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5 maps of activable RECs in port marginalized neighbourhoods and hinterlands

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Table of contents

Sommario

List of Tables

List of Figures

List of Acronyms

Acronym	Meaning
ARERA	Regulatory Authority for Energy, Networks and the Environment
EP	Energy Poverty
GSE	Energy-Services Manager
H2020	Horizon 2020 framework for funding
HEP	Hrvatska Elektroprivreda
IDAE	Diversification and Energy Savings Institute
IRENA	Istrian Regulatory Energy Agency
ISC	Remote Individual Self-Consumption
MASE	Ministry of Ecological Transition
MIS	Minimum Income Standard
NBS	Natural Base Solution
NECP	National Integrated Energy and Climate Plan
OSS	One-Stop-Shop
PNRR	National Recovery and Resilience Plan
REC	Renewable Energy Community
SECAP	Sustainable Energy and Climate Action Plan
TIAD	Text of Diffuse Self-consumption
UHI	Urban Heat Island
VCE	Valencia Climate & Energy Foundation

1. Introduction

1.1 Introduction Spain

In this report different features of the chosen area for the EnerCmed pilot in the city of Valencia will be reviewed, such as its social composition, the spatial planning and the threats caused by climate change and the urban heat island phenomenon. It is also an opportunity to analyze the Open Days carried out in the city together with the key stakeholders identified and the main takeaways messages and highlights.

Purpose & Scope

This report aims to describe the area chosen for the EnerCmed Valencia pilot – the Poblats Marítims district, more precisely the neighborhoods of Nazareth and La Malva-Rosa.

These have unique features that led to this consideration such as: low-income households, high levels of energy poverty, old and poorly isolated houses, closeness to the sea and port, marginalization and strong support network among their inhabitants.

Methodology

Regarding the methodology used, different approaches and perspectives were taken into account to make a comprehensive study of the area and its needs.

1. <u>Normative</u>

First, the organisation of the Spanish State was considered, as there are 4 levels of government and administration: national (Spain), regional (Valencian Community composed of three provinces), provincial (province of Valencia), and local (city of Valencia). This will have a key impact on regulation as Renewable Energy Communities (REC) can be addressed at state, regional and local levels.

Spain has not promoted yet a full transposition of European Directives about Energy Communities (EU 2018/2001 and 2019/944). However, Energy Communities have been partially introduced in Spanish law, introducing Renewable Energy Communities as a new subject of the electricity sector (modification of article 6 from Spanish law 24/2013, 26th December, on the Electric Sector).

At regional and local level, other efforts are being made to introduce or complement self-consumption and energy communities with applied regulation, especially due to their key role at establishing "rights of use of surface".

Normative analysis includes the following:

- Royal Decree 244/2019, of April 5, regulating the administrative, technical and economic conditions of self-consumption of electrical energy.;
- Royal Decree-Law 23/2020, of June 23, approving measures in the field of energy and other areas for economic recovery.;
- National Integrated Energy and Climate Plan (NECP) 2021-2030;
- Draft version of Royal Decree developing the figures of Renewable Energy Communities and Citizen Energy Communities;
- Law 6/2022 on Climate Change and the Ecological Transition of the Valencian Community.

In addition, this analysis will also take into consideration specific agreements taken by the Municipality itself, such as the Valencia Climatic Agreement, the Valencia Urban Agenda 2030, Valencia Climate Mission City and the award winning of European Green Capital 2024. Among the city objectives are the goal to achieve a healthy and sustainable city:

- EU Missions Valencia;
- Valencia Climate City;
- Valencia Green Capital;
- Valencia Urban Agenda 2030.

Finally, regarding energy poverty different initiatives, that are paving the framework and putting this issue into the city agenda, can be mentioned, such as:

- the Energy Poverty Plan, which is currently being developed;
- the creation of the Municipal Energy Poverty follow up commission, with representatives from all sectors involved;
- the update of municipal indicators and statistics to include energy poverty data;
- energy poverty mapping;
- conversations between València Climate and Energy (VCE) and other municipal delegations, especially education, consumer and health, to raise awareness among energy poverty and establish a protocol for energy poverty detection.

2. Technical

The municipality of Valencia is making several efforts to address renewable energy communities (REC), urban heat island (UHI), nature-based solutions (NBS) and energy poverty (EP) through different European projects and initiatives. Here are mentioned several reports carried out by expert agencies, the municipality and VCE such as:

- H2020 Power up report on REC;
- Green Urban Data Report 2022[1] on Climate Shelters;
- Fair Local Green Deals report 2024 on fighting the heat;
- Grow Green report 2022 on NBS strategy for Valencia[2];
- Energy Vulnerability report 2023 on energy poverty data.

These are valuable technical reports that can inform decision making about the EnerCmed pilot site.

