linear woody features as vector product, available in 5m and 100m raster version.
- Solar radiation: Obtained from Global Solar Atlas[18]. PVOUT (photovoltaic power potential), GHI (global horizontal irradiation).
- Wind Speed Power density: Obtained from Global Wind Atlas[19]. Wind resource mapping at 10, 50, 100, 150 and 200 m above ground/sea level.

[14] https://ghsl.jrc.ec.europa.eu/download.php?ds=pop
[15] https://land.copernicus.eu/pan-european/high-resolution-layers/forests
[16] https://land.copernicus.eu/pan-european/high-resolution-layers/grassland
[17] https://land.copernicus.eu/pan-european/high-resolution-layers/small-woody-features
[18] https://globalsolaratlas.info/map
[19] https://globalwindatlas.info/

Data sources used for Kadiköy components analysis

Provided by the city

- Land Use Divided in:
  - administration_areas.shp
  - commercial_areas.shp
  - residential_mixed_use_areas.shp
  - social_cultural_education_health_use_areas.shp
  - active_green_parking_lot_areas.shp
- Urban Macroform
  - retrofitting_areas.shp
  - transformation_areas.shp
- Population Density
  - population.shp
- Water resources
  - sea.shp
  - stream.shp
- Ground Coupling
  - geomorphology.shp
- EV Charging
  - ev_chargers.shp

From public sources

- Kadiköy Spatial Strategic Plan[20]: Existing City Structure Report, most of the layers identified in GIS data that are gathered from the city databases, are evaluated from this report.
- Kadiköy Urban Transformation Strategic Report[21]: Prospective and ongoing urban transformation areas are identified in this report. General information regarding the energy efficiency measures in transformation project is evaluated from this report.
- Solar radiation: Obtained from Global Solar Atlas[22]. PVOUT (photovoltaic power potential), GHI (global horizontal irradiation).

Data sources used for León components analysis

Provided by the city

- Land Use Divided in:
  - green_parking_areas.shp
  - office_commercial_areas.shp
  - residential_mixed_used_areas.shp
  - sport_health_areas.shp
  - public_administration_areas.shp
- Urban Macroform

[20] https://webgis.kadikoy.bel.tr/keos/img/PDF/MSPMDR.PDF
[21] Derived from city archieves
[22] https://globalsolaratlas.info/map

  - reuse_transformation_areas.shp
  - infill_areas.shp
  - retrofitting areas.shp
  - new_development_areas.shp
- Potential Biomass
  - biomass.shp
  - waste_heat.shp
- Population Density
  - population_density.shp
- Water resources
  - river.shp
  - hydro.shp
- Ground Coupling
  - geomorphology.shp
- Heat Grid
  - heat_polygon.shp
- Geothermal water impact area
  - geothermal_heatoutput.shp

Data sources used for Lublin components analysis

Provided by the city

- Land Use Divided in:
  - green_parking_recreation_areas.shp
  - commercial_sales_areas.shp
  - residential_areas.shp
  - public_service_area_spatial_plan.shp
- Urban Macroform
  - development_area.shp
  - retrofitting.shp
- Potential Biomass
  - sewage.shp
  - industrial_waste_heat
- Water resources
  - water_tanks.shp
  - river.shp
- Heat Grid
  - heat_polygon.shp
- EV Charging
  - vehicle_charging_stations.shp

From public sources

- SOLAR POTENTIAL MAP of Lublin[23]: Analyzes conducted by a private company for the generation of the map of the solar potential of roofs for the selected part of Lublin generated with the use of GIS tools.
- Solar radiation: Obtained from Global Solar Atlas[24]. PVOUT (photovoltaic power potential), GHI (global horizontal irradiation).
- EPD Regulations in Poland [25]: Buildings and insulation codes for identifying buildings that needs to be retrofitted.

Data sources used for Trenčín components analysis

Provided by the city

- Land Use Divided in:
  - green_area.shp
  - commercial_area.shp
  - residential_area.shp
  - sport_cultural_educational_socail_area.shp
- Urban Macroform
  - reuse_areas.shp
  - infill_areas.shp
  - retrofitting areas.shp
- Potantial Biomass
  - sewerage.shp
- Population Density
  - density.shp
- Water resources
  - water.shp
- Ground Coupling
  - soil_type.shp
- Heat Grid
  - heat_polygon.shp
- Geothermal water impact area
  - geothermal_heatoutput.shp
- Solar efficient zones
  - Solar_existing.shp
  - Solar_potantial.shp
- EV Charging
  - ev_chargers.shp

From public sources

[23] https://gis-expert.pl/mapa-potencjalu-solarnego/

[24] https://globalsolaratlas.info/map

[25] https://www.researchgate.net/publication/280774780_The_modifications_to_the_requirements_on_energy_savings_and_thermal_insulation_of_buildings_in_Poland_in_the_years_1974-2021

- Trencin geological data:[26]: GIS based geomorphological structure of the city
- Solar radiation: Obtained from Global Solar Atlas[27]. PVOUT (photovoltaic power potential), GHI (global horizontal irradiation).

Data sources used for Vidin components analysis

Provided by the city

For the case of Vidin, the main input has been the "zem_10971.shp" file. The rest of the data has been obtained from public sources.

From public sources

- Population density[28]: Number of inhabitants per grid cell (250x250m). Values transformed to inhabitants per km^2
- Vegetation map: Obtained from Corine land cover from 3 different maps
    - Forest[29]: Tree cover density, dominant leaf type and forest type products for reference year 2018 in 10 meter resolution.
    - Grassland[30]: Grassland status product for reference year 2018 in 10m resolution.
    - Small Woody Features: Small patchy and linear woody features as vector product, available in 5m and 100m raster version.
- Solar radiation: Obtained from Global Solar Atlas[31]. PVOUT (photovoltaic power potential), GHI (global horizontal irradiation).
- Water bodies: European Settlement Map[32]. Spatial raster dataset that is mapping human settlements in Europe based on Copernicus Very High Resolution optical coverage for reference year 2015. Built-up areas classification at a spatial resolution of 2 meters. Distinguishes in no data, land, water and built-up area.

[26] https://www.geology.sk/maps-and-data/?lang=en
https://www.geology.sk/maps-and-data/geoportal-sguds/?lang=en"
[27] https://globalsolaratlas.info/map
[28] https://ghsl.jrc.ec.europa.eu/download.php?ds=pop
[29] https://land.copernicus.eu/pan-european/high-resolution-layers/grassland
[30] https://land.copernicus.eu/pan-european/high-resolution-layers/small-woody-features
[31] https://globalsolaratlas.info/map
[32] https://ghsl.jrc.ec.europa.eu/download.php?ds=ESM

Annex III: GIS intermediate results

This section explains the data treatment followed to create GIS layers included in the assessment of each city. Data sources, reclassification criteria considered and GIS layers reclassified are explained.

GIS intermediate results of Bassano de Grappa

Land Use

Sources: Land use GIS information provided by the city.

To generate the final Land Use layer, all the layers corresponding to this category are combined and the weights are assigned. It is necessary to include a "Rest" parameter with a value of 1, which is the minimum assignable, since the layer has to include all the areas within the established boundary.

Land use	Remap Value	Land use	Remap Value
activeGreen	6	pawer_industruial_areas	3
cultural_area	9	residential_areas	9
educational_area	9	social_areas	9
industrial_commercial_area	7	sport_areas	9
parking	6	Others	1

Table 285: Land use remap value – Bassano de Grappa

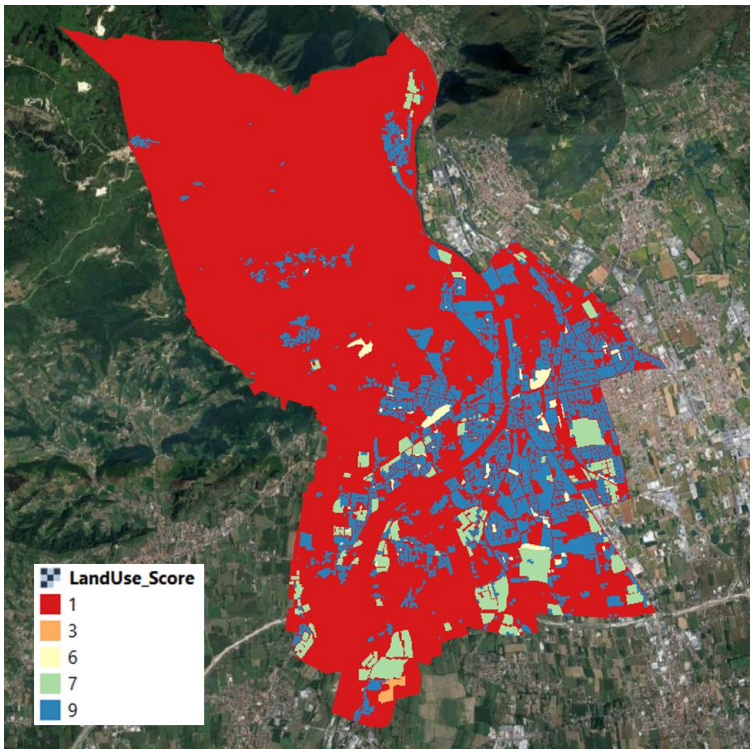


Figure 34: Land use GIS layer with remap values assigned – Bassano de Grappa

Urban macroform

Sources: In this case it has been necessary to include information from different sources:

- The **new development areas** come from the layer c0506021_copsuolo defined as "Aree in costruzione"
- **Retrofitting areas** are defined as those areas with a construction period previous to 1990 (criterion defined by the city)
- The **reuse areas** have been sent in a layer by the city
- Areas that do not belong to any of the aforementioned categories are defined as "**Land**" and are assigned the lowest score.

Urban macroform	Remap Value
Reuse Areas	9
Land/Other	1
Retrofitting areas	6
New development areas	9
Reuse Areas	9

Table 286: Urban macroform remap value – Bassano de Grappa

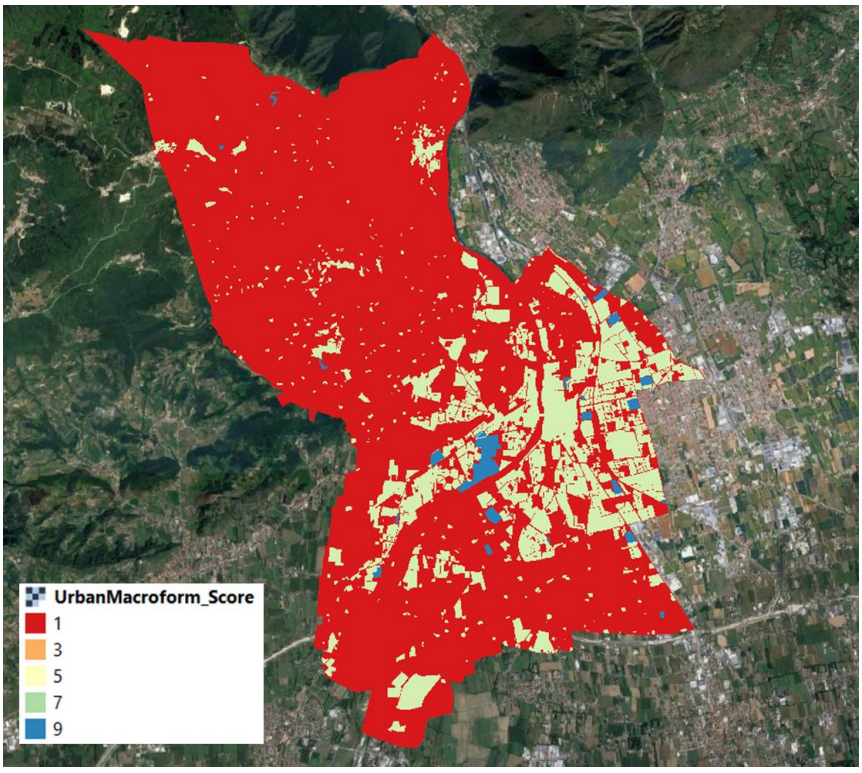


Figure 35: Urban macroform GIS layer with remap values assigned – Bassano de Grappa

Population density

Source: The population density has been provided by the city at district level.

In this case, a higher population density has been rated better.

Population density (hab/km²)	Remap Value
< 500	1
500-1500	3
1500-2500	5
2500-3500	7
> 3500	9

Table 287: Population density remap value – Bassano de Grappa

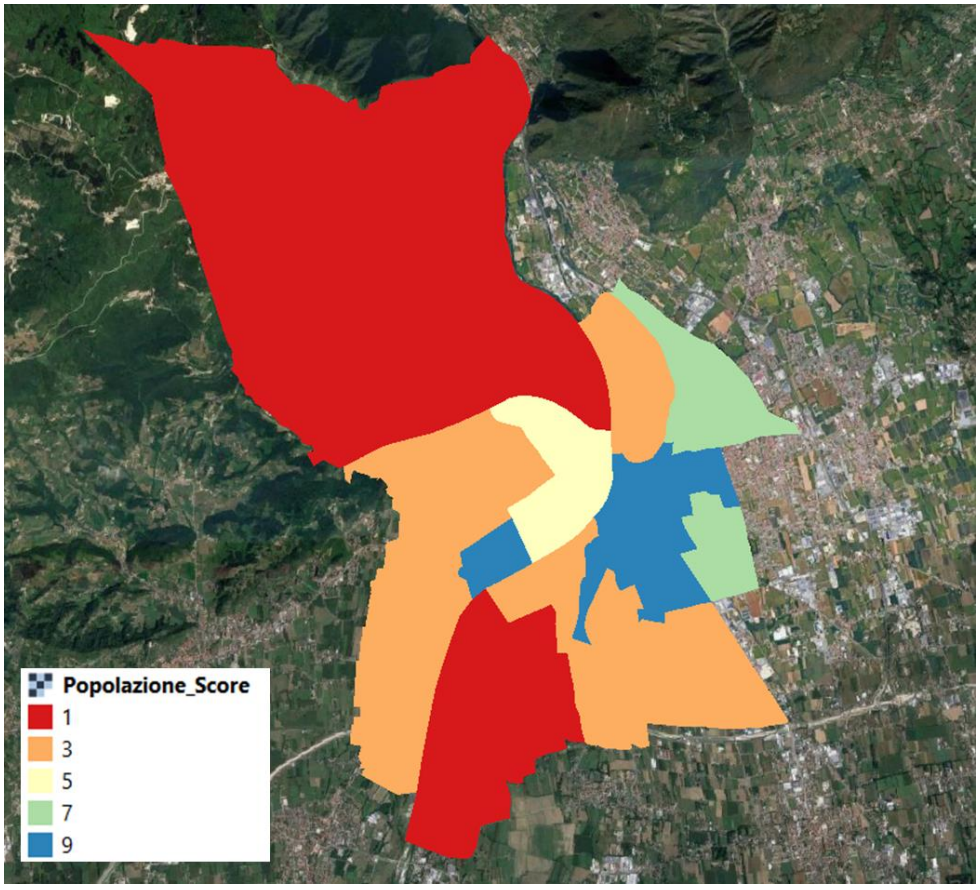


Figure 36: Population density GIS layer with remap values assigned – Bassano de Grappa

HydroPower (proximity)

Source: GIS information provided by the city with the location of hydropower plants.

Hydropower layer has been reclassified according to the distance to existing hydropower plants, giving a better rating to the closest areas.

Distance to hydropower plants (m)	Remap Value
<100m	9
100-250m	7
250-500m	5
500-1000m	3
>1000m	1

Table 288: Hydropower remap value – Bassano de Grappa

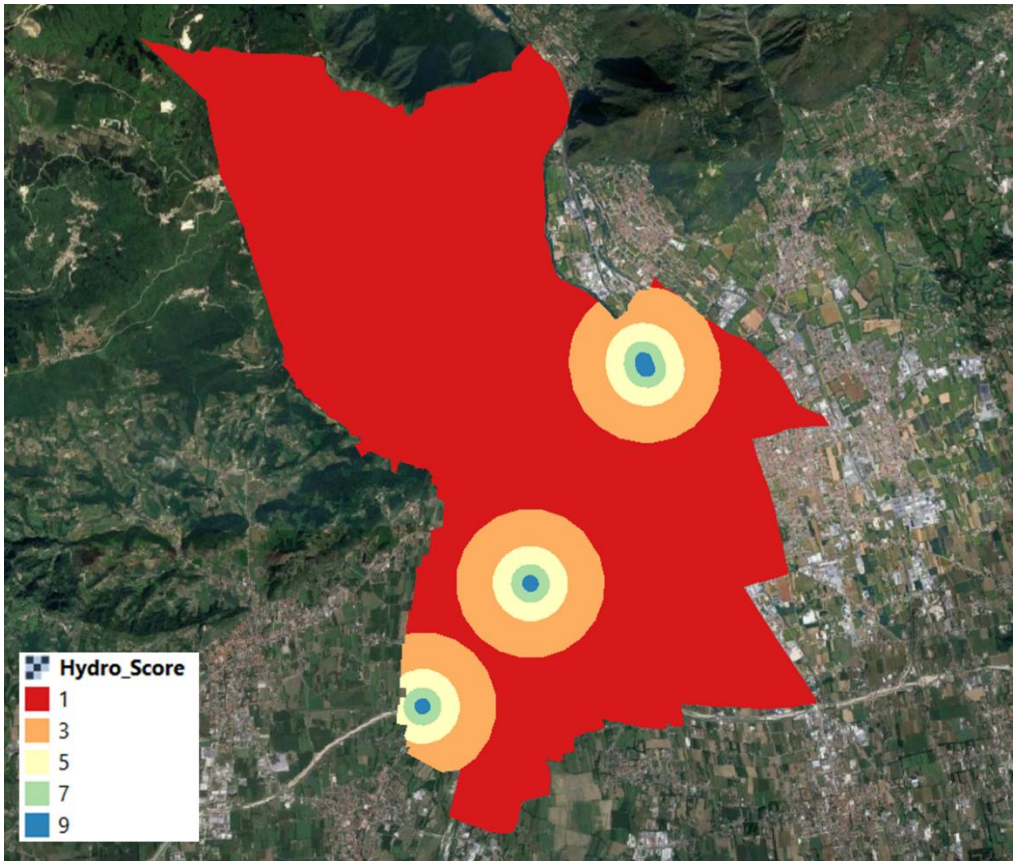


Figure 37: Hydropower GIS layer with remap values assigned – Bassano de Grappa

Biomass (Vegetation map)

Sources: 3 maps of Corine Land Cover: Forest, Grassland, Small woody features.

For the generation of the vegetation map, the 3 layers mentioned above have been combined, giving rise to a single layer in which 4 zones can be distinguished: Areas without vegetation, grasslands, areas with small bushes (SWF) and forest areas (FTY).

In this case, the forest areas are the best evaluated because of their greater potential as a biomass source.

Biomass (vegetation type)	Remap Value
FTY (forest)	9
SWF (Small woody features)	7
Grassland	1
No vegetation	1

Table 289: Biomass remap value – Bassano de Grappa

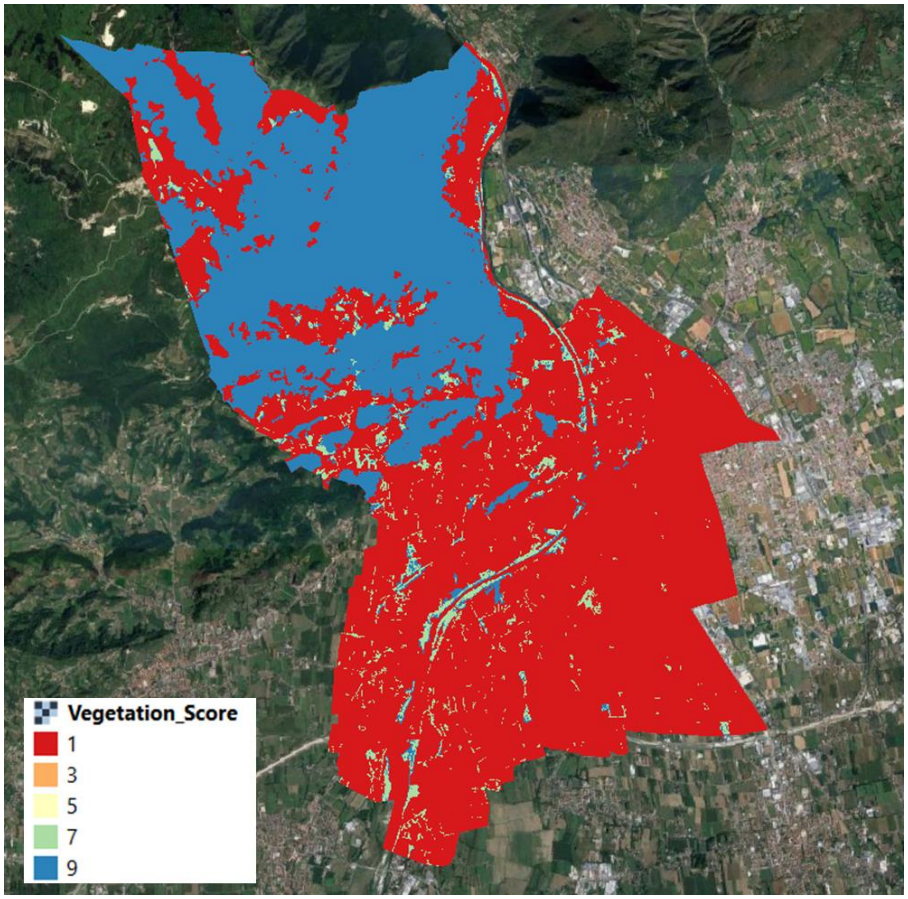


Figure 38: Biomass GIS layer with remap values assigned – Bassano de Grappa

Public/private map

Source: For the definition of the public areas, the municipality provided a layer with the information.

Public spaces have been considered most suitable to become positive: public administration areas, cultural, educational, sports and social centres.

Public domain	Remap Value
Public	9
Private	1
Other	1

Table 290: Public domain remap value – Bassano de Grappa

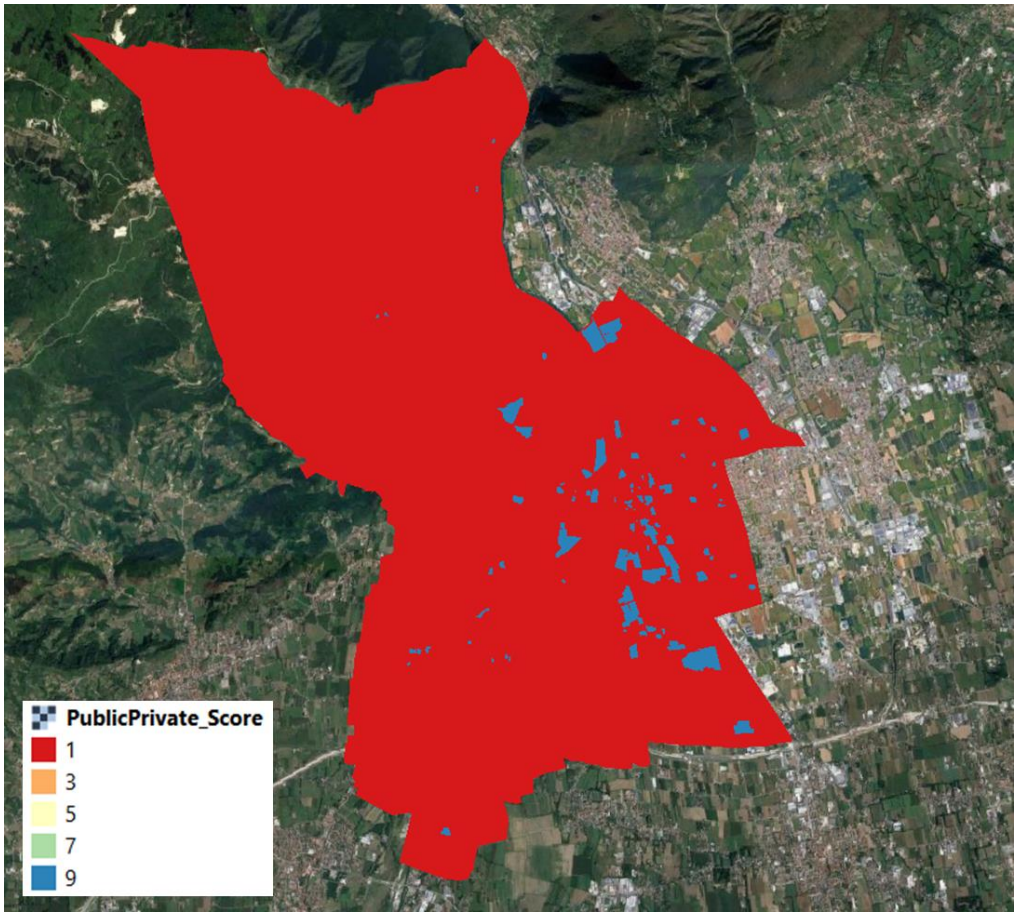


Figure 39: Public domain GIS layer with remap values assigned – Bassano de Grappa

Solar (Building surface availability for solar installation map+ current installations)

Regarding solar energy both solar potential and existing installations have been considered. Each GIS layer has been defined according to different criteria as it is explained below.

Solar potential

Sources: GIS information sent by the city to perform the building stock model assessment in WP1.

New layer has been created based on the ratio between the building roof surface and the total built surface. Grids of 250x250 with values closest to 1 are considered the most suitable because it means more space available.

Building surface availability RATIO	Remap Value
< 0,2	1
0,2-0,3	2
0,3-0,5	4
> 0,5	9

Table 291: Solar potential remap value – Bassano de Grappa

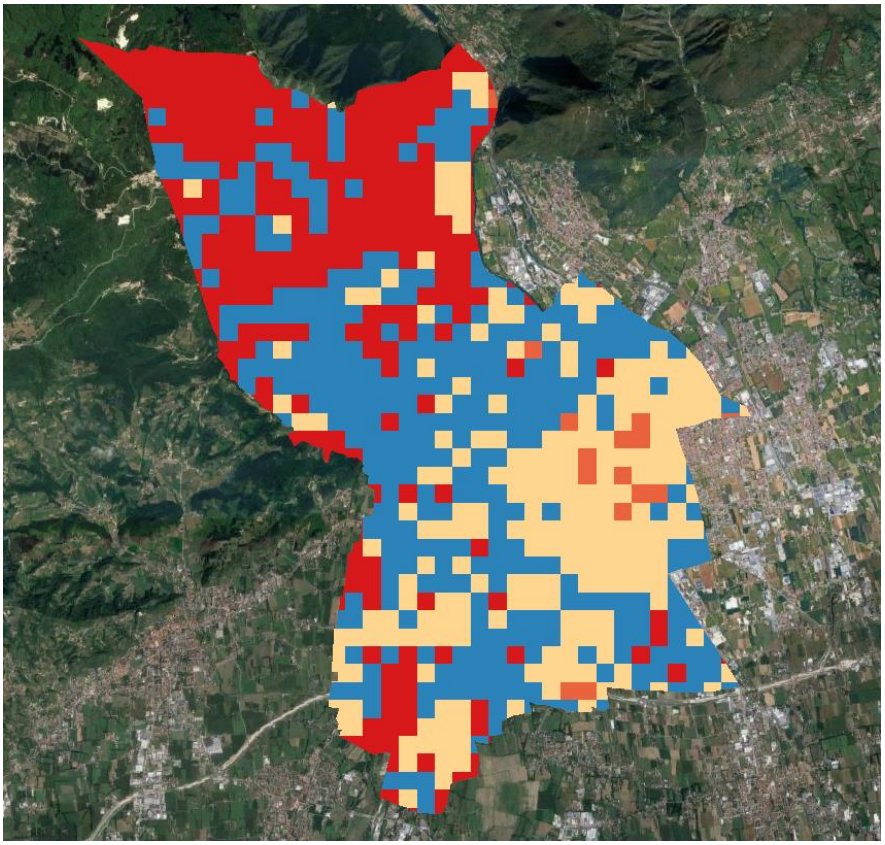


Figure 40: Solar potential GIS layer with remap values assigned – Bassano de Grappa

Solar photovoltaic installations

Source: Existing solar installations map from atlaimpianti[33], which includes the location and installed power of all the solar installations in the city.

According to atlaimpianti there are 892 solar PV installations in Bassano del Grappa. The information from Atlaimpianti can be spatially visualized, however, it cannot be downloaded in GIS format.

[33] https://atla.gse.it/atlaimpianti/project/Atlaimpianti_Internet.html

Therefore, the installations with the highest power have been included manually in a new GIS layer. In total are 32 installations that represents the 50% of installed power in the city.

To make the reclassification of this information, two criteria have been considering. Firstly, buffers have been created with different distances depending on the power of the installation (see Table 292). Secondly, the areas potentially covered by two or more installation have been considered the most suitable (see Table 293).

Power of Solar PV installation (kW)	Buffer ratio (m)
<100	150
100-200	250
200-400	350
400-600	400
>600	450

Table 292: Buffer used in Solar PV remap value – Bassano de Grappa

Power of Solar PV installation (kW)	Remap Value
Areas covered by 2 or more PV installations	9
Areas covered by 1 PV installation	6
Other	1

Table 293: Solar PV installations remap value – Bassano de Grappa

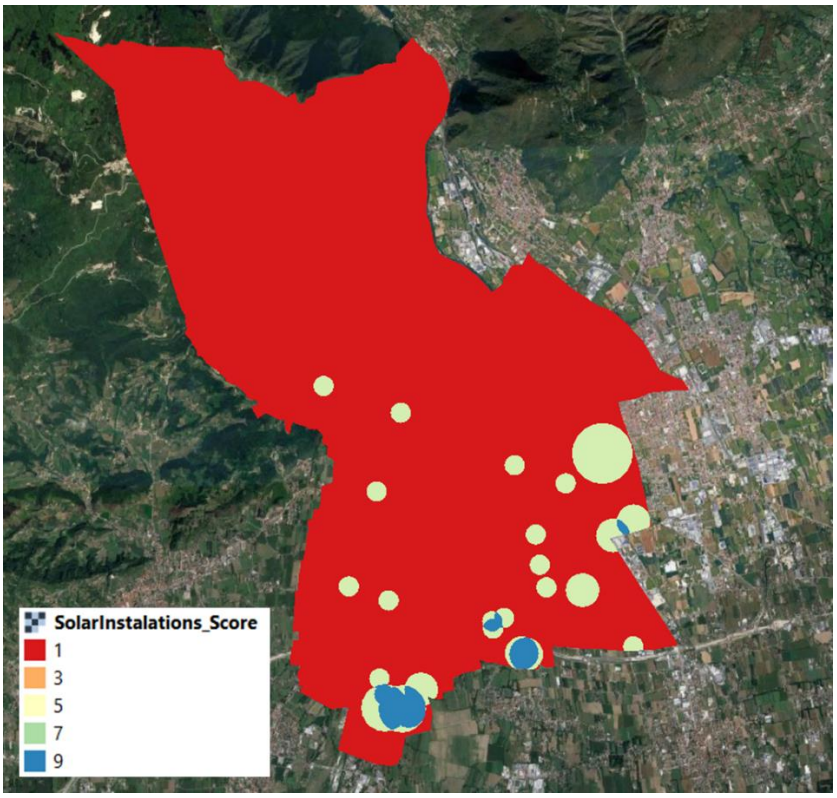


Figure 41: Solar photovoltaic GIS layer with remap values assigned – Bassano de Grappa

Wind – Power Density

Sources: wind power density

With regard to wind energy, the installation potential has been defined as a function of the power density depending on the area. The distance of at least 300m to residential areas has been defined as an exclusion criterion, and therefore these areas have been rated with the lowest score, regardless of the wind potential.

Wind Power density / surface area /distance to a residential area	Remap Value
> 200W/ m^2 & > 20000 m^2 > 300m	6
>200 W/ m^2 & >10000 m^2 > 300m	5
> 150 W/ m^2 & > 10000 m^2 > 300m	3
Rest	1

Table 294: Wind energy remap value – Bassano de Grappa

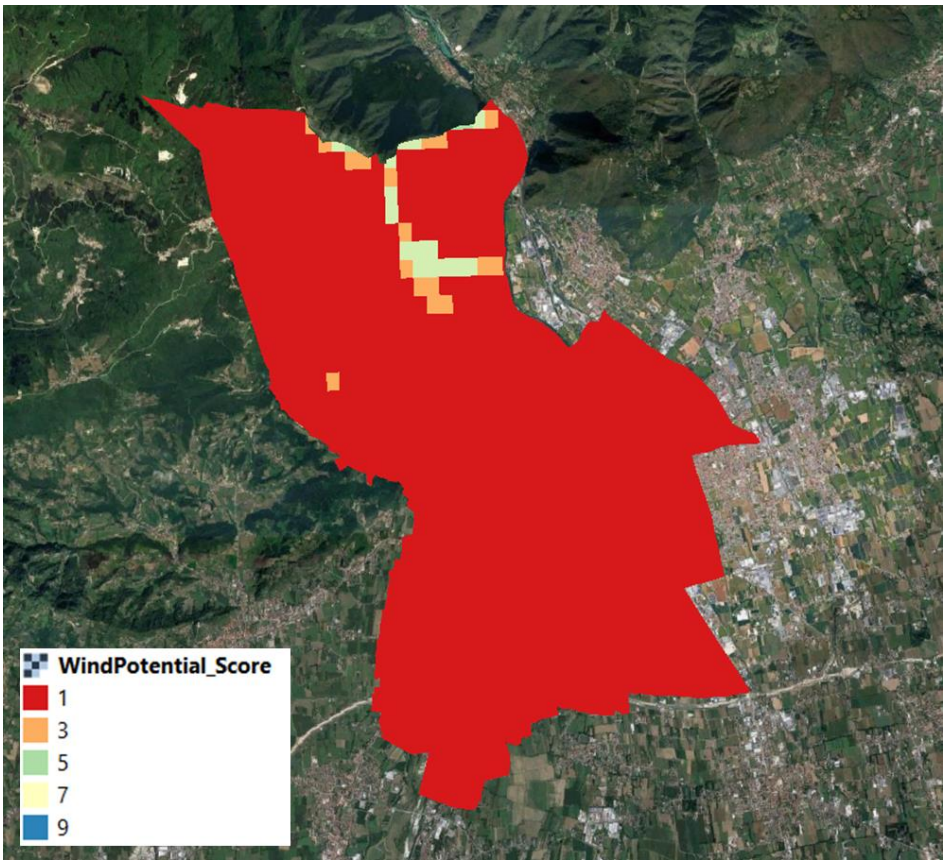


Figure 42: Wind potential installations with remap values assigned – Bassano de Grappa

GIS intermediate results of Kadiköy

Land Use

Sources: Land use GIS information provided by the city.

Remap values (coming from MCDA) indicate the most relevant reclassification group of each layer. Publicly owned, especially administration areas are promoted by incentives and subsidies and 300kwp solar generation is committed in Kadiköy Strategic Plan to be implemented in active green and carpark areas.

Land- Use	Reclassification Groups	Remap Value
Residential & Mixed-Use Areas	Residential, Residential+Commercial	5
Commercial Areas	Retail, Offices, Industrial	1
Active Green / Open Parking Lots	Recreational, active green, open carparks	7
Public Administration Areas	Public Administration	9
Social / Cultural	Public and privately owned social,cultural	9
Educational/Sport Areas	Public and privately owned educational	4

Table 295: Land use reclassification & Remap value – Kadiköy

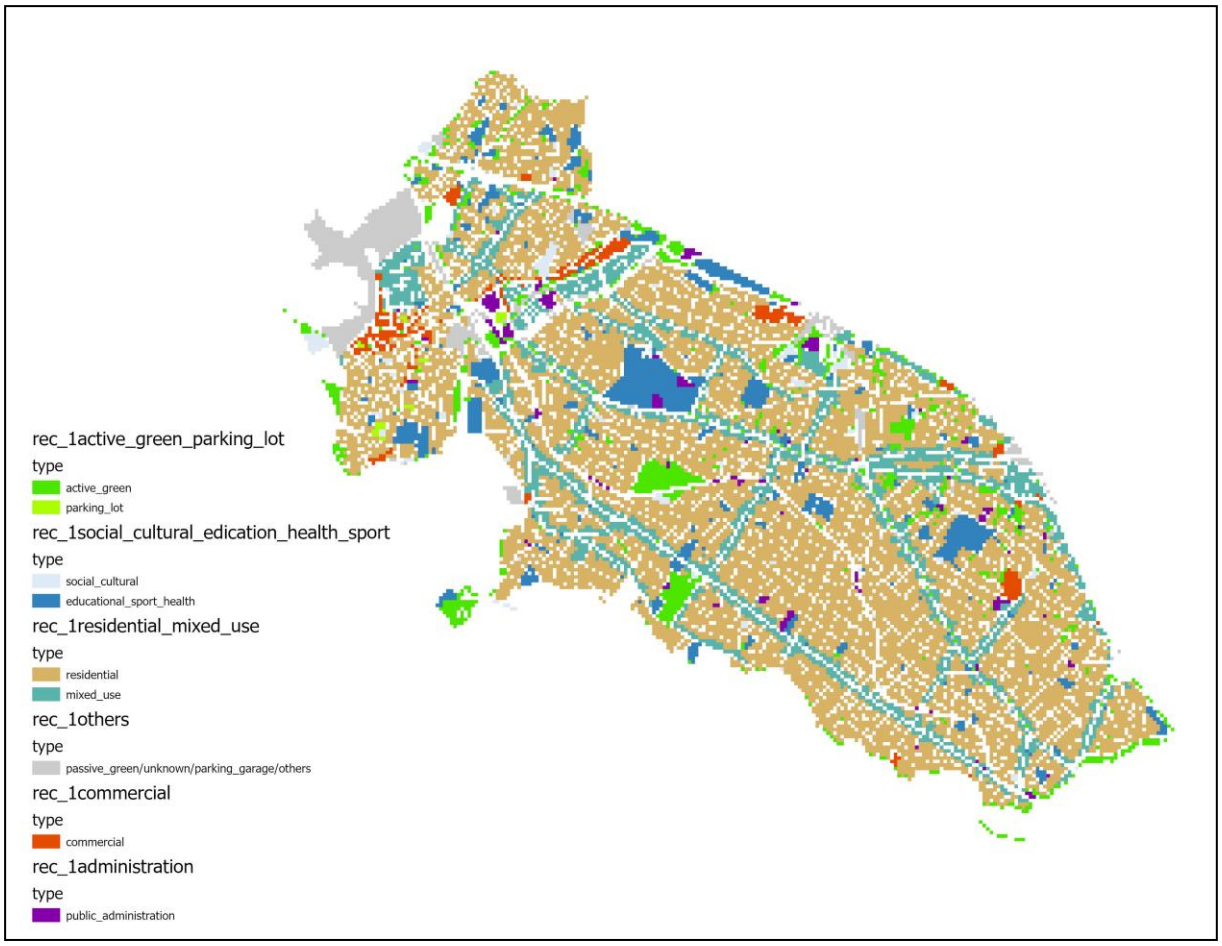


Figure 43: Land use reclassified layer - Kadiköy

Urban macroform

Sources: Land use GIS information provided by the city.

Kadiköy Urban Transformation Report has been prepared in 2019. Some of the transformation areas are already in construction which are called as “ongoing” and some of them are “prospective”. Ongoing transformation areas are evaluated as potential PED areas since economic viability is high and buildings are more energy efficient.

Retrofitting areas are evaluated as the buildings that were built before and after 2008. Before 2008, the buildings were not obligated to be insulated. Thus, higher scale value is given to the ones that are built after 2008.