3. Climatic

In the case of Valencia, the city's greatest impact on the climate is the heat island effect. To evaluate the climatic conditions in Valencia, and the particularities of sea and port areas, the above-mentioned reports, the dedicated deliverables and meteorological parameters will be considered, to evaluate: temperature evolution and mapping, thermal stress over population, spatial distribution, surface characteristics, green spaces, building characteristics, wind patterns and humidity among others.

The NBS will be considered as an adaptation action to climate change to address heat impacts from the urban environment. EnerCmed is an opportunity to introduce co-creation with local actors such as schools, students, NGOs or neighborhood associations to empower them and address real necessities. Thus, the importance of establishing networks and promoting dialogue – such as the Open Days.

4. Social, economic and political

This thematic analysis has been done taking into consideration the data offered by the Municipal Statistics Office and the dedicated report from VCE together with an energy consultancy expert. Here different socio-economic features will be considered, both at city and neighborhood level to assess the feasibility and suitability of the pilot implementation in Poblats Maritims area. These were particularly significant:

- Population evolution and density;

[1] Green Urban Data (2022): "Inventario, mapeado y caracterización de espacios susceptibles de ser empleados como refugios climáticos en el T.M. de Valencia", Municipality of Valencia and Valencia CLimate and Energy Foundation

[2] Grow Green (2022): "Towards a Nature-based solutions strategy in the city of Valencia"

- Age and gender;
- Migrant rates;
- Social and family composition;
- Educational level;
- Employment level;
- Income levels;
- Housing and living conditions;
- Access to energy;
- Energy poverty rates;
- Social services action.

1.2 Introduction Croatia

The transition towards sustainable energy systems requires innovative approaches that actively involve local communities. One such approach is the establishment of REC, which empower citizens, public institutions, and local businesses to collectively produce, manage and consume renewable energy. As part of the pilot projects, the development of this report serves as a strategic tool to identify suitable location for REC implementation. This process is further supported by the activation of local stakeholder groups, enabling a participatory co-design process. By fostering collaboration among community members, local authorities and energy sector, this initiative aims to create a socially inclusive, environmentally sustainable and economically viable patch toward energy transition in targeted pilot areas.

Purpose & Scope

This deliverable aims to gather the reasons that contributed to the choice of the areas selected for the pilot activity. The contents are based on the results of the thematic analyses carried out in the previous deliverables.

Methodology

The decision-making process for the selection of the pilot sites was developed from different points of view.

1. Normative

The selection of pilot sites in Pula and Novigrad was guided by Croatia's national regulatory frameworks on energy transition and renewable energy sources. Key legal documents, such as the Law on RES and High-Efficiency Cogeneration and the Law on Electricity Market, define the establishment and operation of RECs. Local spatial documents like the Urban Development

Plan for Bikokere in Novigrad and the Spatial Plan of the City of Pula, set out zoning rules and technical requirements regarding the installation of the PV systems. These normative guidelines ensure compliance of the operation with construction, environmental, and energy efficiency regulations, supporting the feasibility of the pilot site selection.

2. Technical

The technical feasibility of pilot sites was a crucial consideration, focusing on the availability of suitable infrastructure and potential for renewable energy generation. In Novigrad, the Bikokere residential area and the Marketi sports and recreational zone were selected due to their suitability for solar PV installation on rooftops and open parking areas. In Pula, the Monte Zaro district was chosen because of its capacity to have PV systems on public buildings, like the Children's Creative Center. Existing electrical grid connections and substation proximity were also essential technical factors influencing site selection.

3. Climatic

Climatic considerations played a key role in the selection sites. Specific studies have been collected such as meteorological parameters, morphological characteristics, and urbanization patterns that influence the intensity of UHI effects. Additionally, land cover, presence of green area, and the degree of urbanization were the factors considered.

4. Social, economic and political

This analysis considered factors such as education level, unemployment level, income level, social composition, demographics, accessibility to energy and housing types and living conditions. The social, economic and political dimensions were crucial in selecting pilot sites, particularly for addressing energy poverty and social vulnerability. In Pula, the Monte Zaro neighborhood was prioritized due to its concentration of vulnerable groups like low income households and social benefit recipients. Similarly, in Novigrad, the Home for Elderly in Bikokere was also identified as key site, given the socio economic needs of its elderly residents.

1.3 Introduction Italy

This document describes the decision-making process that led to the identification of the area chosen for the pilot action in the Municipality of Genoa, for the EnerCmed project. The results of the thematic analyses, the opportunities and critical issues found are discussed, also considering the feedback received during the open day and the meetings with the stakeholders.

Purpose & Scope

This document aims to gather the reasons that contributed to the choice of the areas selected for the pilot activity. The main reasons that guided the choice of the area are linked to the proximity to the port areas, in conjunction with the socio-economic parameters relating to the possible risk of energy poverty of the inhabitants. The contents are based on the results of the thematic analyzes carried out in the previous deliverables.

Methodology

In following it is described the decision-making process for the selection of the pilot site from different point of view.

1. Normative

The evolution of the legislation at European and national level was analyzed and is summarized below.

Italy's progression in renewable energy communities (RECs) and self-consumption configurations reflects efforts to align with European directives, particularly RED II. This evolution began with the Milleproroghe Decree (Legislative Decree 162/19), which introduced a transitional framework allowing renewable energy plants up to 200 kW within the same secondary substation. This initial phase aimed to test REC configurations.

In December 2021, Legislative Decrees 199/2021 and 210/2021 broadened these parameters, increasing capacity limits to 1 MW and extending the perimeter to primary substations. These measures laid the groundwork for REC expansion and their integration into the energy market, ensuring fair participation.

To refine self-consumption, Regulatory Authority for Energy, Networks and the Environment (ARERA) launched Consultation 390/2022, addressing tariff structures, grid interactions, and incentives. This feedback shaped practical regulations. Simultaneously, the Ministry of Ecological Transition (MASE) reviewed existing measures to eliminate barriers and align regulations with market and technological advancements.

In December 2022, ARERA introduced the Integrated Text of Diffuse Self-consumption (TIAD), consolidating guidelines for collective and individual self-consumption models, energy communities, and administrative procedures.

The most relevant requirements are those of January 2024, when a significant development came with the CACER Decree (Decree 414/2023), effective from January 2024. It offered financial incentives for RECs, though cumulative incentives were capped at 40% of eligible investment costs. EU-funded projects exceeding this cap could not claim premiums for self-consumed energy.

By January 2024, TIAD's technical standards were under review, and by February 2024, the Energy-Services Manager (GSE) issued operational rules to facilitate incentive access and compliance, promoting best practices.

Considering the limits imposed by the legislation, for EnerCmed where the capital contributions (CAPEX) is 100% of the eligible costs project the incentive tariff is not paid. Consequently, the REC is unattractive for the potential participants and there is no mitigation of energy poverty. Due to this consideration, another kind of self-consumption configuration has been identified for the project: Remote Individual Self-Consumption (ISC), a single end customer utilizing the existing distribution network to connect production and consumption sites within the area of the same primary substation.

2. Technical

The most important criterion for the creation of the identified configuration, ISC, is represented by the requirement that the users are powered by the same primary distribution substation. Therefore, considering the distribution of the cabins on the territory of the Municipality of Genoa, the choice fell on the primary cabin which covers the Cornigliano district, also considering the proximity to the port areas.
Other criteria considered are the size and the orientation of the roofs of the chosen buildings, the state of maintenance and accessibility, and finally the general safety requirements.

3. Climatic

To evaluate the effects of urban heat islands and heat waves in the city of Genoa some specific studies have been collected. The analysis also considered meteorological parameters, such as trends in maximum temperatures and wind patterns, together with morphological parameters and parameters relating to the type of land cover, presence of green areas and degree of urbanization.

Some areas of the city are particularly exposed to this type of phenomenon, in particular the peri-port areas are having to deal with high levels of pollutants due to naval traffic and the consequent production of nitrogen dioxide. In addition, it is important to underline how the city of Genoa has high concentration values of Ozone (O3), whose harmful effects are added to those given by high temperatures. In fact, one of the adaptation strategies present in the Sustainable Energy and Climate Action Plan (SECAP) concerns the mitigation of the effects of urban heat islands.

4. Social, economic and political

This thematic analysis was carried out by analyzing various descriptive indices of the socio-economic aspects of the Municipality of Genoa. Among these were particularly significant:

- Unemployement level;
- Educational level;
- Income level;
- Social and family composition;
- Demographic indices;
- Housing types and living conditions;
- Accessibility to energy.

1.4 Introduction Greece

This section provides an overview of the chosen area for the EnerCmed pilot in Greece, focusing on the Municipality of Patras. The analysis encompasses the social composition, spatial planning, energy challenges, and climatic conditions impacting the area, particularly concerning energy poverty and urban heat island (UHI) effects. It also reflects on the outcomes of Open Days and stakeholder involvement activities that informed the selection of the pilot site.

Purpose & Scope

The pilot in Patras was selected for its unique challenges and opportunities in addressing energy transition and resilience. The focus is on a school complex located near the municipal forest of Dassilio, the old port, and a high-traffic perimeter road. These features make it a compelling case study for integrating Renewable Energy Communities (RECs) with urban and environmental planning strategies.

The goal of this section is to outline the specific characteristics of the area, including socio-economic and environmental aspects, and the rationale behind its selection as a pilot site. The emphasis is on leveraging local assets, such as green spaces and community networks, while addressing systemic barriers like energy poverty and administrative challenges.

Methodology

1. Normative Framework

The selection process considered Greece's legislative framework for Renewable Energy Communities (RECs), particularly the provisions under Law No. 4513/2018 and Law No.

5037/2023. These laws provided the regulatory foundation for implementing community-driven renewable energy solutions, emphasizing inclusivity and sustainability.