Urban macroform	Reclassification Groups	Remap Value
Retrofitting areas	Before 2008	1
	After 2008	4
Transformation / Reuse Areas	ongoing	9

	prospective	5

Table 296: Urban macroform reclassification and remap values – Kadiköy

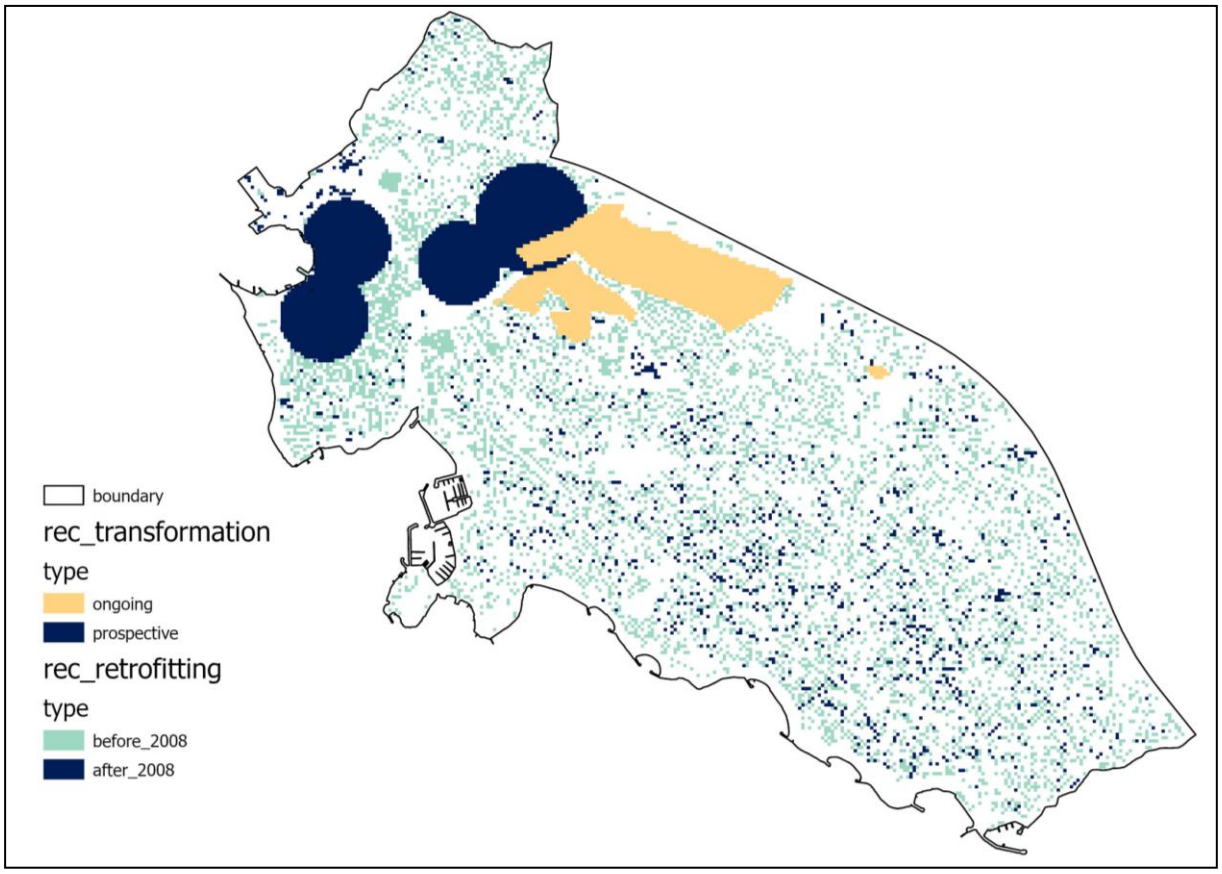


Figure 44: Urban macroform reclassified layers - Kadiköy

Population density

Source: The population density has been provided by the city at district level. A 25*25m grid has been drawn and zones/islands inside 625m2 are coloured according to their population density varying from -3 (the least populated) to +3 (the most populated). Kadiköy Spatial Strategic Report has also been taken into account for this study.

In this case, a higher population density has been rated more.

Population density (inh/km^2)	Remap Value
-3	2
-2	3
-1	4
0	5

1	6
2	7
3	8

Table 297: Population density reclassification and remap values – Kadiköy

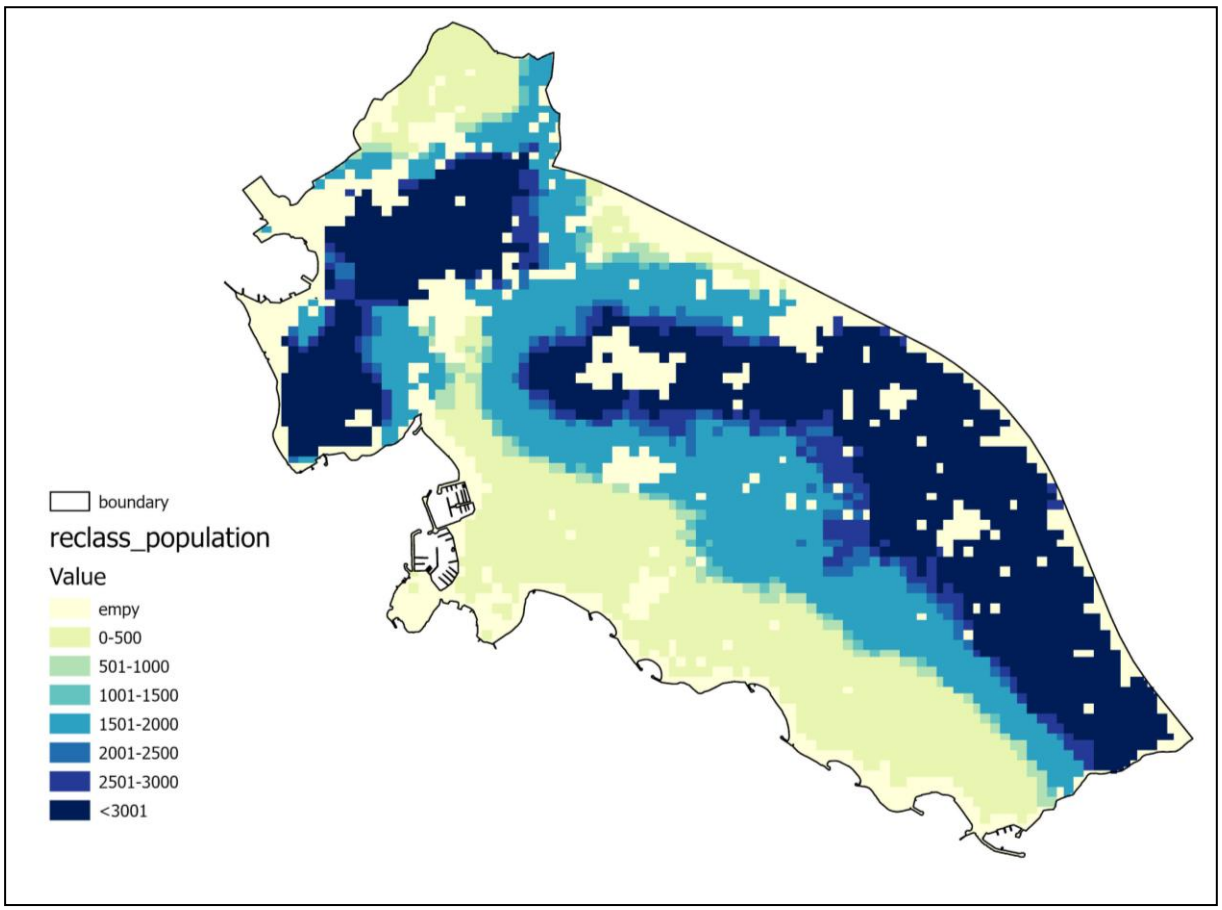


Figure 45: Population reclassified layer - Kadiköy

Potential Solar investment zones

Source: GIS information provided by the city

The irradiance level for solar energy output capacity in Kadiköy is high and in Strategic Plan 2020-2024 of Kadiköy mentions 300kwp solar installation in Kadiköy. For this reason, potential zones are displayed by the city in GIS format and all zones (as provided in terms of polygon features) are expected to be grouped in one.

Reclassification Groups	Remap Value
All zones in one group	6

Table 298: Potential solar investment zones remap value – Kadiköy

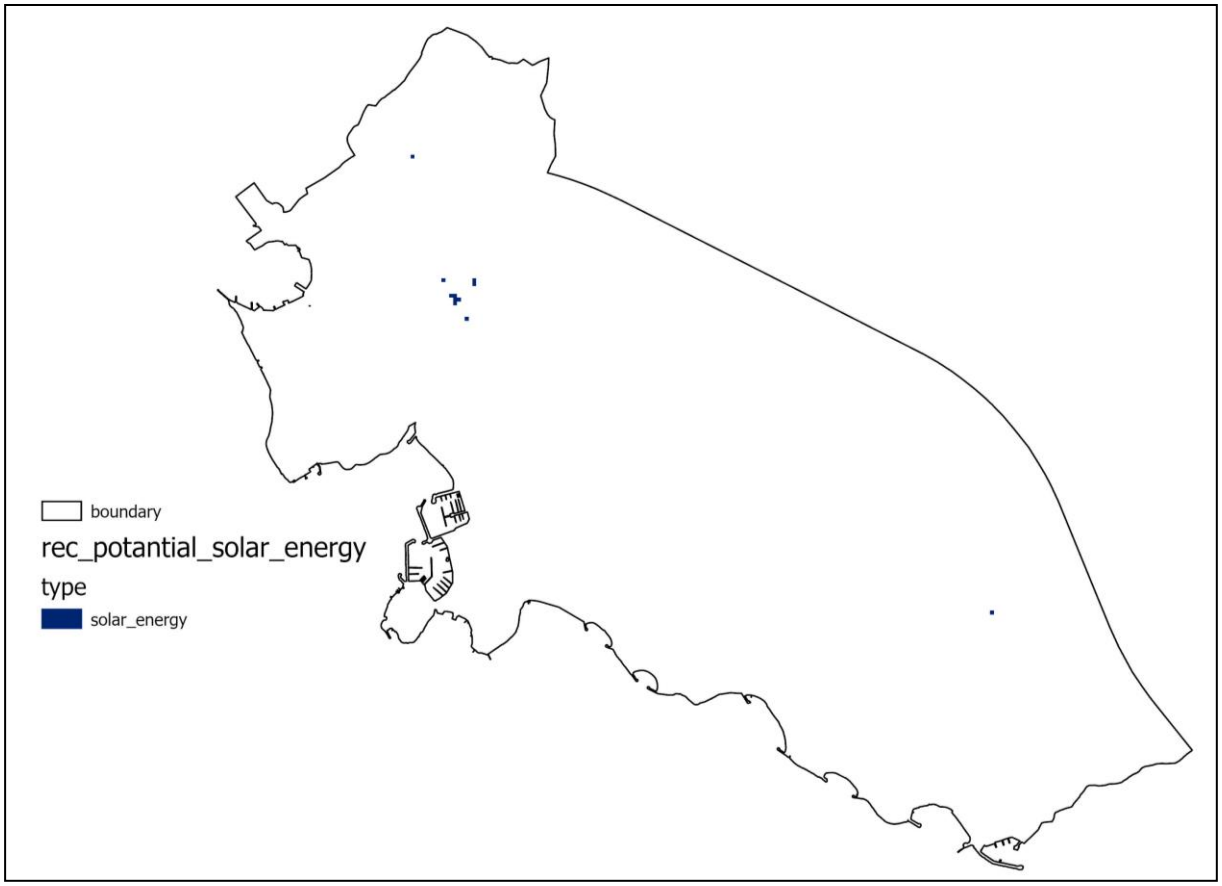


Figure 46: Solar potential reclassified layer – Kadiköy

Ground Coupling

Source: GIS information provided by the city

According to aquifer implementations in Groningen, it is observed that clay and sand-based earth provide high thermal conductivity and has a potential for long-term thermal storage. In Kadiköy, 6 types of earth formations are seen from the spatial information gathered from ground systems department of the municipality. The soil types are grouped under each formation.

Soil Types for Thermal Storages	Remap Value
1)Sandstone, loamystone, conglomerate, shale (Trakya Formation)	3
2)Clay, Thin Sand, Micaceous shale, Calcite (Limestone) (Kartal Formation)	9
3)Calcite, Sandstone, Shale, Argillaceous limestone, reef limestone (Dolayaba Formation)	7
4)Argillaceous limestone, lyddite, lumpy limestone, shale (Tuzla and Baltalimanı Formation)	3

5)Alluvial deposit (no potential for thermal storage)	1
6)Landfill (no potential for thermal storage)	1

Table 299: Extensive ground coupling potential reclassification and remap value – Kadiköy

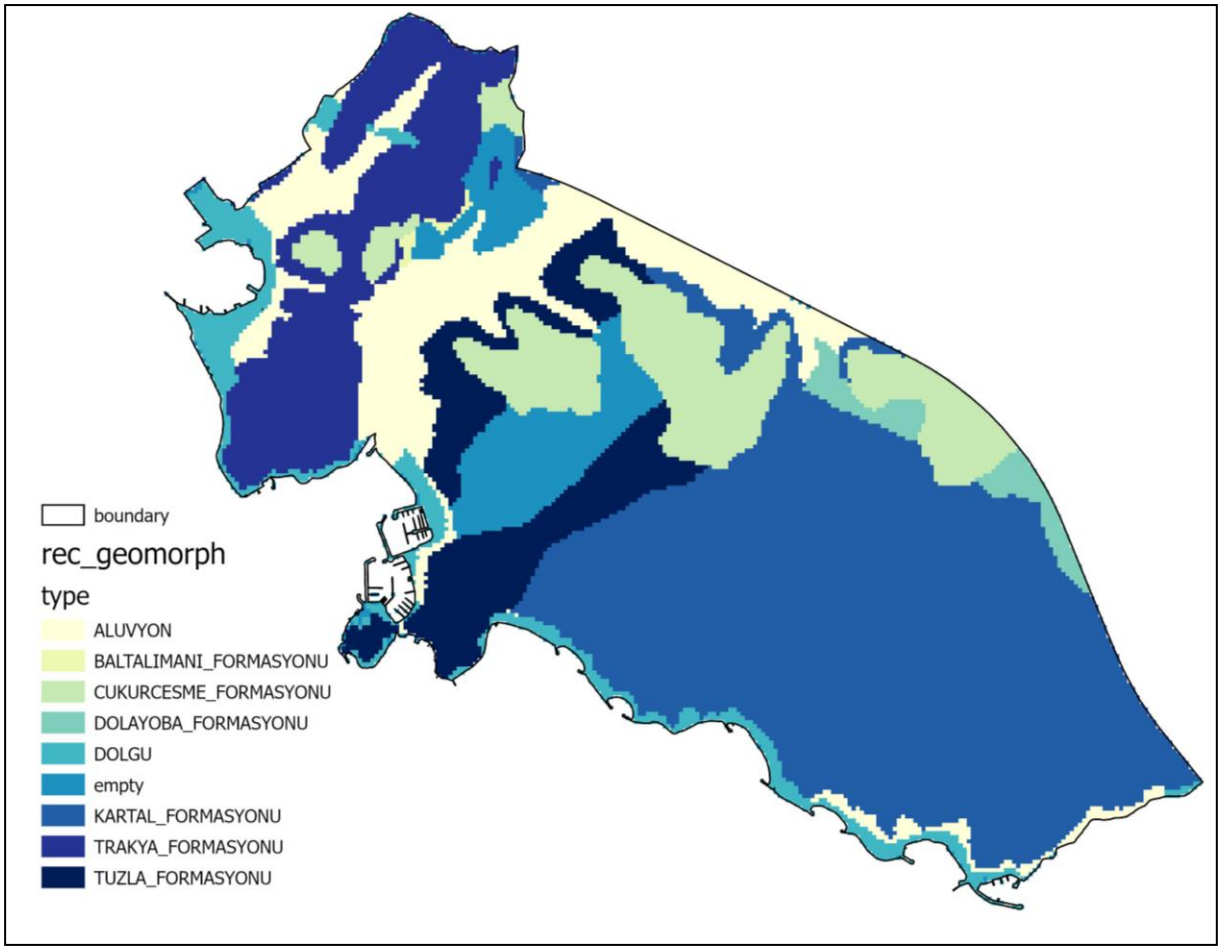


Figure 47: Ground coupling reclassified layer – Kadiköy

E-mobility Infrastructure

Source: EV vehicles chargers' location.

Buffers have been created surrounding the location of the EV charger stations. Charging stations owned by the community or the public administrations. There is no legal infrastructure permits trading.

Buffer zone (m)	Remap Value
0-100	6
250- 500	6

500- 750	1
750-1000	1

Table 300: e-mobility infrastructure remap values – Kadiköy

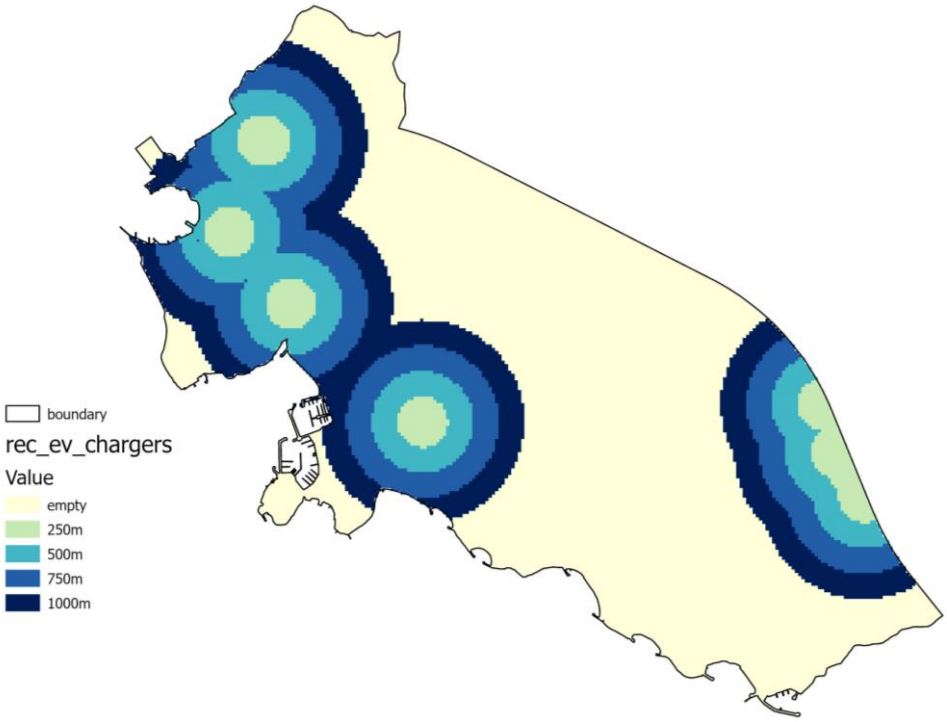


Figure 48: ev-chargers buffer zone reclassified layer – Kadiköy

GIS intermediate results of León

Land Use

Sources: Land use GIS information provided by the city.

Commercial areas include commercial, industrial and office areas. Remap values (coming from MCDA) indicate the most relevant reclassification group of each layer.

There are two calls for the business sector (which obviously includes commerce), in a competitive competition/attendance regime, one had the objective of promoting the use of renewable energies and another the increase in energy efficiency Castilla y León. Both are for large companies, SMEs, self-employed and farmers and ranchers. The funds are ERDF 2014-2020, European funds, and the management is conducted by the regional government.

Besides, publicly owned areas are supported with incentives and subsidies which provide opportunities for PED implementations.