2. *Technical Feasibility*

The technical analysis focused on the availability of suitable infrastructure in Patras, including school rooftops for photovoltaic installations and proximity to grid connections. The school complex was identified as an ideal site due to its significant energy demand and the feasibility of integrating renewable energy systems.

3. *Climatic and Environmental Factors*

The study highlighted the impacts of Urban Heat Island (UHI) effects in Patras, driven by dense urban morphology and limited ventilation. The proximity of the site to the municipal forest of Dassilio and other green spaces was identified as a key factor in mitigating local microclimatic challenges.

4. *Social, Economic, and Political Considerations*

The area was chosen for its high prevalence of energy poverty, with many households unable to meet their heating and cooling needs. The socio-economic profile of the residents, coupled with strong local engagement during Open Days, demonstrated the potential for community-driven energy initiatives to address these vulnerabilities effectively.

5. *Stakeholder Engagement*

Extensive consultations with local authorities, residents, and community organizations were conducted to ensure the project aligns with local priorities. Stakeholder feedback emphasized the importance of addressing energy poverty while leveraging existing resources, such as green spaces and social networks, to foster resilience and sustainability.

2. Thematic analysis results

2.1 Thematic analysis results Spain

Normative dashboards

The definition of RECs comes literally from the EU definition, lacking further elaboration on what each term means ('The renewable energy communities, which are legal entities based on open and voluntary participation, autonomous and effectively controlled by partners or members who are located in the vicinity of the renewable energy projects that are owned by said legal entities and that these have developed, whose partners or members are individuals, SMEs or local authorities, including municipalities and whose primary purpose is to provide environmental, economic or social benefits to their partners or members or to the local areas where they operate, instead of financial gains').

Nevertheless, a draft version of Royal Decree developing the figures of Renewable Energy Communities and Citizen Energy Communities was made available by the Ecological Transition Ministry for public consultation and proposal of amendments in April 2023, still waiting to be enacted. Even if numerous amendment proposals were submitted by relevant and various stakeholders, it can be expected that the core part of provisions won't vary too much.

Besides specific provisions on Energy Communities, significant advancements have been made in the field of self-consumption of renewable energy, which has become the main activity of Energy Communities up to now.

As a result of the evolution of different Royal Decrees and Laws the approval of Royal Decree 244/2019, of April 5, can be mentioned, regulating the administrative, technical and economic conditions of self-consumption of electrical energy. This introduces important elements such as the figure of collective self-consumption, in which several consumers are supplied with electrical energy from production facilities close to and associated with consumption facilities. Likewise, different types of self-consumption are introduced, allowing the supply of surpluses so generation facilities can, in addition to supplying energy for self-consumption, inject surplus energy into the transport and distribution networks.

In a broader perspective, Energy Communities are mentioned in several strategic plans and working lines from the Ministry. The National Integrated Energy and Climate Plan 2021-2030 (NECP) expressly provides for citizen participation mechanisms in various measures. In measure 1.1. Development of new electricity generation facilities with renewables, through local participation in renewable generation projects; in measures 1.2. Demand management, storage and flexibility and 1.4. Development of self-consumption with renewables and distributed generation, through the promotion of citizen participation; in "Measure 1.6. Framework for the development of thermal renewable energies" through the development of renewable energy communities linked to air conditioning networks; in measure 1.14. Promotion of the proactive role of citizens in decarbonisation, through citizen participation in the definition of local, regional and national energy policies and, finally, in Measure 1.13. Local energy communities, whose objective is to facilitate the participation of citizens, SMEs and local entities in the energy transition.

Finally, at regional level, Law 6/2022 on Climate Change and the Ecological Transition of the Valencian Community has been enacted. It introduces the following point on self-consumption and Energy Communities:

- Valencian public administrations will preferably promote renewable energy self-consumption energy communities.

Moreover, regarding public procurement for establishing "rights of use of surface":

- Public administrations may establish a right of surface on assets owned by them in favor of cooperatives, renewable energy communities or legally constituted citizen energy communities for the development of renewable energy generation or energy storage projects.
- the right of surface for this purpose may only be granted through a public tender reserved for this type of entity.

About REC membership, according to the only official definition about RECs (article 6 from Spanish law 24/2013) partners or members can be:

- individuals;
- SMEs;
- local authorities, including municipalities.

This is further being developed as the *draft version of Royal Decree developing the figures of Renewable Energy Communities and Citizen Energy Communities,* groups or associations of individuals, SMEs or local authorities may also be partners or members of renewable energy communities, as long as they meet their basic principles on openness, democratic control etc. and whose effective and financial limits are not higher than those established for SMEs (annual turnover or total annual balance sheet does not exceed 10 million euros). This is particularly relevant for EnerCmed and its social and community building perspective.

About technical requirements for REC, there's no specific provision or limitation regarding the type and size of installations that can be owned and operated by Energy Communities, as long as they are based on renewable energy in the case of RECs.

Finally, to establish the REC on the pilot site, it is also worth mentioning the potential benefits that Energy Communities can have according to the IDAE (Diversification and energy savings institute from the Ecological Transition Ministry):

- generation of energy from renewable sources;
- providing energy efficiency services (including, for example, building renovations);
- supply, consumption, aggregation and storage of energy and potential distribution;
- provision of electric vehicle charging services or other energy services.

This is particularly relevant as IDAE establishes as a participation advantage the provision of fair and easy access to local renewable energy resources, the ability to take control over consumption, the integration of renewable energy into the system, the community opportunities and the environmental benefits. These are completely aligned with EnerCmed core objectives.

Spatial Planning

The target area is the 11th district of Valencia, namely Poblats Maritims. This is the easternmost area of the city, on the edge of the seaside. The study focuses on two of them: Natzaret and Malva-Rosa.

Figure 1. Natzaret Map

Figure 2. La Malva-Rosa Map

Both Malva-Rosa and Nazaret have conflicting backgrounds in terms of urban planning. While Nazaret suffered big changes because of the new port facilities, losing its beach and starting a process of degradation, La Malva-Rosa neighbors and grassroot organization could be able to stop some urban plans which foresaw a complete transformation of the current fisherman's type of edifications and environment.

Nonetheless, both neighborhoods and especially Malva-Rosa have been more carefully considered during the last years in terms of urban planning by decision-makers, developing special plans which foresee more green areas, new public facilities and continuous renovation and retrofitting plans for public-owned buildings. These plans are, however, still under definition, with constant modifications and pending advancements in administrative procedures. The current phase doesn't provide a clear view about the urban plan to be considered when planning the EnerCmed project implementation.

Nevertheless, the studied spots can be considered independent from the masterplan guidelines which are more focused on public space. Additionally, EnerCmed is considered well aligned with the current municipal policies on energy transition and greening of spaces being Valencia the European Green Capital 2024. This gives a positive framework to propose the EnerCmed planned infrastructure investments in municipal facilities.

The analysis considers municipal buildings present in the neighbourhoods of Nazaret and Malva-Rosa, in terms of PV potential, use, grid connectivity (medium/low voltage) and other factors.

The below-mentioned list of buildings and their different features and indicators is based on a previous technical feasibility study contracted with an expert partner in the frame of the H2020 POWER UP project. The study methodology is based on GIS and 3D modelling as well as access to real consumption data from DSOs platform, when available.

The study included working sessions and input from different municipal departments.

Building name	**Neighbourhood**	**Type/Use**	**PV Potential**	**Energy Demand**	**Grid connectivity**
Biblioteca del Mar	Nazaret	Library	130 kWp	57 MWh/year	MV
CEIP Ausiàs March	Nazaret	School	64 kWp	42 MWh/year	LV

Centro de Fauna Exótica	Nazaret	Exotic animals shelter	100 kWp	51 MWh/year	LV
Escuela Infantil Gent Menuda	Nazaret	Infant school	54 kWp	19 MWh/year	LV
CMSS Nazaret	Nazaret	Social Services Delegation	60 kWp	42 MWh/year	MV
Centro Municipal de Juventud Nazaret	Nazaret	Youth Municipal Centre	45 kWp	Unknown	MV
Polideportivo Nazaret	Nazaret	Sports Centre	781 kWp	570 MWh/year	Unknown
CMSS Malvarrosa	Malvarrosa	Social Services Delegation	60 kWp	51 MWh/year	LV
Pabellón Malvarrosa	Malvarrosa	Sports Pavilion	288 kWp	55 MWh/year	LV
CEIP Malvarrosa	Malvarrosa	School	100 kWp	26 MWh/year	LV
CEIP Ballester Fandos	Malvarrosa	School	65 kWp	Unknown	LV
Museo Blasco Ibáñez	Malvarrosa	Museum	21 kWp	37 MWh/year	LV

Table 1. List of buildings with features and indicators based on a technical feasibility study contracted with an expert partner in the frame of the H2020 POWER UP project

The site selection has considered multiple factors, not all of them from a technical approach.

The first requirement is to have a PV potential between 30 and 120 kWp. 30 kWp is considered to be the minimum size to have enough potential for launching a powerful energy community, while 120 kWp (100 kWn at inverter level) is the upper threshold considered in normative to avoid complex permitting with main authorities and a more difficult management of the plant. The same thing goes for the grid connection voltage, which must be *low voltage* to avoid extra costs of grid adaptation.

Secondly, the building must include some open space available for the integration of NBS. Additionally, to ensure maximum social impact, buildings with social/community use and well perceived by citizens must be prioritized.

All these criteria lead to select, as a first choice, Public Schools. Moreover, the social particularities of the families attending these schools must be considered. The two selected schools CEIP Ballester Fandos and CEIP Ausiàs March are within two of the most deprived areas in the target neighborhoods, with high grades of migrant and low-income families involved. In addition, both schools have a strong community movement around, with various NGOs and grassroot organizations. That could pave the ground for the establishment of energy communities with high social impact.