Land- Use	Reclassification Groups	Remap Value
Residential & Mixed-Use Areas	Residential, Residential + Commercial	5
Commercial Areas	Retail, Offices, Industrial	4
Active Green / Open Parking Lot.	Recreational, active green, open carparks	8
Public Administration Areas	Public Administration	9
Social / Cultural /Educational/Sport Areas	Public and privately owned social, cultural, educational, sport	9

Table 301: Land use reclassification and remap values – León

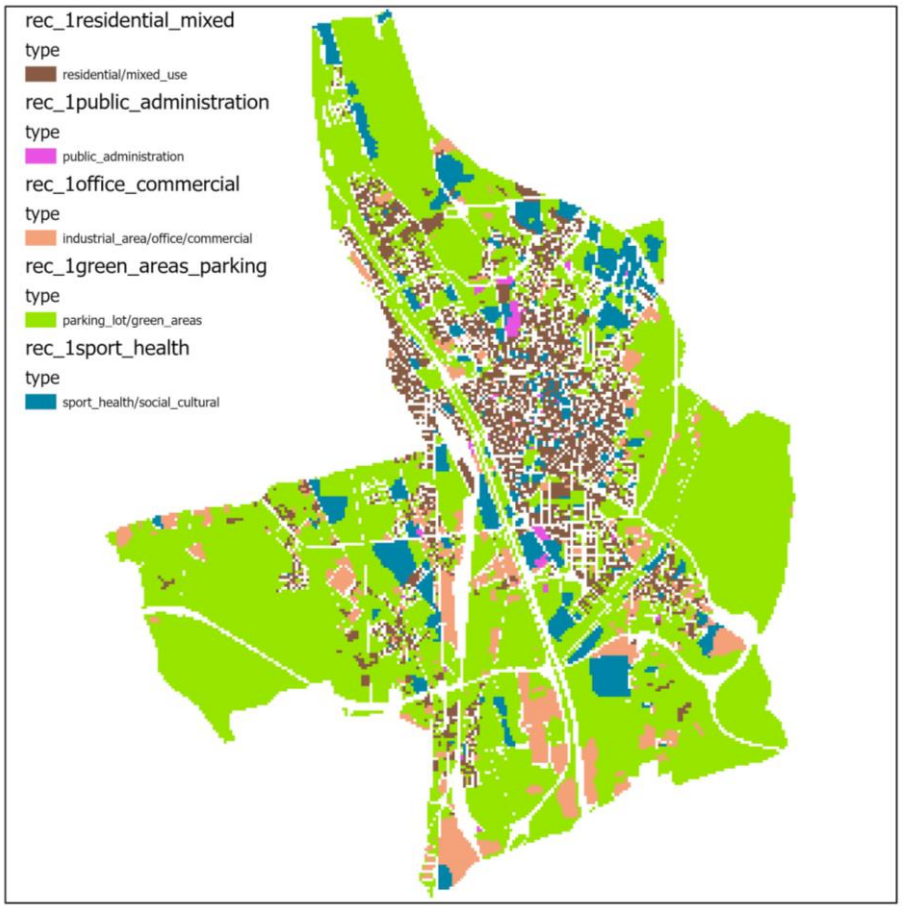


Figure 49: Land use reclassified layer - León

Urban macroform

Sources: Land use GIS information provided by the city.

As León is a shrinking city, it is expected a very low development in new areas, or even unexpected.

Currently new building regulation has high requirements for renewable use of energy and efficiency, and district heating is included. Every year the tax deduction is reviewed and sometimes there are specific deduction for renewable implementation or improvements in energy efficiency for retrofitting, and transformation areas. Retrofitting is more promoted when compared to new development, infill or transformation areas.

Urban macroform	Remap Value
New development areas	6
Retrofitting areas	9
Infill areas	7
Transformation / Reuse Areas	6

Table 302: Urban macroform remap values – León

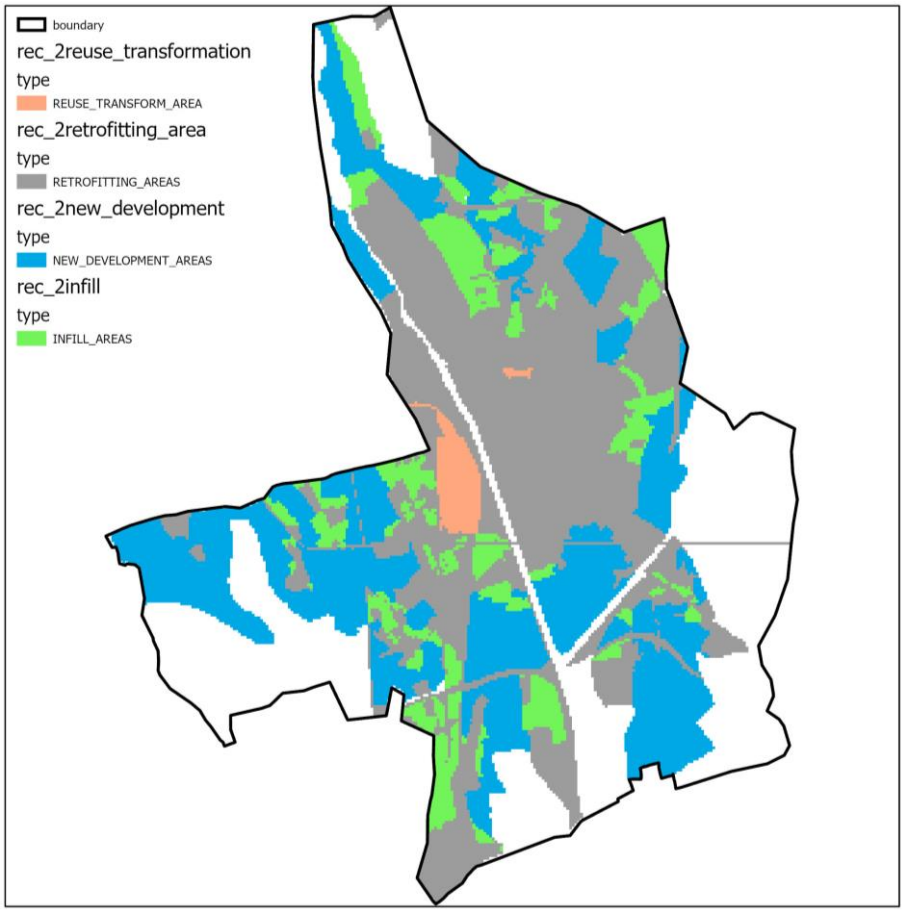


Figure 50: Urban macroform reclassified layer - León

Population density

Source: The population density has been provided by the city at district level.

In this case, a higher population density has been rated better. The Edusi area resides mostly medium and low income levels, thus not just public investment should be expected. In León, there are no specifically energy associations, but there are neighbourhood associations.Furthermore, almost every building compound of several dwellings, (unless the entire building belongs to a single person or company) has to establish itself, must be constituted as a "neighbour 's community" or" owners community", that is a legal person as an entity. In both cases, at both levels, there are "representatives " and you do not have to talk which every single person, one by one. So, there are no specifically energy associations in León, but the "structures" are there.

Population density (inh/km^2)	Remap Value
0-500	2

501-1000	3
1001-1500	4
1501-2000	5
2001-2500	6
> 2501	7

Table 303: Population density remap values – León

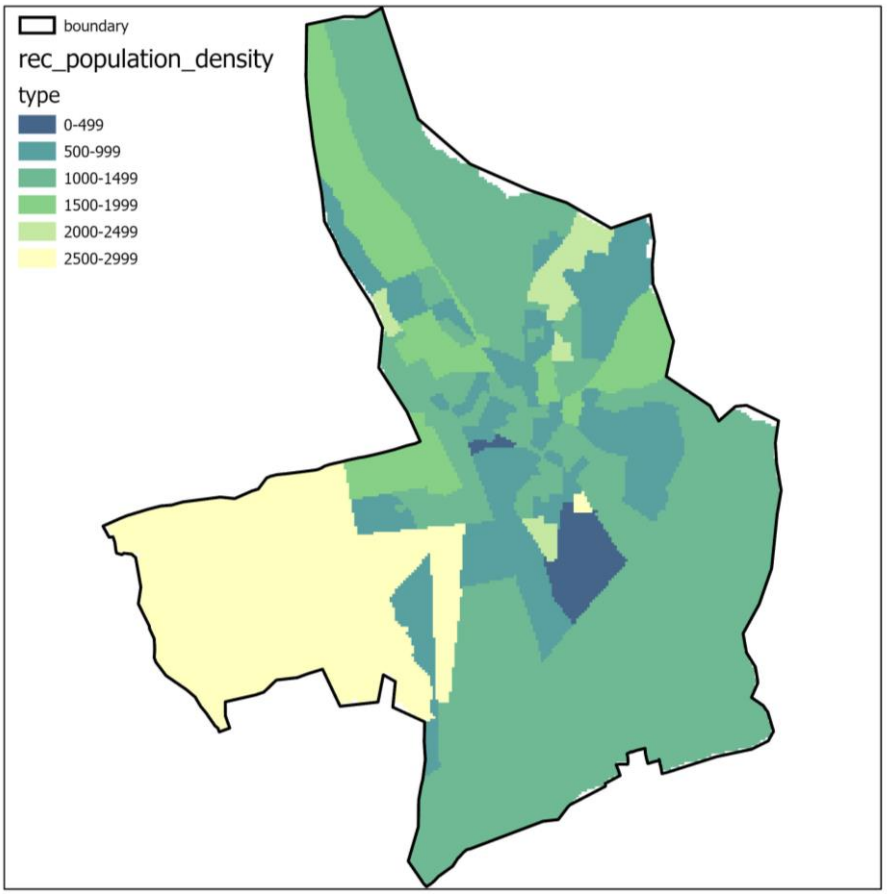


Figure 51: Population density reclassified layer - León

Hydropower (proximity)

Source: GIS information provided by the city

Hydropower layer has been reclassified according to the distance to existing hydropower plants, giving a better rating to the closest areas. Surface water layer was obtained as a "polyline feature", buffer ring zones were assigned at certain distances aligned with the expert opinions and was made ready for the raster step. 250 m buffer zone up to 1km is created to use for energy generation potential. 100m buffer zone up to 500m is created to use for evaporative potential. Expert opinions were collected to identify buffer ring zones were created at certain distances.

There are some streams and two rivers but without relevant potential.

Distance to water resource (m)	Remap Value
250-500m	2
750-1000m	1

Table 304: Potential surface water resources for energy generation remap values – León

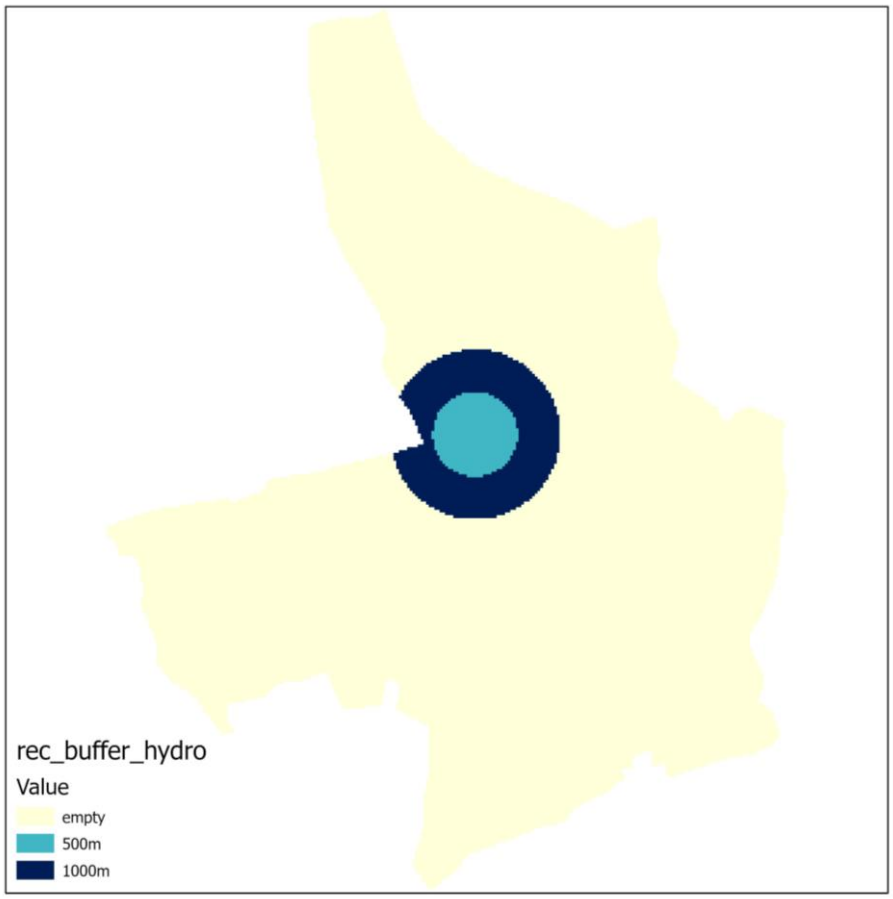


Figure 52: Potential surface water resources reclassified layer - León

Medium percentage of water surface is exposed to the river passing over. There are two old ponds (5.000 m2) from the water supply infrastructure (currently empty and with no use) located in the upper level of the city.

Distance to water resource (m)	Remap Value
100	7
200	5
300	3
400	1

500	1

Table 305: Water surfaces with evaporative potential remap values – León

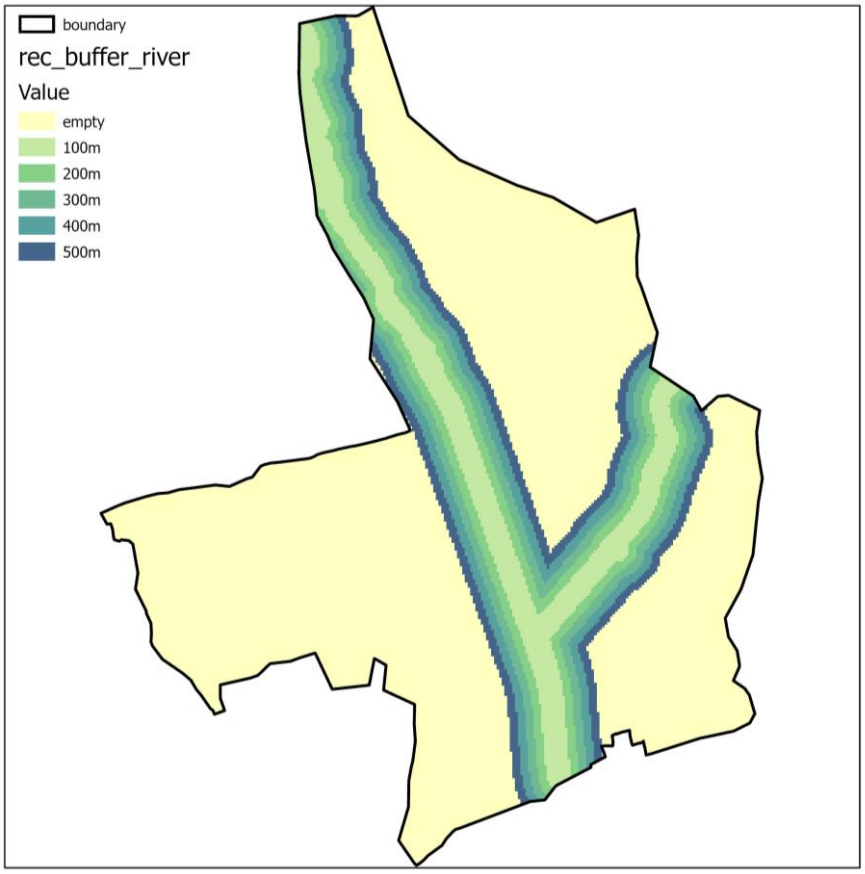


Figure 53: Water surfaces reclassify layer - León

Solar investment zones

Source: GIS information provided by the city

Potential solar energy investment zones owned by the community or the public administration. There is a privately owned solar park around the city which is a roof of the congress center ~16000m2. Social acceptability of the solar energy is assessed as high-medium. Potential zones have high solar potential (radiation higher than 1.500 kWh/m2year). Regulatory framework is suitable for solar energy implementation.

Buffer zone (m)	Remap Value
0-250	9
250- 500	9
500- 750	1
750-1000	1

Table 306: Buffer used for existing solar investment zones – León

Mostly Parking Lots and Abandoned Areas are considered to be solar potential areas and most of them are municipally owned.

Buffer zone (m)	Remap Value
All zones	9

Table 307: Buffer used for potential solar investment zones – León

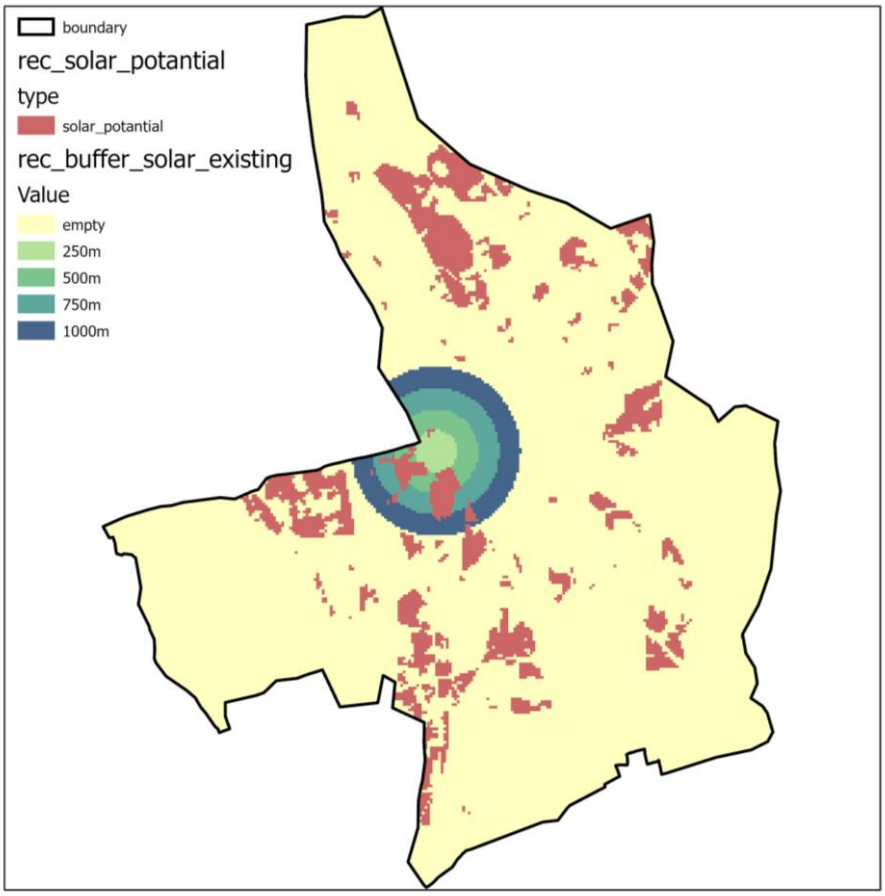


Figure 54: Solar efficient zones reclassify layers of León

Ground Coupling

Source: GIS information provided by the city

Extensive ground coupling potential for cooling and heating purposes. Available zones exist for drilling and there is medium ground temperature for heating/cooling purposes. Fortunately, there is no problem with legal framework for public drilling

Soil type	Remap Value
1)Silts, sands, and gravels. Floodplain	1

2)Siliceous gravels medium terraces	2
3)Siliceous gravels low terraces	3
4)Sands and gravels. current bed	8
5)Polymictic or petromictic conglomerates	2

Table 308: Extensive ground coupling potential remap values – León

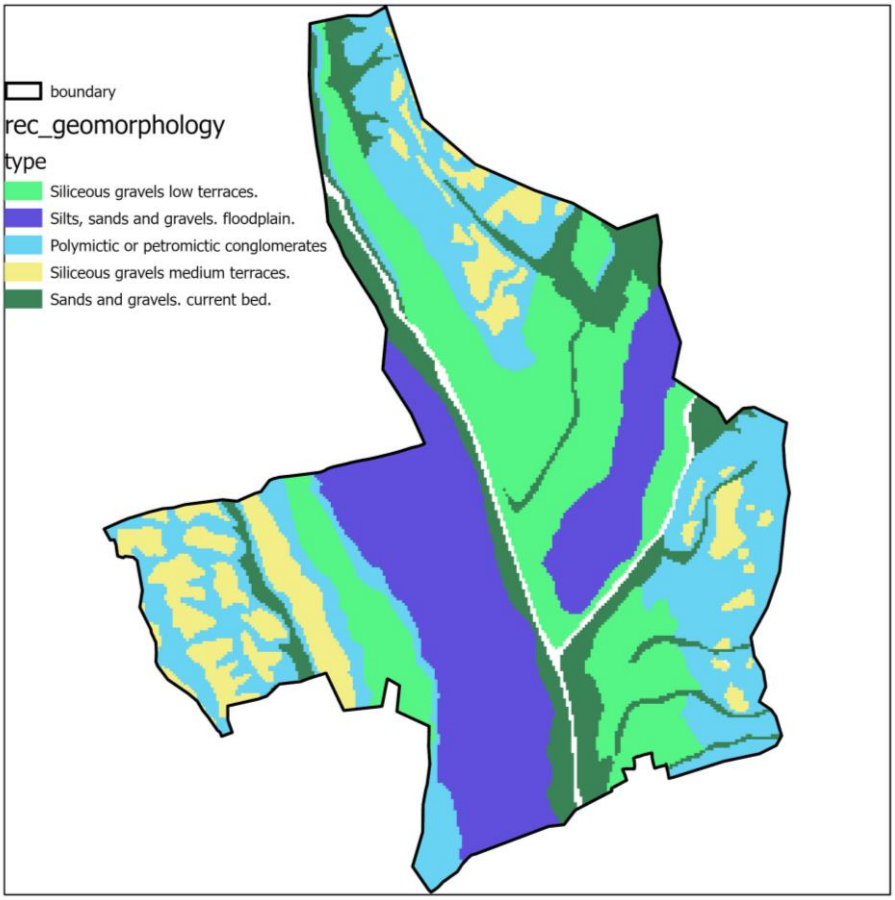


Figure 55: ground coupling reclassified layer - León

e-mobility Infrastructure

Source: EV vehicles chargers location.

Buffers have been created surrounding the location of the EV charger stations. Legal Infrastructure permits trading in public charging stations

Buffer zone (m)	Remap Value
0-100	9

250- 500	9
500- 750	1
750-1000	1

Table 309: e-mobility infrastructure remap value – León

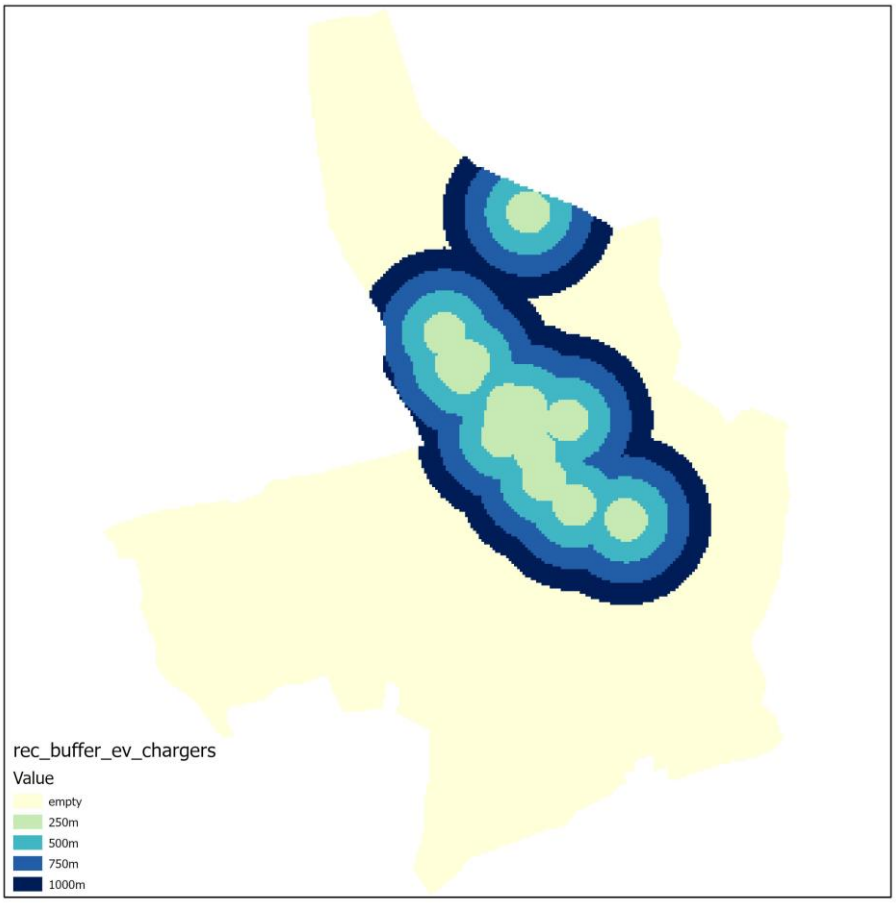


Figure 56: E-Mobility Infrastructure reclassified layer - León

GIS intermediate results of Lublin

Land Use

Sources: Land use GIS information provided by the city.

Citizens have a medium acceptability of new developments in residential & mixed-use areas. Commercial areas include commercial, industrial and office areas.

Land- Use	Remap Value
Residential & Mixed-Use Areas	8
Commercial Areas	9
Active Green / Open Parking Lot.	5
Public Administration Areas	9

Table 310: Land use remap values – Lublin

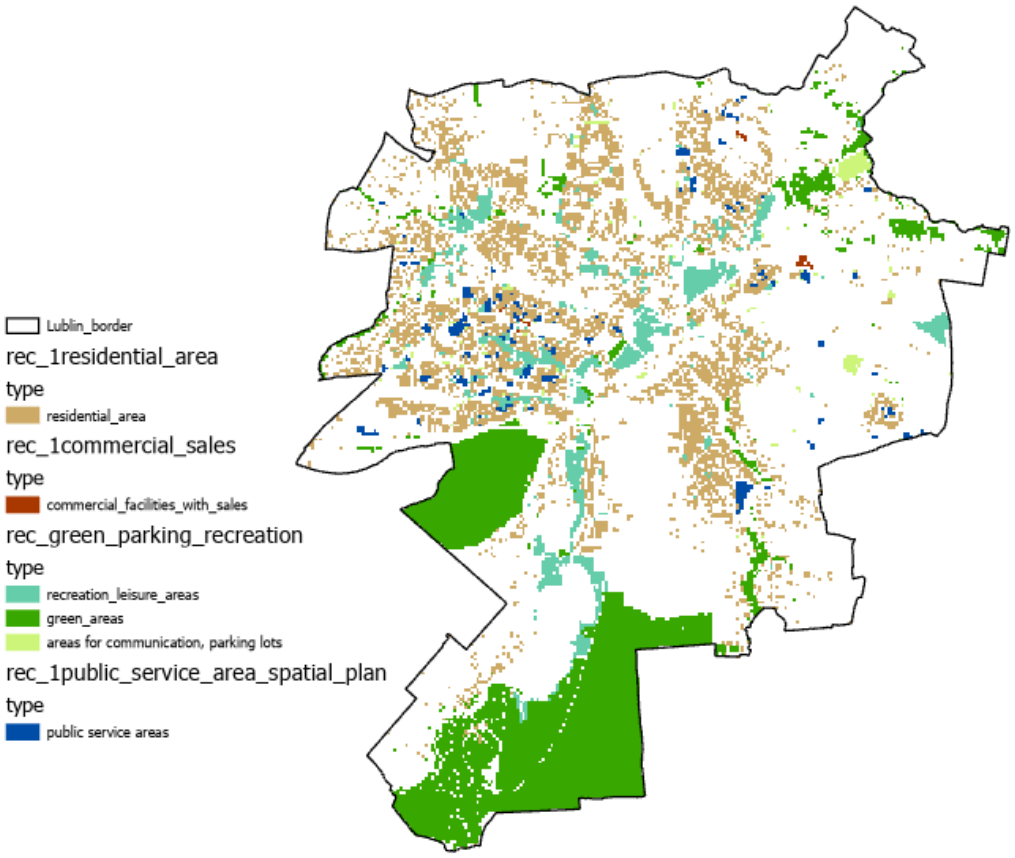


Figure 57: Land use reclassified layers - Lublin

Urban macroform

Sources: Land use GIS information provided by the city.

New development areas exist and although it is not mentioned in a strategic plan, decisions through energy efficiency, energy production or low energy consumption, could be potential areas for PED implementation. According to EPD Regulations, buildings before 2002 are estimated as not insulated in the city.

Urban macroform	Reclassification Groups & Remap Value	
New development areas	6	
Retrofitting areas	Before 2002	5
	After 2002	1

Table 311: Urban macroform reclassification and remap values – Lublin

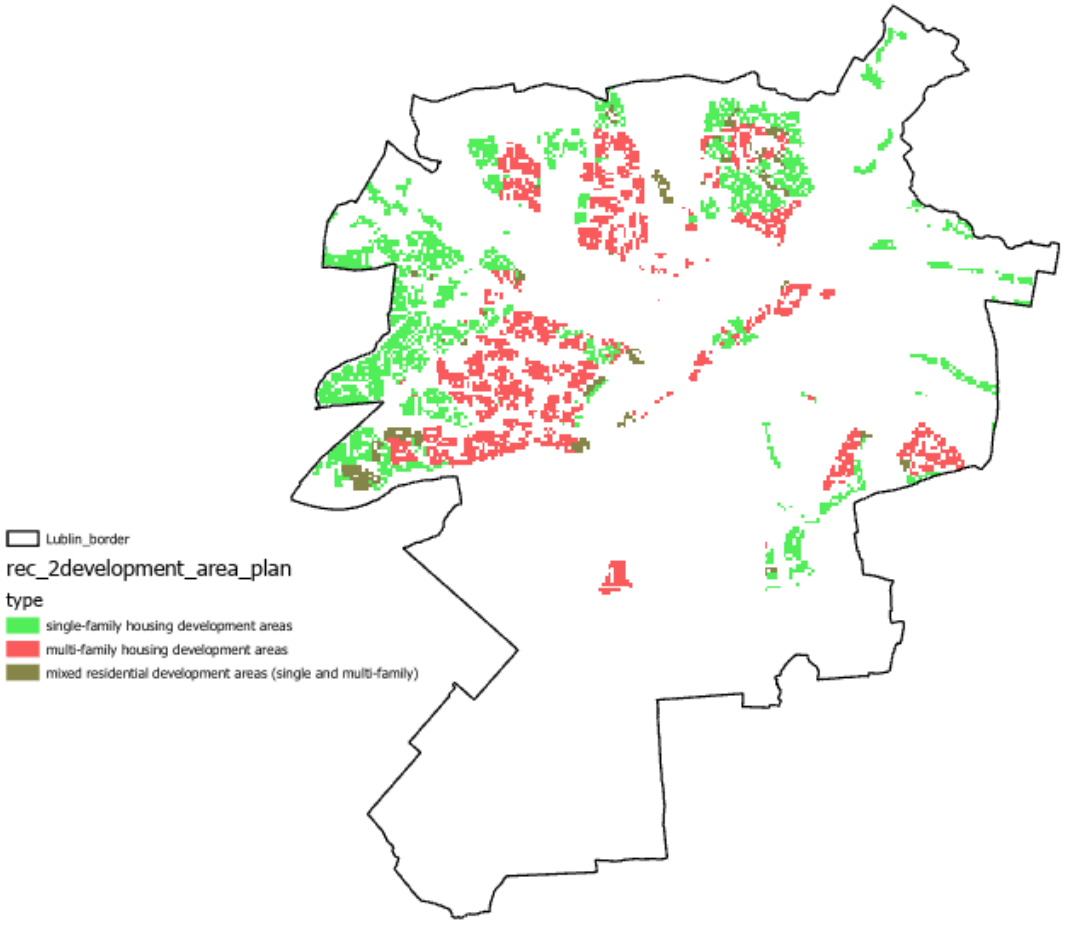


Figure 58: Development area reclassified layer – Lublin

According to EPD Regulations in Poland, buildings before 2002 are estimated as not insulated. Studies present that modifications to the requirements on energy savings and thermal insulation of buildings in Poland are conducted in 2002. Besides, in Lublin legal framework is suitable for Nearly zero energy building retrofitting projects and there are fundings, as well.

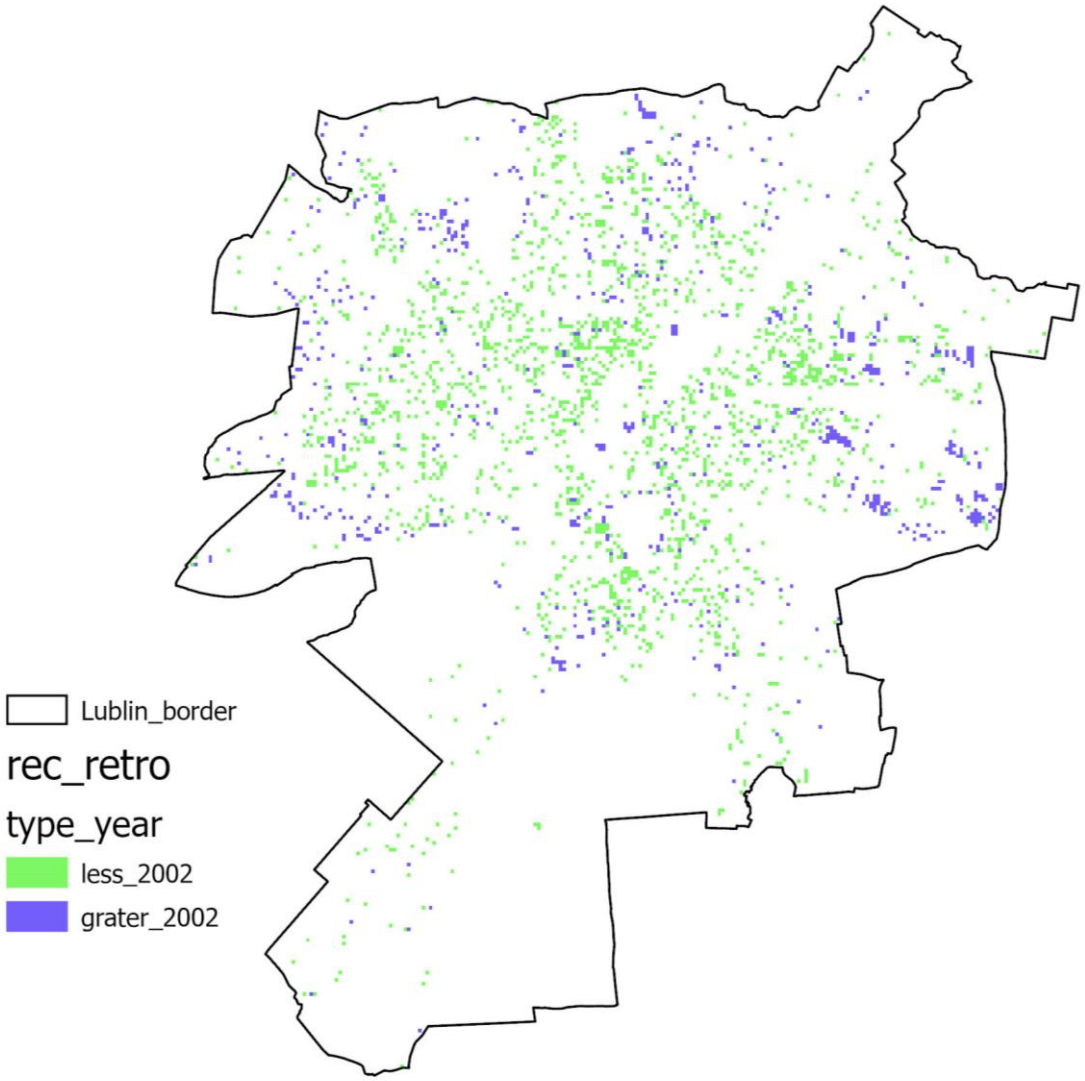


Figure 59: Retrofitting reclassified layer - Lublin

Hydropower (proximity)

Source: GIS information provided by the city

In Lublin, there are streams with energy generation potential. Hydropower layer has been reclassified according to the distance to potential hydropower plants, giving a better rating to the closest areas. Surface water layer was obtained as a “polyline feature”, buffer ring zones are assigned at certain distances aligned with the expert opinions and made ready for the raster step. 250 m buffer zone up to 1km is created to use for energy generation potential. Expert opinions are collected to identify buffer ring zones that are created at certain distances.

Distance to water resource (m)	Remap Value
250	6
500	6
750	1
1000	1

Table 312: Water surfaces with hydropower remap values – Lublin

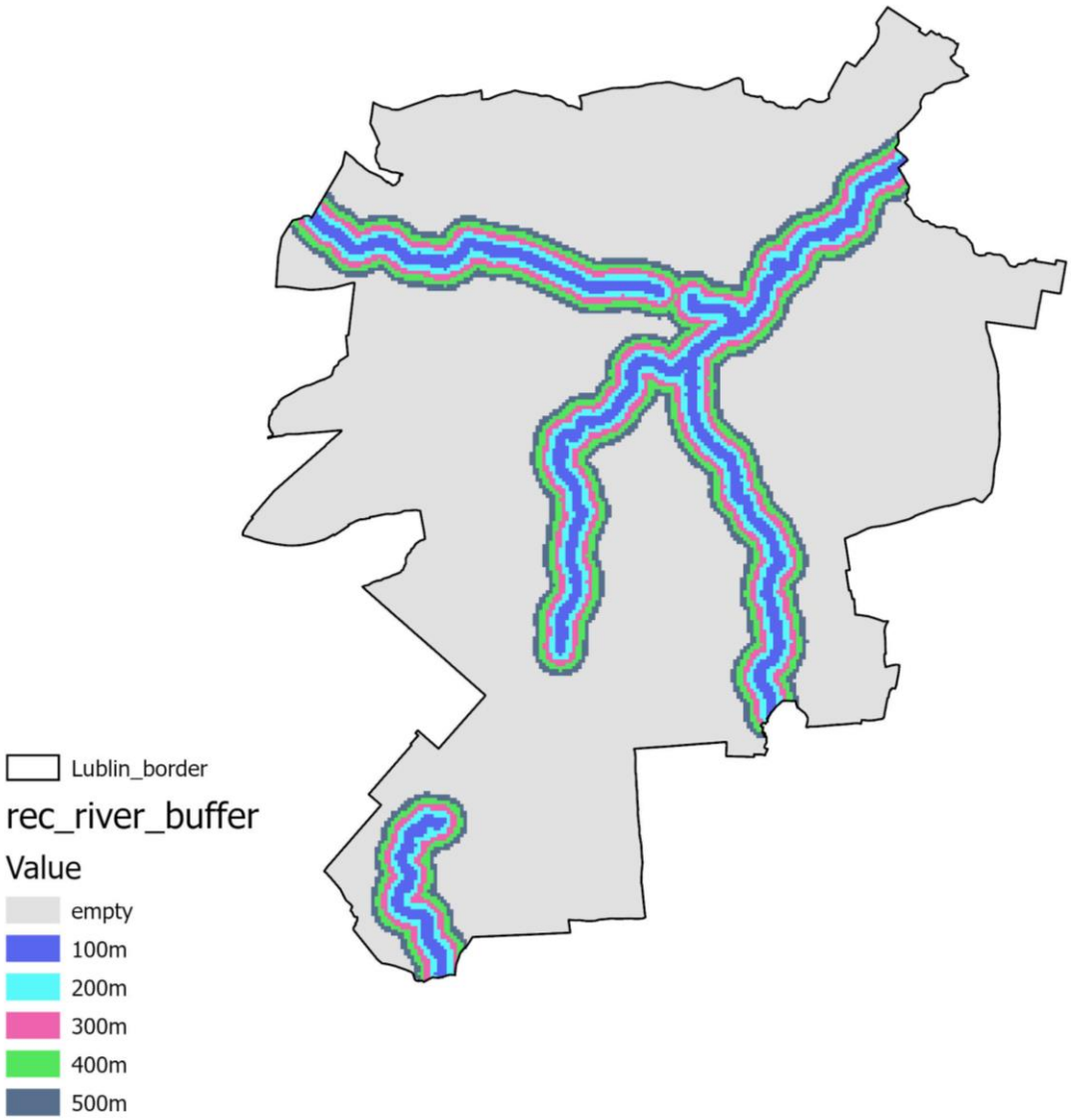


Figure 60: River buffered reclassified layer - Lublin

Waste heat and Biomass Potential

Within the area of the Lublin Commune there are, among others, installations dedicated to biomass combustion located in enterprises producing construction and commercial woodwork, maintenance of greenery and boilers in private buildings. In the area of Lublin, a potential source of biomass may be the biodegradable part of industrial and municipal waste. One method of obtaining energy from the organic fraction of municipal waste is the fermentation process. There is great potential in the waste of the organic fraction in the Lublin Commune. An installation with 500 kWe installed capacity is located at the landfill site in Rokitno, generating electricity from landfill biogas. The installation is operated by Neoenergy, the installation using energy from biogas is also located in the Hajdów sewage treatment plant, belonging to Miejskie Przedsiębiorstwo Wodociągów i Kanalizacji w Lublinie Sp. z o.o. This plant is located in the eastern part of the city and treats domestic and industrial sewage from Lublin, Świdnik, Wólka, Głuska and Konopnica."