The recently launched solar map in the city provides very valuable information regarding the potential for installation and energy savings in these rooftops:

Figure 3. CEIP Ballester Fandos

Figure 4. CEIP Ausias March

UHI & Microclimate analysis[3]

The target area is the 11th district of Valencia, Poblats Maritims, which is the easternmost area of the city, on the edge of the seaside. More concretely the pilot action will focus on Natzaret and La Malva-Rosa, two deteriorated neighbourhoods close to the port and the sea with high levels of vulnerability and heat index. Both areas arose as maritime and fishing neighbourhoods with their own unique features and lifestyle. They are considered working-class neighborhoods. Regarding Natzaret, it was originally made up of humble houses of fishermen and port workers. On the other hand, La Malva-Rosa neighbourhood is the union between the sea and the orchard, surrounded by old ditches, which makes it a very humid area.

According to the Köppen criteria for climate classification, the city of Valencia can be considered as a mild Mediterranean climate, with a transition between Mediterranean and warm semi-arid climates. The city's greatest impact on the climate is the heat island effect. This is a multicausal phenomenon, caused among other factors, by the high heat capacity of some construction materials, the release of heat in cities (road traffic, lighting, domestic activities, air

[3] Fair Local Green Deals Report (2024): "Practical guide of actions fighting the heat - Framed in the revision of the Valencia Climate Agreement", Municipality of Valencia, Valencia Climate and Energy Foundation, Paisaje Transversal

conditioning, etc.), and the effectiveness of drainage systems. This is why summer heat waves and UHI are a huge concern.