Rokitno is not located in Lublin. It is a landfill from outside Lublin with which the City of Lublin have signed agreements.

Hajdów sewage treatment plant. There is also a photovoltaic farm. In spatial development plan layer Hajdów sewage treatment plant is marked as "technical infrastructure areas - power engineering"

Waste heat potential	Remap Value
Industrial Waste Heat	7
Sewage Treatment and Biogas	6

Table 313: Waste heat potential remap values – Lublin

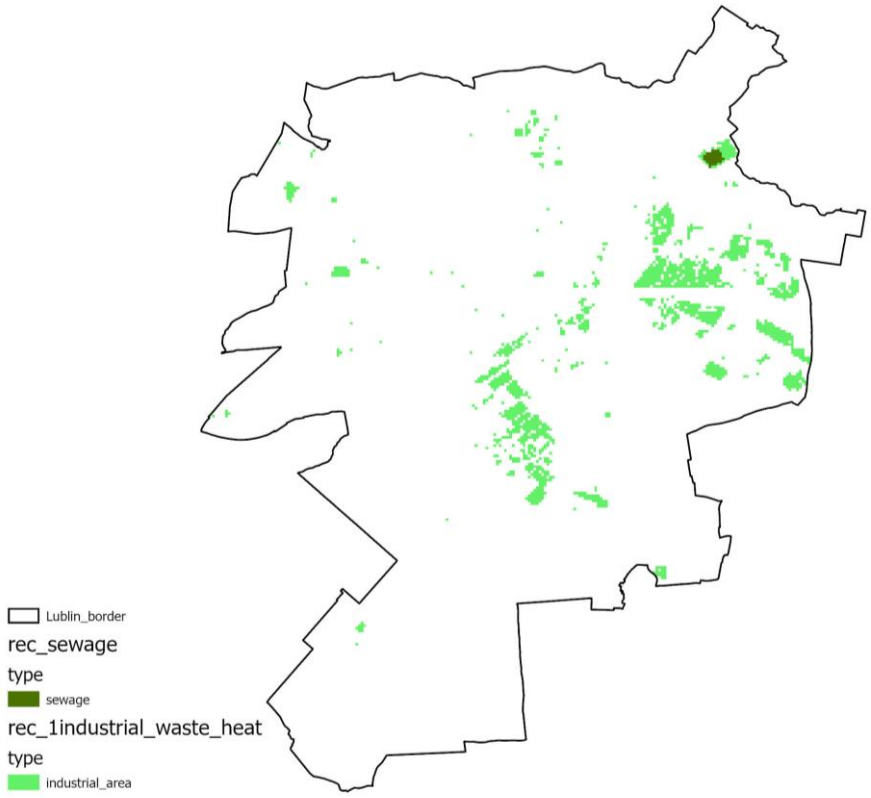


Figure 61: Industrial waste heat reclassified layer - Lublin

Heat Grid

The district heating system is based on the heat produced by power plants. The Lublin heating system consists of a district heating network managed by the municipal company Lubelskie Przedsiębiorstwo Energetyki Cieplnej S.A. and two combined heat and power plants: PGE Energia Ciepła S.A. Branch Elektrociepłownia in Lublin Wrotków and Elektrociepłownia MEGATEM EC-Lublin Sp. z o.o.

Lubelskie Przedsiębiorstwo Energetyki Cieplnej S.A. deals with heat transmission, distribution, and trading in the Lublin Commune. (LPEC S.A.)

The company provides heat to apartments, schools, hospitals, shopping centers, offices, sacred buildings, sports facilities and many others, and takes care of the technical efficiency of the Lublin heating system. LPEC supplies heat to almost 75% of households in Lublin, heating nearly 250,000 of its inhabitants.

LPEC S.A. purchases 100% of heat in combined heat and power plants and then sends it to its customers as hot water through its own district heating networks. The supplied heat is used for central heating, domestic hot water preparation and ventilation.

System heat is generated in an ecological cogeneration process. This means that it is produced in a combined heat and power plant, in the same production process as electricity (Power plants in Lublin generate electricity mainly with the use of coal and gas boilers).

Heat grid	Remap Value
Heat grid polygon around the grid lines.	7

Table 314: heat grid reclassification and remap value – Lublin

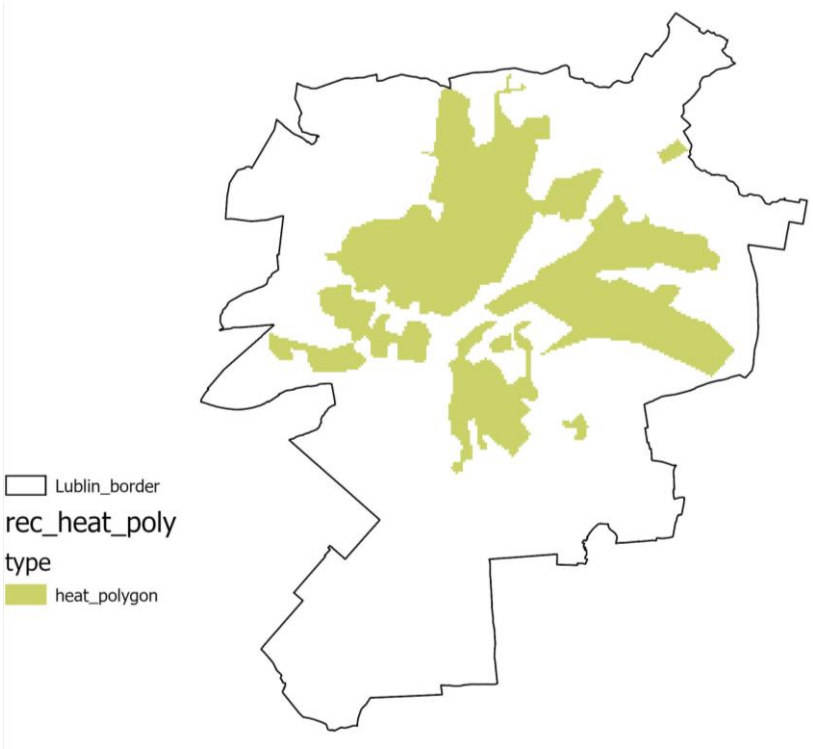


Figure 62: Heat grid polygon reclassified layer - Lublin

e-mobility Infrastructure

Source: EV vehicles chargers location.

Buffers have been created surrounding the location of the EV charger stations.

Buffer zone (m)	Remap Value
0-100	9
250- 500	9
500- 750	1
750-1000	1

Table 315: e-mobility infrastructure remap values – Lublin

Figure 63: Ev chargers reclassified layer - Lublin

GIS intermediate results of Trenčín

Land Use

Sources: Land use GIS information provided by the city. Citizens have a high acceptability of new developments and legal mechanism promoting energy efficiency retrofitting. Active Green (forest, intense vegetation) has seen as high positive impact on cooling loads in the city.

Land- Use	Remap Value
Residential Areas	9
Commercial Areas	9
Sports, Social and Cultural Areas	9
Green Areas	8

Table 316: Land use remap values – Trenčín

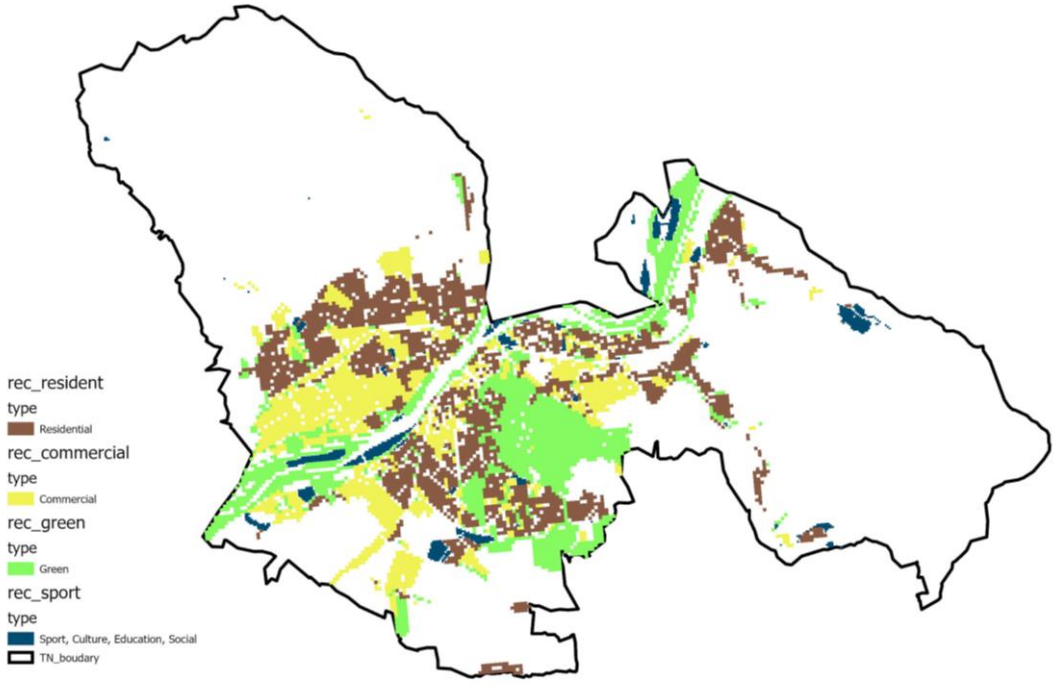


Figure 64: Land use reclassified layer - Trenčín

Urban macroform

Sources: Land use GIS information provided by the city. Selected areas for retrofitting exist and funding mechanism are already approved. There are infill areas and are mentioned in strategic plan, incentives or any regulations through energy efficiency for new building stock, for PED implementation. some

funding is expected for selected areas for transformation /reuse exist. Strategy of urban regeneration allows the implementation of PED in transformation/reuse areas.

Urban macroform	Reclassification Groups & Remap Value
Retrofitting Areas	6
Infill Areas	6
Transformation-Reuse	5

Table 317: Urban macroform reclassification and remap values – Trenčín

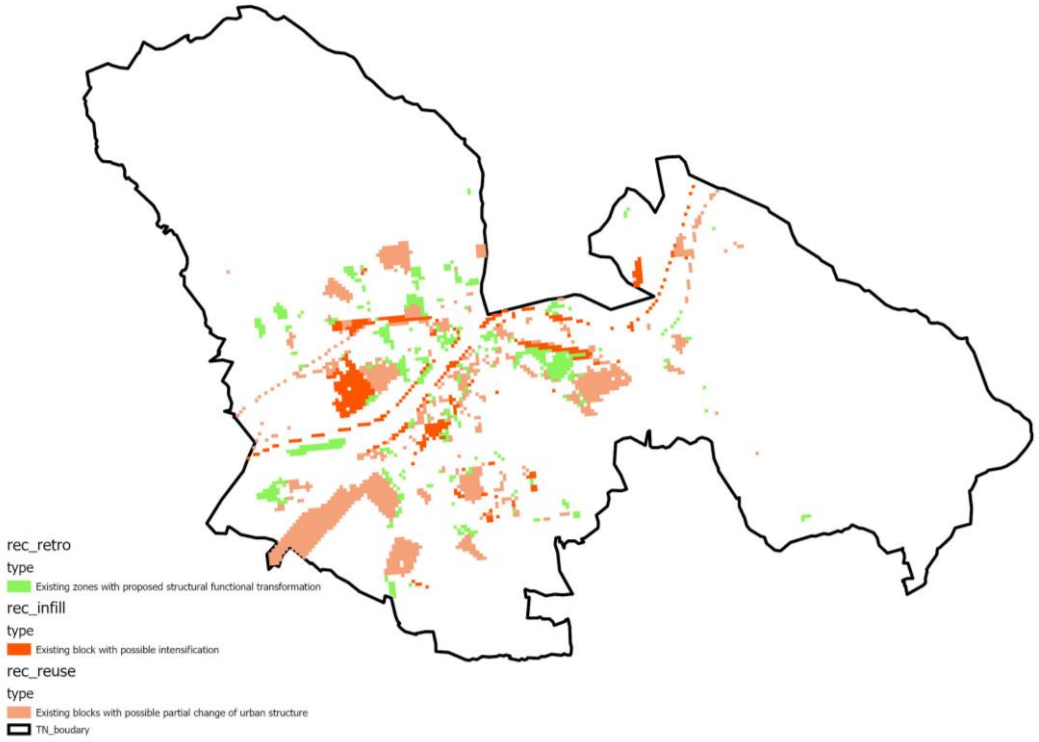


Figure 65: Urban macroform reclassified layer - Trenčín

Ground Coupling

Source: GIS information provided by the city

There are zones with medium geothermal potential. Legal Framework allows drilling boreholes. Drilling and geothermal technology can be find for the implementations.

Soil Types for Thermal Storage	Remap Value
1) Cambisols	4
2) Fluvisols	1

3) Haplic Luvisols	2
4) Mollic Fluvisols and Mollic Gleysols	1
5) Rendzic Leptosols	3
6) Calcaric Cambisols	2

Table 318: Soil types for thermal storeage remap values – Trenčín

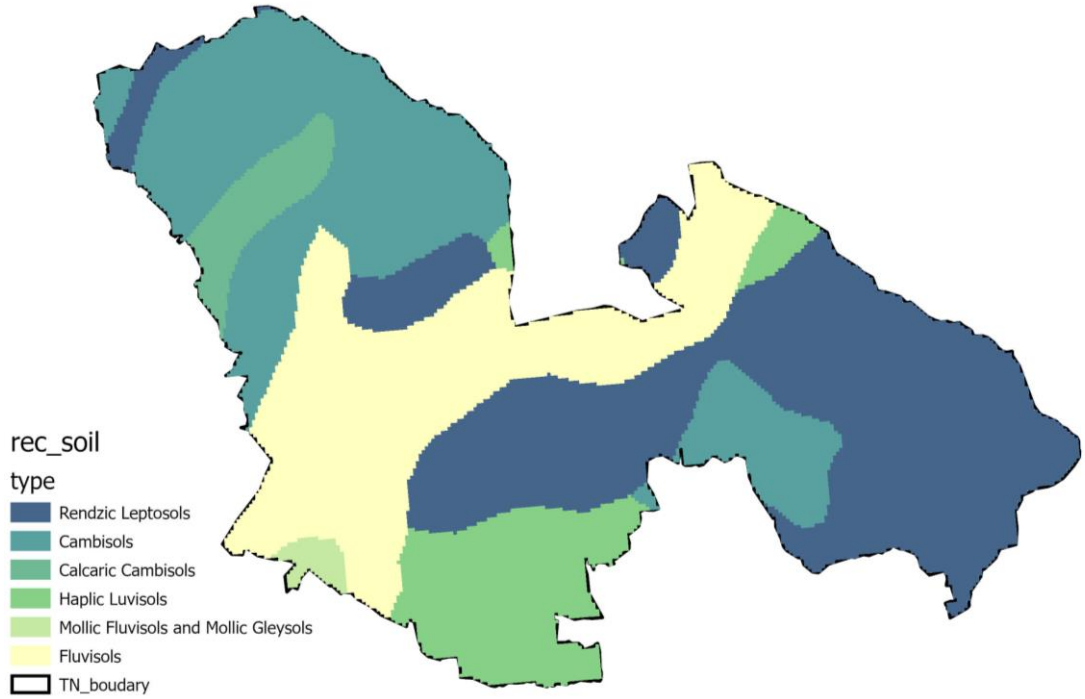


Figure 66: Ground coupling reclassified layer – Trenčín

Geothermal water impact area:

Source: GIS information provided by the city. Geothermal energy has high-medium social acceptability in the city. Legal framework allows the implementation of geothermal but restrictions exist.

Geothermal water impact area	Remap Value
Group 1	3
Group 2	3
Group 3	2
Group 4	2

Group 5	1
Group 6	1

Table 319: geothermal water impact area remap values – Trenčín

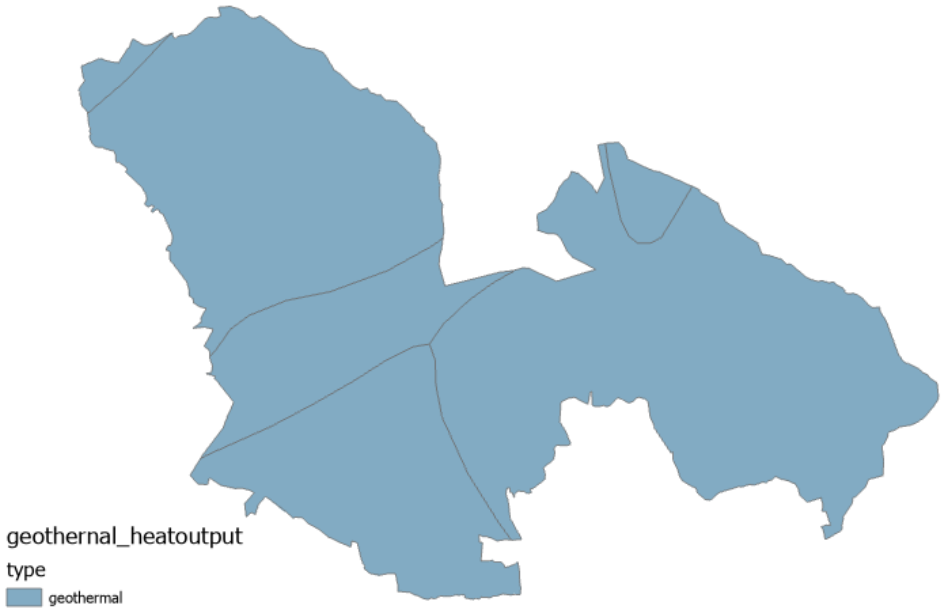


Figure 67: Geothermal water impact area reclassified layer – Trenčín

Hydropower (proximity)

Source: GIS information provided by the city

There is current sea, lakes, streams, creeks in the city with high energy generation potential. Public Investment provides feasible installation for hydropower. Legal framework allows the use of water resources for energy generation but some restrictions exist.

Distance to water resource (m)	Remap Value
250	9
500	9
750	1
1000	1

Table 320: hidropower remap values – Trenčín

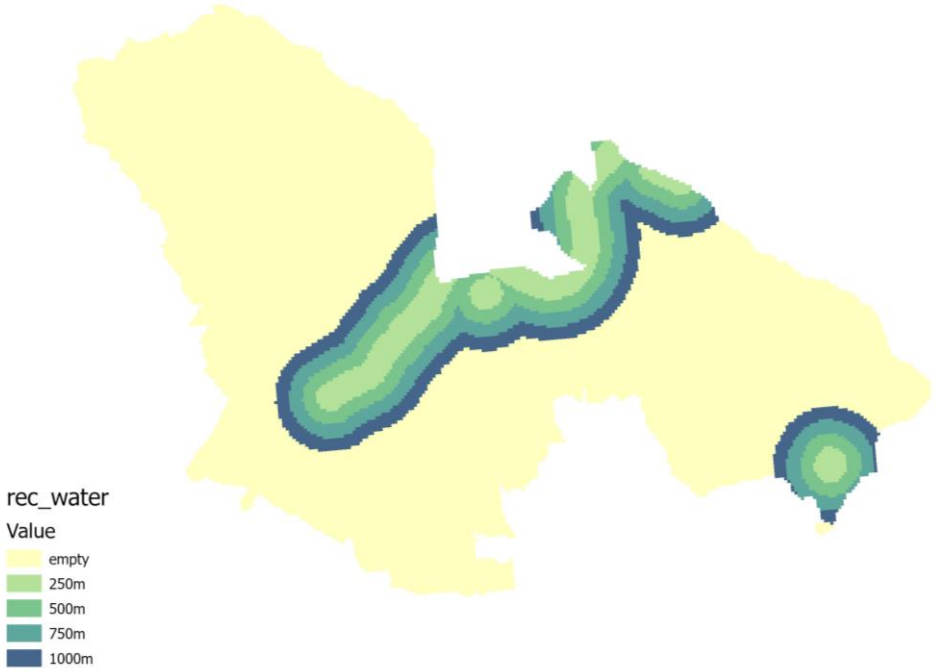


Figure 68: Potential surface water resources reclassified layer – Trenčín

Biomass Potential

Source: GIS information provided by the city

There is biomass available close to the city. Social acceptability of biomass can be assessed as medium-high.

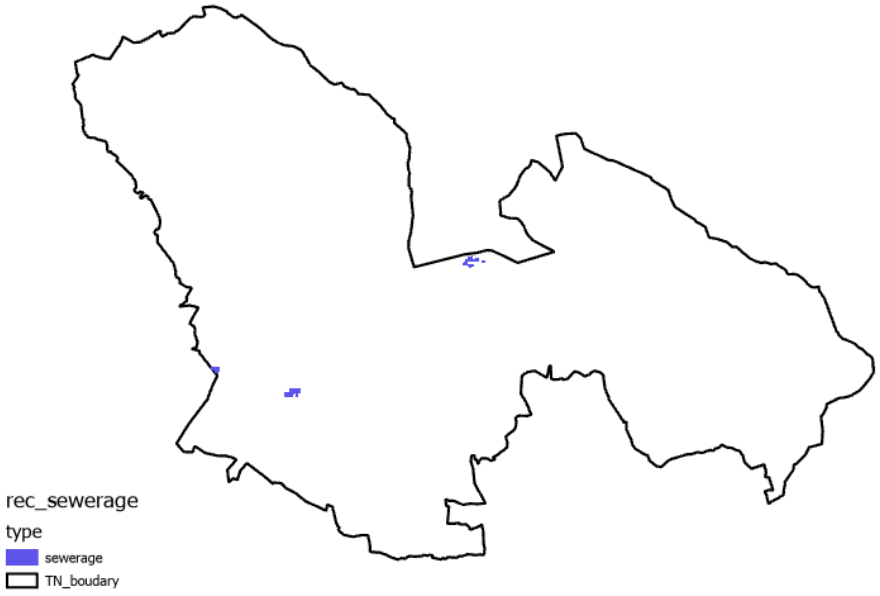


Figure 69: Potential biomass area reclassified layer – Trenčín

Population density

Source: The population density has been provided by the city at district level

There are medium density zones in the city. Not solvent income level but expected investments. The municipality has the capacity to make changes in new development zones in the concern of population density.

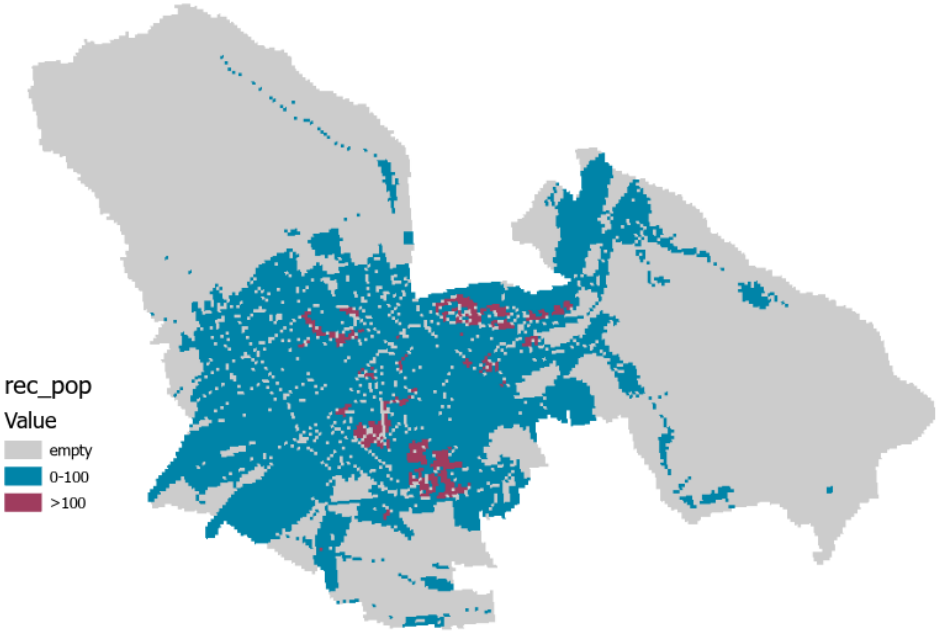


Figure 70: Population density reclassified layer – Trenčín

GIS intermediate results of Vidin

Land Use

Source: The zones for the different categories in land use have been defined from information the "zem_10971.shp" file provided by the city.

Each of the more than 250 uses defined in the input file has been included in one of the categories shown in the table below:

Land use area	Remap Value
Public Administration areas	9
Commercial areas	9
Active Green / Open Parking Lot.	9
Social / Cultural/Educational/Sport Areas.	9
Industrial Zones/sewega systems/thermal plants with waste heat energy generation potential (in the city or next to it)	1
Residential & Mixed Use Areas	8
Other	1
Public Administration areas	9

Table 321: Land use remap value – Vidin

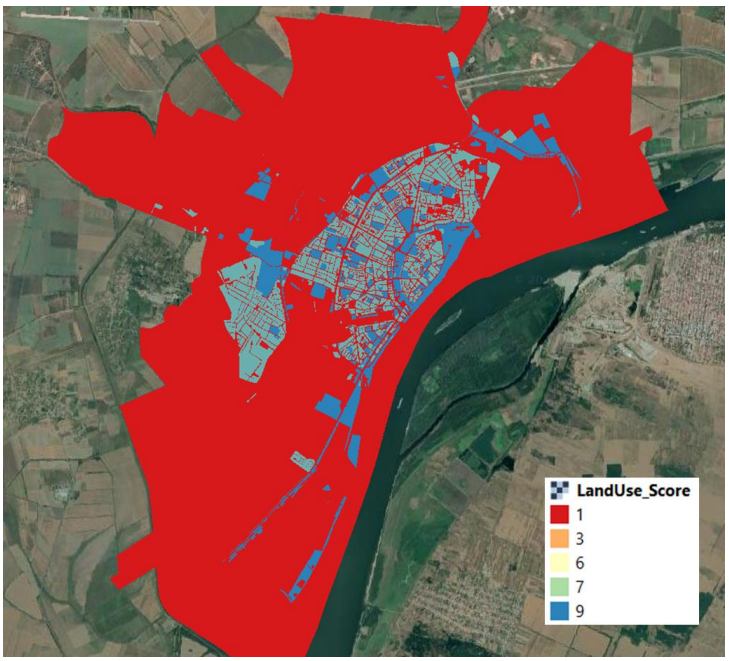


Figure 71: Land use with remap values assigned – Vidin

Urban Macroform

Source: As well as for the land use, the **new development areas** of the information for the urban macroform layer has been obtained from the "zem_10971.shp" file provided by the city.

the retrofitting areas are included manually from a map with the addresses for the buildings that are expected to be retrofitted.

The rest of the city has been included as Other and given the lowest score.

Urban macroform	Remap Value
New development areas	6
Retrofitting Areas	9
Other	1

Table 322: Urban macroform remap value – Vidin

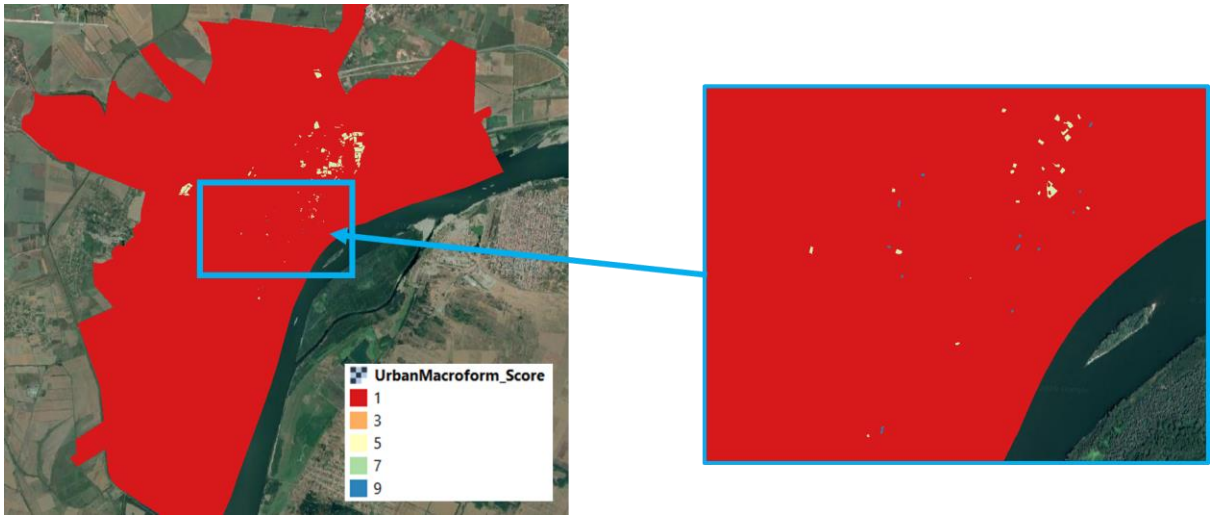


Figure 72: Urban macroform with remap values assigned – Vidin

Geothermal

In order to generate the layer of areas suitable for Geothermal Energy, the areas of Grassland (of the vegetation layer) + Active green (of the land use layer) that are located more than 1000m from the river are selected. The areas closest to the river will be taken into account for hydrothermal.

Distance to an area with geothermal potential	Remap Value
0-100	9
100-250	7
250-500	5
500-1000	3
> 1000	1

Table 323: Geothermal potential remap value – Vidin

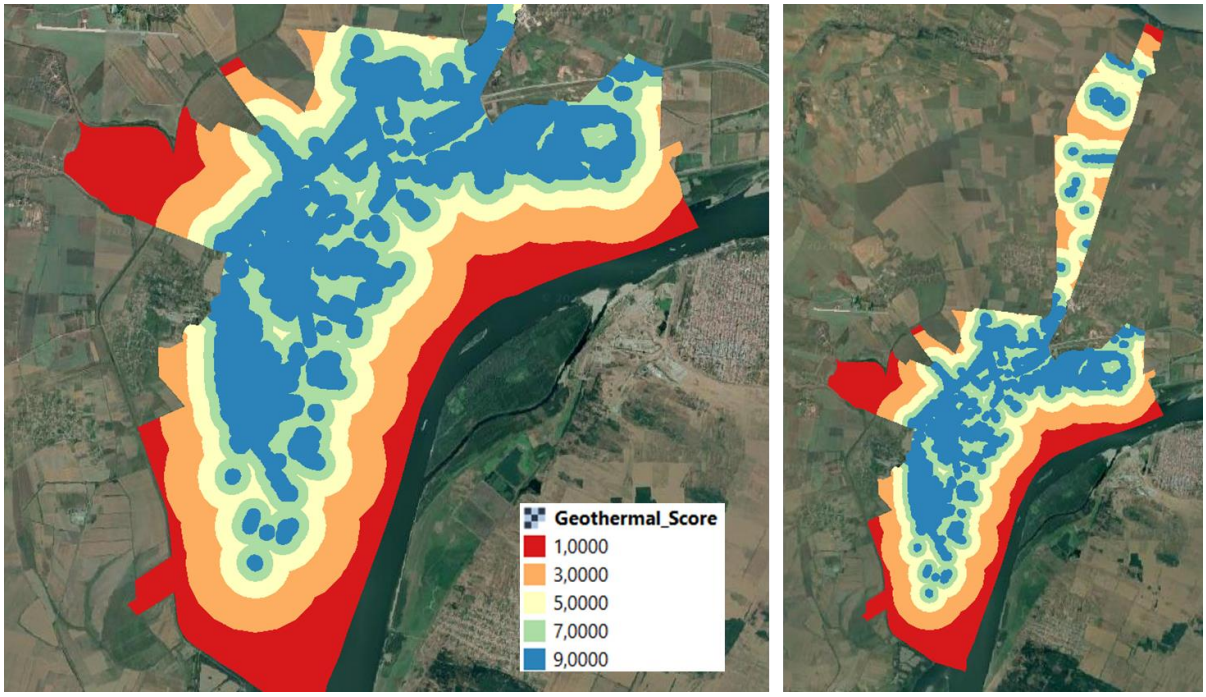


Figure 73: Geothermal potential with remap values assigned – Vidin

Hydrothermal

For the generation of the layer of areas suitable for Hydrothermal, the areas of Grassland (of the vegetation layer) + Active green (of the land use layer) that are less than 1000m far from the river are selected.

Distance to an area with hydrothermal potential	Remap Value
0-100	9
100-250	7
250-500	5
500-1000	3
Other	1

Table 324: Hydrothermal remap value – Vidin

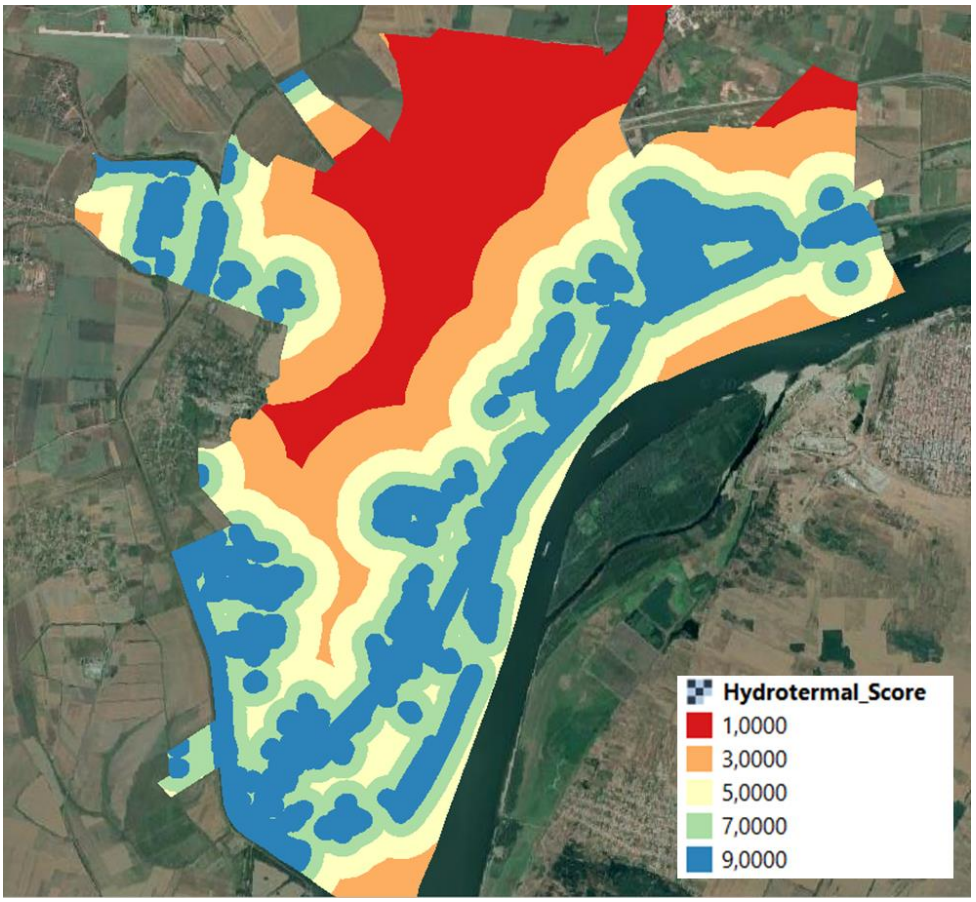


Figure 74: Hydrothermal with remap values assigned – Vidin

Population density

Source: The population density has been obtained from a public source.

The data obtained has been adapted since the values where given per 250x250m grid cell. These values have been transformed to inhabitants per km2. In this case, a higher population density has been rated better.

Population density (hab/km^2)	Remap Value
< 400	1
400-1200	3
1200-2000	5
2000-2800	7
> 2800	9

Table 325: Population density remap value – Vidin

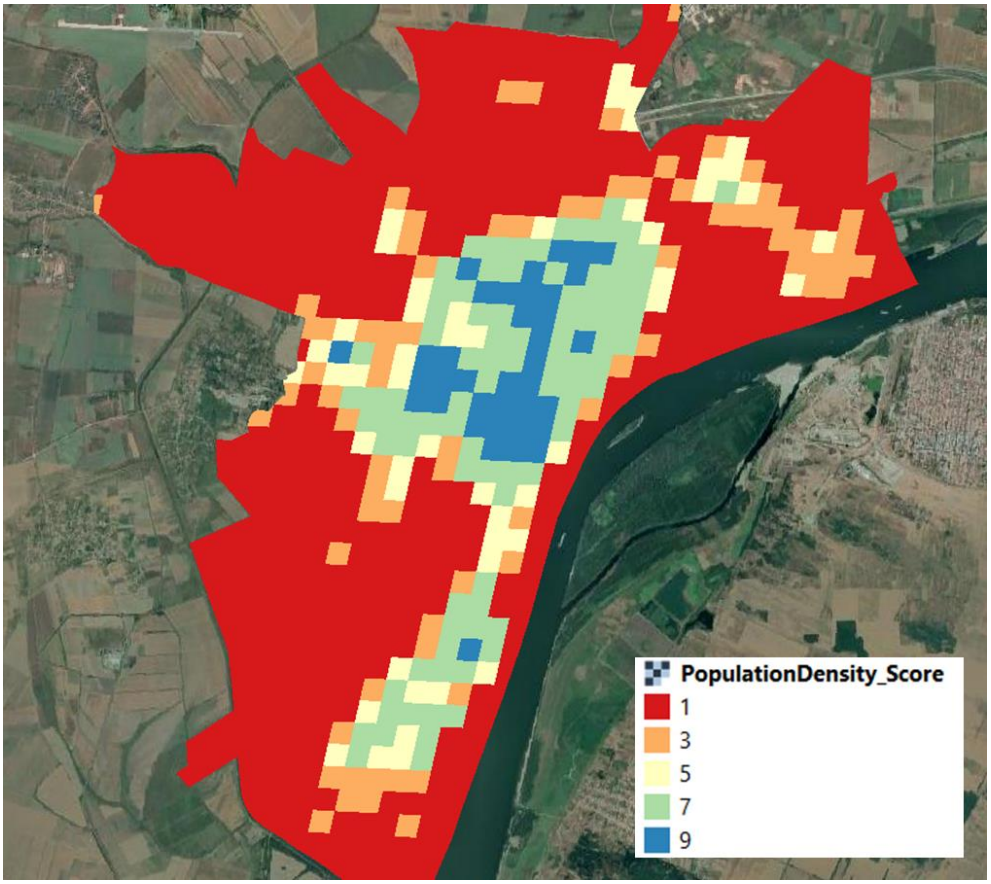


Figure 75: Population density with remap values assigned – Vidin

Public and Private áreas

Source: The map of public areas has also been extracted from the “zem_10971.shp” file