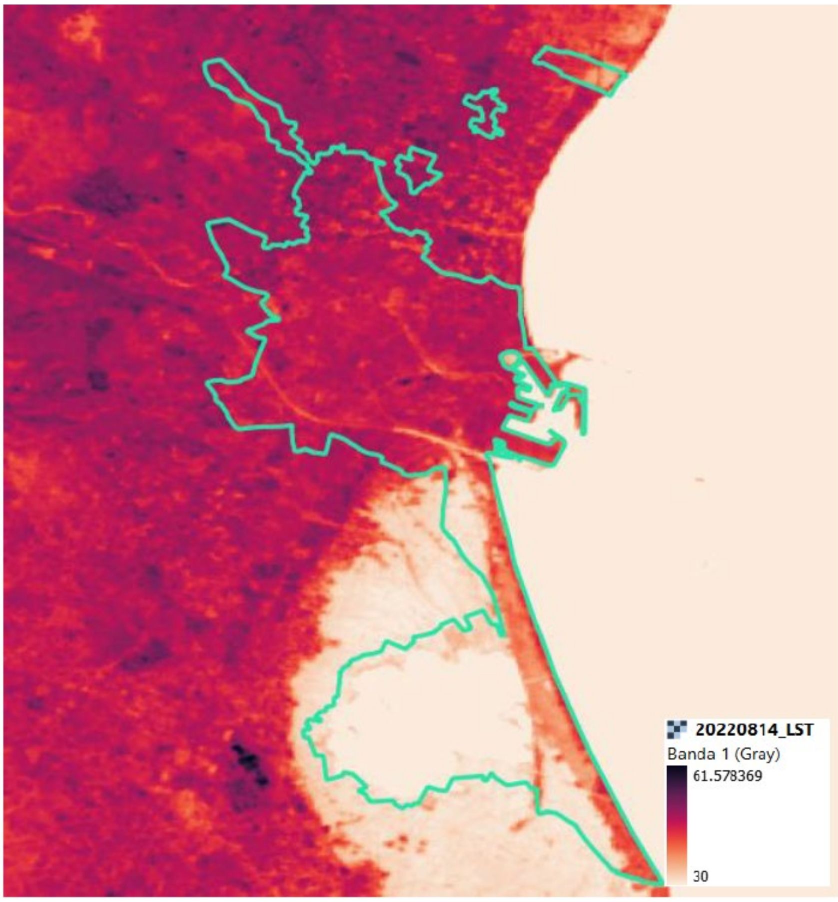

Figure 5. Surface temperature (ºC) from Landsat 9 sensor - 14/8/22

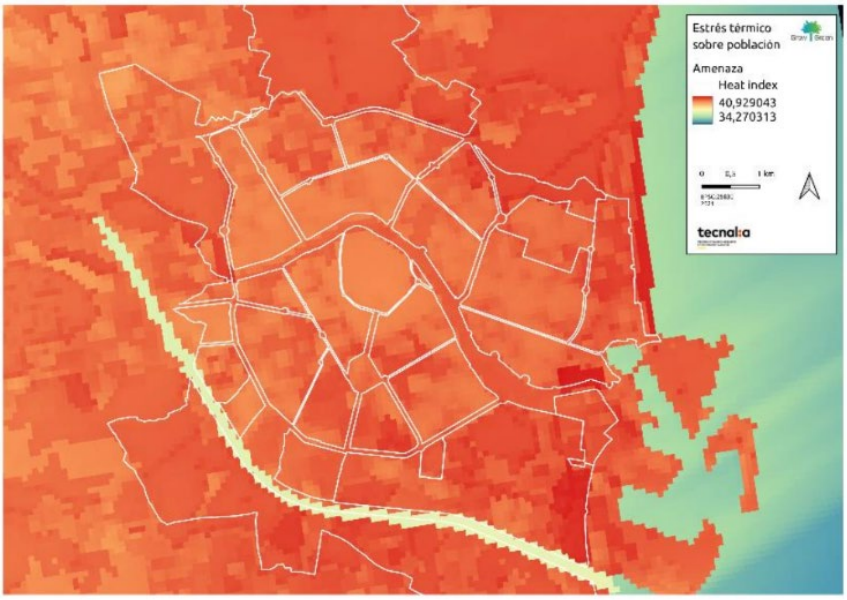

Figure 6. Thermal stress threat over population in the city of Valencia, 2022

The hot season lasts about 3 months, from June to September, and the average daily maximum temperature is more than 27°C. The warmest month of the year in Valencia is August, with an average maximum temperature of 30 °C and minimum temperature of 22 °C. The cool season lasts around 4 months, from November to March, and the average daily maximum temperature is less than 19°C. The coldest month of the year in Valencia is January, with an average minimum temperature of 6 °C and maximum of 16 °C.

However, this is slightly changing. In summer of 2022 - the record year of heat waves, high temperatures and extreme heat and droughts events - several days reached more than 35 degrees combined with high levels of humidity - sometimes more than 70% - due to the closeness to the sea.

It is also worth mentioning the progressive increase of the minimum temperatures and the consequent reduction of the range between maximum and minimum temperatures - which is particularly noticeable during night-time hours. This can lead to thermal stress, lack of sleep, anxiety, health problems and even mortality. In fact, Valencia is among the Spanish cities where heat waves have the greatest impact on mortality mainly due to high temperatures at night and sudden and unexpected rises.

Regarding Natzaret and La Malva-Rosa, both neighbourhoods benefit from the sea breeze to lower temperatures. Nevertheless, they face UHI challenges caused by:

- small percentage of tree-lines (1.5% and 3.05% compared with other areas having 9%-13%);
- limited access to green spaces;
- poor connectivity to the rest of the city (especially Natzaret);
- high presence of asphalts roads;
- empty wastelands;
- not very high buildings (shadowing impact) and single family-houses (direct sun radiation);
- poor construction materials (house cooling and insulation);
- high levels of humidity (creating discomfort, heath problems, lack of sleep, mould and damp problems and torrid nights);
- low-income population and high levels of energy poverty.

The Municipality of Valencia, through the Valencia Climate and Energy Foundation is making several efforts to address the heat waves and impacts by launching an action plan against heat and mapping all the potential climate shelters across the city. There is a need to adapt and implement different strategies against UHI adapted to urban environments in order to address the heat impacts from a comprehensive and transversal perspective. At this point, naturalization and NBS can make a big difference when it comes to coping with the heat and UHI. NBS can improve:

- biodiversity;
- air quality;
- shadowing;
- acoustic comfort and Traffic noise mitigation;
- heat copying;
- lowering of temperatures;
- social cohesion;
- physical and mental health.

Schools can play a key role in addressing UHI as they are public spaces where people, especially kids, spend most of their time. Both CEIP Ballester Fandos and Ausias March have playgrounds made of cement with little shadow and vegetation spaces – impacting children's physical and mental health. This is also an opportunity to improve citizens' resilience to extreme climate events and its consequences and foster innovation for climate change adaptation. The EnerCmed project is also a chance to introduce co-creation with local actors such as schools, students, NGOs or associations to empower them and address real necessities at neighborhood level.

Figure 7. Natzaret, trees, pools, beach and public spaces that could be climate shelters (schools, libraries, youth centres…)

Figure 8. La Malva-Rosa, trees, pools, beach and public spaces that could be climate shelters (schools, libraries, youth centres...)

Social composition & energy poverty[4]

Poblats Maritims district and the neighbourhoods of Natzaret and La Malva-Rosa have a very concrete social composition and structure. The analysis of different social, economic and cultural indexes provides a more accurate view on the neighbourhood characteristics.