Property	Remap Value
Public	9
Private	1
Other	1

Table 326: Public domain remap value – Vidin

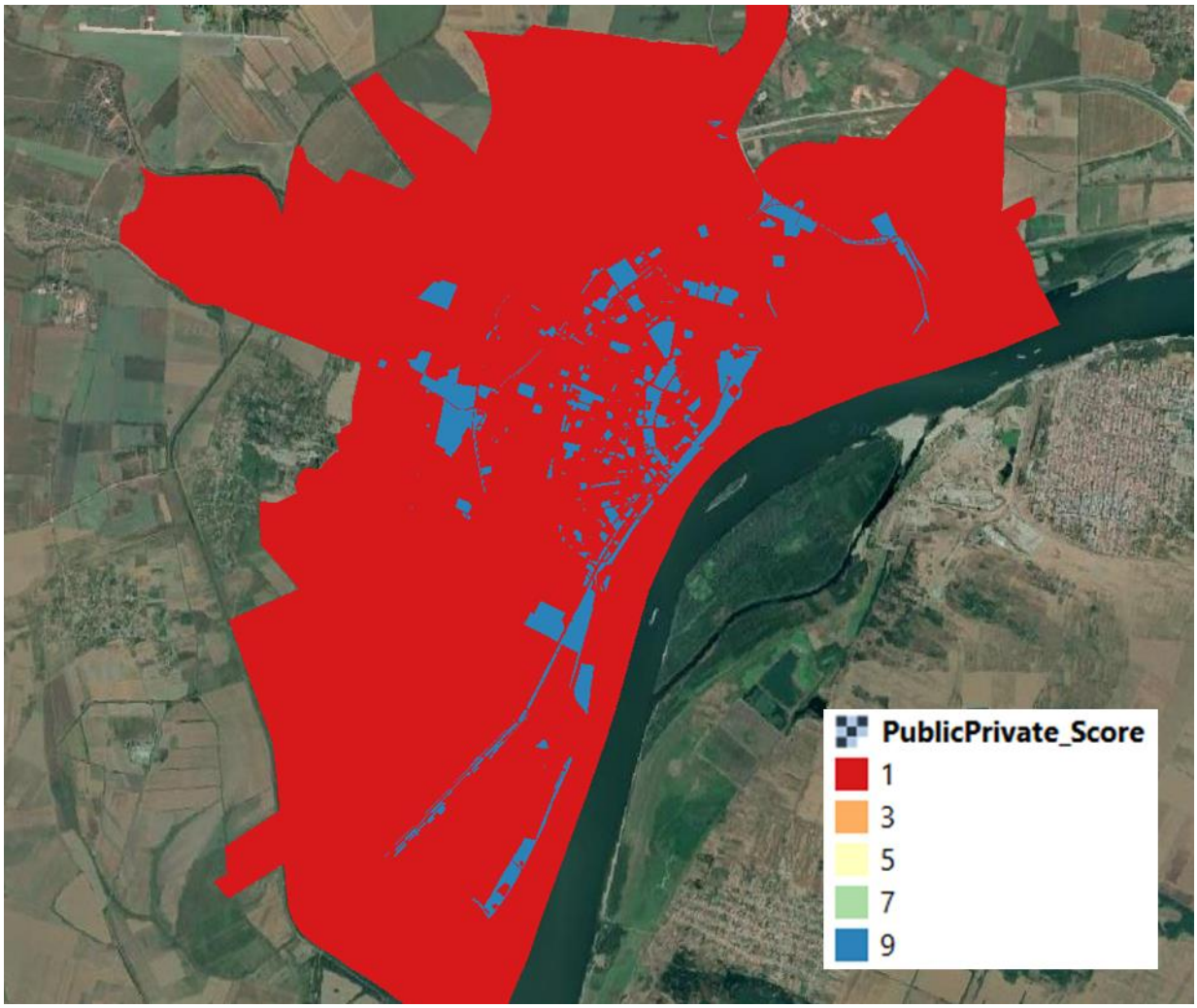


Figure 76: Public domain with remap values assigned – Vidin

Solar potential

Rooftop solar potential

Sources: GIS information sent by the city to perform the building stock model assessment in WP1.

This parameter represents the ratio between the roof surface and the total built surface of each building. In order to obtain a more homogeneous layer and not to represent only the silhouettes of the buildings, this information has been transferred to 250x250m squares.

Building surface availability RATIO for solar installation map	Remap Value
< 0,2	1
0,2-0,3	2
0,3-0,5	4
> 0,5	9

Table 327: Solar potential remap value – Vidin

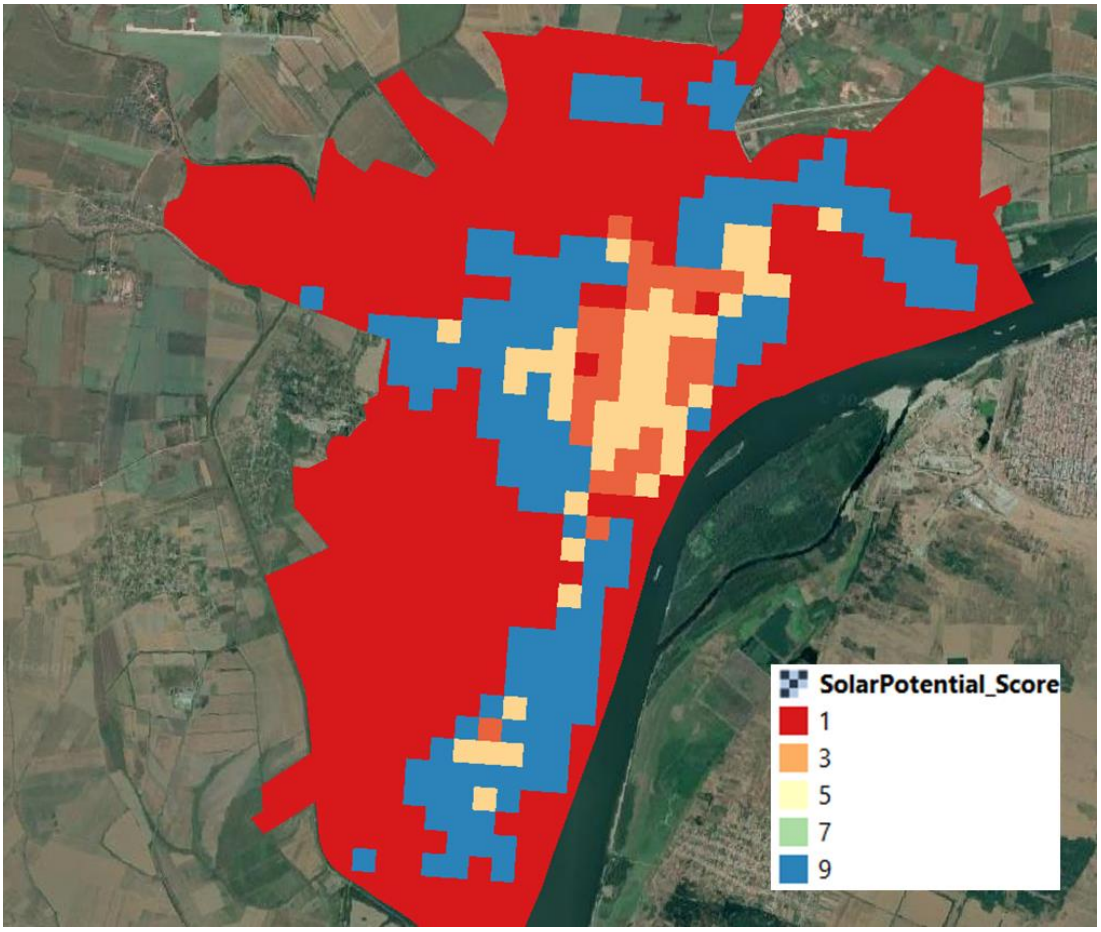


Figure 77: Solar potential with remap values assigned – Vidin

Biomass (Vegetation map)

Sources: 3 maps of Corine Land Cover: Forest, Grassland, Small woody features.

For the generation of the vegetation map, the 3 layers mentioned above have been combined, giving rise to a single layer in which 4 zones can be distinguished: Areas without vegetation, grasslands, areas with small bushes (SWF) and forest areas (FTY).

In this case, the forest areas are the best evaluated because of their greater potential as a biomass source.

Vegetation type	Remap Value
FTY	9
SWF	7
Grassland	1
No vegetation	1

Table 328: Biomass remap value – Vidin

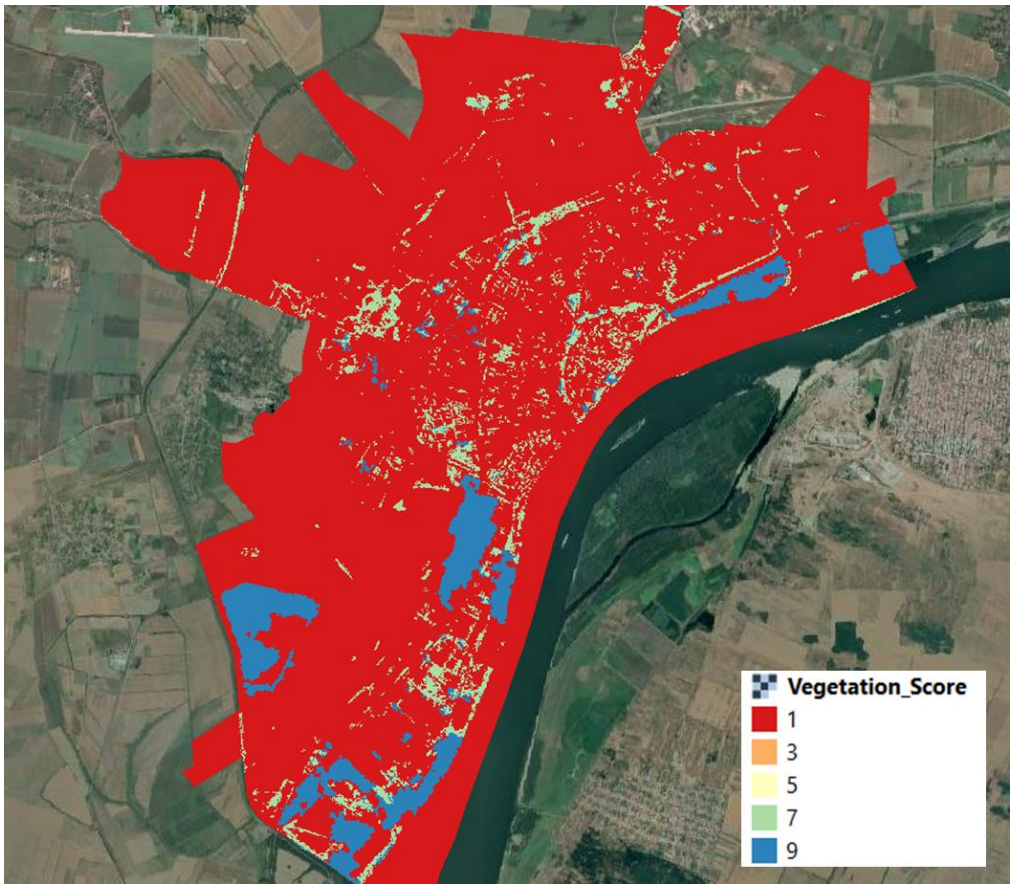
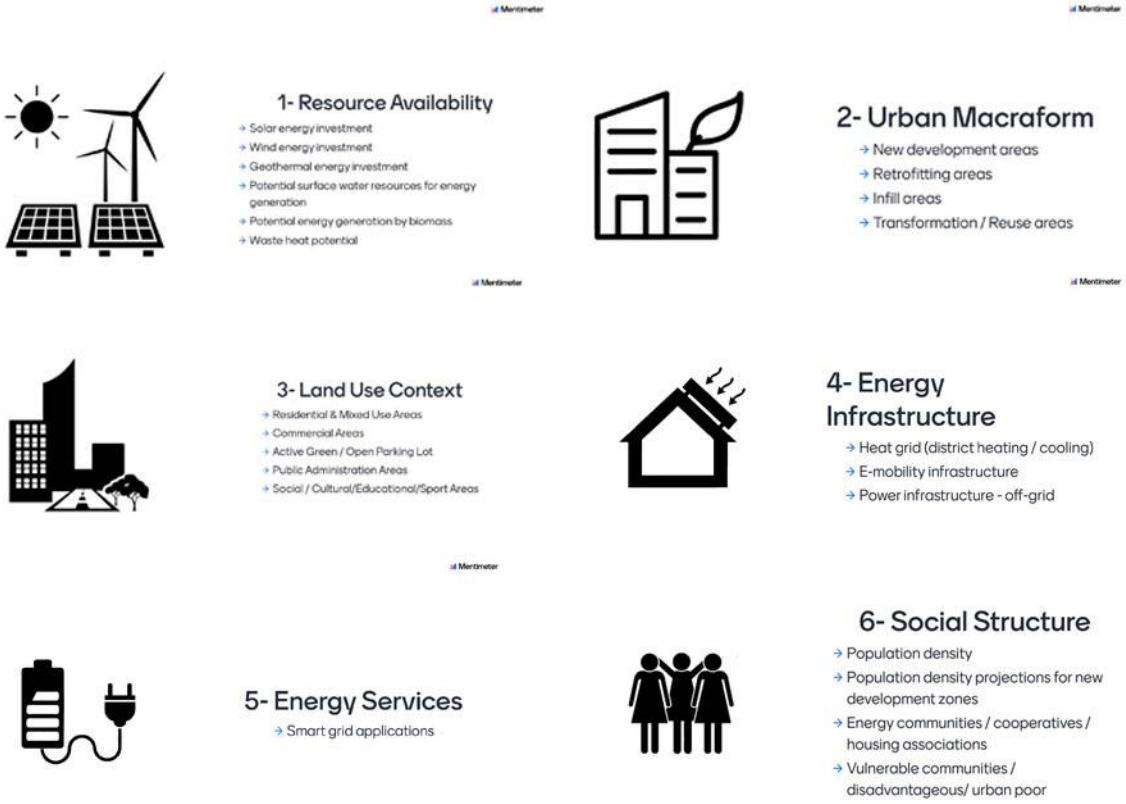


Figure 78: Biomass with remap values assigned – Vidin

Annex IV: GamePED- Workshop for defining PED Areas

A workshop series are being held in Periodic Meetings that are mentioned in replication action plan of MAKING-CITY. These workshop series are titled as "GamePED" and are being developed and updated by DEM. First workshop was held in 2nd Periodic Meeting in Groningen and more information may be found in D4.1 Methodology for PED Design. Second one was held digitally in 4th Periodic Meeting that focused on the identification of PED areas in FWCs. For this purpose, PED Analytical components are listed in each FWC breakout rooms, and discussions were held between FWC representatives and other LHC partners and technical partners of MAKING-CITY. The main target is to transfer knowledge/experience from LHCs to FWCs.



GamePED- Workshop Results for Bassano del Grappa

PED Components	Discussions during WS
Resource Availability	In terms of renewable energy Bassano del Grappa can use solar and wind energy besides potential water surface for energy generations. There are no geothermal, waste heat or other forms of renewables.
Urban Macroform	The most suitable urban areas for the development of PED's in Bassano del Grappa are existing building stock via retrofits and reuse of areas. Infill areas could also be used.
Land Use	The PED development needs to be citizen/business driven since the resources and impact area of public is limited. The land use requirements/feasibility need to be fulfilled with residential or tertiary buildings/areas.

Energy Infrastructure	In Bassano del Grappa some e-mobility infrastructure has started to emerge. There are no plans for building district heating networks.
Energy services	No smart grid services yet but it could change within the near future
Social structure	N/A

GamePED- Workshop Results for Kadiköy

PED Components	Discussions during WS
Resource Availability	5. Although solar irradiation and the potential is below the average of Turkey, Kadıköy is definitely located in a favorable location with more than 1400 kWh/m2 average annual irradiation. With a dense urban characterization, solar and PV is the first resource considered as available. Although applications and capacities are not diffused yet in the Urban landscape, there are national incentives available. 6. As the 2. Abandoned RES, wind is considered to be a free and considered to be "everywhere", however the low average wind speeds throughout the year in Kadıköy lowers the economic potential of wind energy in the city.
Urban Macroform	The most suitable urban areas for the development of PED's in Kadıköy are transformation and reuse areas since Kadıköy is in the process of urban transformation. 2nd potential development areas are retrofitting areas.
Land Use	The first applications of PED concept could be Public administrative areas since it provides a simpler approach in decision making process as well as relatively easy access to non-private funds that could be utilized for such standard project concepts. Residential and mixed used areas are also interesting areas where public private partnership models could be used for financing.
Energy Infrastructure	Although there is not much of an e-mobility infrastructure yet in Kadıköy, the trend of electrification of mobility could present potential intersections with the PED development areas.
Energy services	No smart grid services or plans have been reported
Social structure	The number one social driver is the population density. Kaıköy is heavily populated small area with tight building block characterization.

GamePED- Workshop Results for León

PED Components	Discussions during WS
Resource Availability	7. León is well endowed with solar irradiation and the potential for its contribution to León's energy mix both via distributed "rooftop" installation and/or large-scale solar farms in the periphery is huge. This is the largest and most convenient renewable energy asset. There are some regional and national incentives available and several installed systems but nothing near the potential available. 8. The second abundant renewable resource is biomass due to a lto of farming area and some forest area around the city. These could be sustainably harvested for biomass use in the city. The agricultural waste could also be a good source of biomass supply with good planning. 9. There is low temperature geothermal resources in the area which could be used for heating.
Urban Macroform	The most suitable urban areas for the development of PED's in León are existing building stock via retrofits and other investment. Also infill areas could be used.
Land Use	The PED development needs to be public driven whether regional or national because of the inexistence of alternative finance. The land use requirements/feasibility will therefore start from social-cultural-sports complexes with high visibility and potential to generate fast pay-backs for the public (or for that matter private) investments. The same logic goes for public administration buildings.
Energy Infrastructure	In León there is the power grid and a dispersion of eV charging points. No advanced implementations of data accumulation and its use for demand side efficiency has been mentioned. The plans for building district heating networks has received much public opposition and have been dropped.
Energy services	No smart grid services or plans have been reported
Social structure	The emphasis in León for the selection of urban sustainability project are the vulnerable urban populations and the regions of the city inhabited by the urban poor. These also happen to be more organized in housing associations associated to the local government or rooted in the public.

GamePED- Workshop Results for Lublin

PED Components	Discussions during WS
Resource Availability	There is medium potential for Lublin for solar energy generation. An average of 66 sunny days. Biogas production from sewage treatment plant in the city boundaries

	can also be counted as resource availability. Besides, waste heat from industrial areas should also be considered.
Urban Macroform	Mostly, retrofitting areas are promoted in the city with incentives from national and local resources.
Land Use	Public Administration and publicly owned social / educational / sport areas are also promoted in terms of energy efficiency and lowering energy demands.
Energy Infrastructure	There is district heating grid system that is based on the heat produced by power plants. It is owned by a municipal company. There is a potential for energy sharing mechanisms. There are a few charging stations, as well. Political framework allows trading via stations.
Energy services	No virtual infrastructure exists in the city.
Social structure	The vulnerable communities or disadvantageous groups are being supported for energy efficiency measure to increase public health.

GamePED- Workshop Results for Trenčín

PED Components	Discussions during WS
Resource Availability	In terms of renewable energy Trencin can utilize surface water, biomass and solar energy as renewable. There is not much potential for wind, geothermal, waste heat or other forms of renewables.
Urban Macroform	The most suitable urban areas for the development of PED's in Trencin are new development areas, transformation and reuse of areas.
Land Use	The PED development needs to be public driven whether regional or national because of the inexistence of alternative finance. The land use requirements/feasibility will therefore start from social-cultural-sports complexes and revenue generating commercial sector.
Energy Infrastructure	In Trencin there is only heat grid (districtheating / cooling) system.
Energy services	No smart grid services planned yet.
Social structure	The emphasis in Trencin for the selection of urban sustainability project are the housing associations.

GamePED- Workshop Results for Vidin

PED Components	Discussions during WS
Resource Availability	Solar energy investment is the most determinant factor for selection of PED area. There are also wind energy and geothermal investments in Vidin to be evaluated for PED. Finally, water resources it the least important value for Ped. In Vidin there is no biomass energy potential.
Urban Macroform	Only retrofitting areas are available to defining for PED areas. Other values are not significant to selection of PED area.
Land Use	The most suitable land use context is residential & mixed-use areas for PED development. Also, it needs to be public administration areas. Respectively, social, cultural, educational & sports area, active green area and open parking lot would be conceivable.
Energy Infrastructure	In Vidin there is mobility infrastructure plan which is going to implemented soon. Although there is no the power infrastructure plan yet, it is thought to be planned for implementation of it in the near future.
Energy services	There is no energy service in Vidin.
Social structure	In Vidin, for the selection of PED area the important values are population density and its projection for new development zones. Following this, energy communities and vulnerable communities would be conceivable.