Both are working class neighbourhoods with a traditional associative lifestyle and a strong social network with different entities and NGOs working together to improve the image and living conditions. This is due to the fact that both neighborhoods have a bad reputation among others in the city due to insecurity problems and drugs in the past, despite the efforts of social entities and civil associations to change this image. This has contributed to progressive

[4] Ajuntament de València (2022): "Districte 11. Poblats Marítims. Barri 5 Natzaret" Oficina d'Estadística de València (https://www.valencia.es/estadistica/inf_dtba/2022/Districte_11_Barri_5.pdf; Ajuntament de València (2023): "Districte 11. Poblats Marítims. Barri 3. La Malva-Rosa" Oficina d'Estadística de València (https://www.valencia.es/estadistica/inf_dtba/2023/Districte_11_Barri_3.pdf)

Ajuntament de València (2024): Dades estadístiques de la ciutat de València. Num 3 Juliol-Setembre 2024" Oficina d'Estadística de València
https://www.valencia.es/estadistica/pdf/Dades243.pdf

isolation or marginalization, especially in the case of Natzaret which is even physically poorly connected with the rest of the city.

This has had an impact on the cadastral value of housing in Natzaret and La Malva-Rosa. Nowadays they are among the lowest in the city (35.000 € or less). Therefore, people with lower incomes usually can only afford housing in these neighbourhoods.

Moreover, both have been slightly losing population over the years. In 2021, the population in Valencia was of 788.842 inhabitants making it the third most populated city in Spain[5]. In 2022, Natzaret had 6.088 population and a 66,4 density whilst La Malva-Rosa had 12.925 residents and 177,4 of density. The average age for Natzaret is 43, whilst 46,2 in La Malva-Rosa.

Natzaret	Total	0-14	15-29	30-44	45-59	60-79	80 +
Total	**6088**	886	1053	1221	1391	1195	342
Men	**2980**	463	534	595	739	534	115
Women	**3108**	423	519	626	652	661	227

La Malva-Rosa	Total	0-14	15-29	30-44	45-59	60-79	80 +
Total	**12925**	1481	1970	2555	2842	3271	806
Men	**6206**	758	1046	1279	1400	1454	269
Women	**6719**	723	924	1276	1442	1817	537

Table 2. Inhabitants of Natzaret and La Malva-Rosa (year 2022)

Regarding the household composition it is worth taking a look at the percentage of migrant population (outside Spain), coming to these areas: 19,3% in Natzaret and 16,4% in La Malva-Rosa. These are quite high relative numbers for the city of Valencia and it is partially explained by the strong social and supportive network operating in the area, which facilitates integration, as well as the lower price of housing compared with the rest of the city.

[5] Municipal Population Registration Office open data
https://valencia.opendatasoft.com/explore/dataset/catalogo-de-datos-abiertos/table/?flg=es-es

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Europeans and South Americans are the largest groups living in. This is explained by the facilities of EU migrants (bureaucracy and legal permissions) and the language (Spanish mainly spoken in South America).

Regarding general civil status data, according to the mentioned reports, Natzaret (2022) has 55% of single people, 35,68% married, 4,75% widowed and 4,58% divorced or separated inhabitants. Moreover, 25,8% of women do not have kids, whilst 74,2% have - among them, 21,4% have one kid, 40% two children and 38,5% three or more.

On the other hand, La Malva-Rosa (2023) has 39,4% of single people, 44,2% married, 8,5% widowed and 7,7% divorced or separated people. Regarding children, 32,88% of women living in La Malva-Rosa do not have kids, whilst 67,12% have - among them, 22,9% have one kid, 48,3% have two children and 28,8% have three or more.

This is relevant as new families are moving in and, especially in Natzaret, households have a large number of children living in.

Both neighbourhoods have high unemployment rates. In Natzaret (2022) the unemployment rate among the active population in working age amounts to a 48,84%, whilst in La Malva-Rosa (2023) is 34,61%. Not active population values are also worth mentioning, being 30,45% and 58,06% respectively.

Moreover, women rates are significantly higher for “not active” (52% and 59%) and “part-time job” (86,7% and 75,4%) categories, evidencing that in most cases they also take care of house tasks and/or family members.

Regarding the education levels, a significant difference between both neighborhoods occurs. Most of the population in Natzaret has a school graduate (or even lower) whilst a smaller percentage of people have a bachelor degree or higher education. In La Malva-Rosa, percentages are more alike between categories, bachelor or higher education being the highest percentage.

This, combined with the previous demographic analysis, provides evidence of the progressive deterioration, or even marginalization, of Natzaret and La Malva-Rosa. In addition, both neighbourhoods have two dedicated Municipal Social Services delegations, being among the most active in València.

Regarding energy poverty[6], according to the MIS (Minimum Income Standard), 23,23% of Valencian households have an income level that, once energy and housing expenses are deducted, it still remains below the highest minimum insertion income (AIEOLUZ, 2023). Moreover, according to the 2M indicator (AIEOLUZ 2023) in 2021 21,16% of Valencian

[6] AEIOLUZ Energy Consultancy and the municipal Valencia Climate and Energy Foundation (2023): “Energy Vulnerability Report in the city of Valencia and its Action Plan 2023-2030”

households allocated more than double the median percentage of annual income to purchasing energy for housing. According to the MIS indicator, 32,85% of Valencian households are in energy poverty which is a 9% increase since 2016.

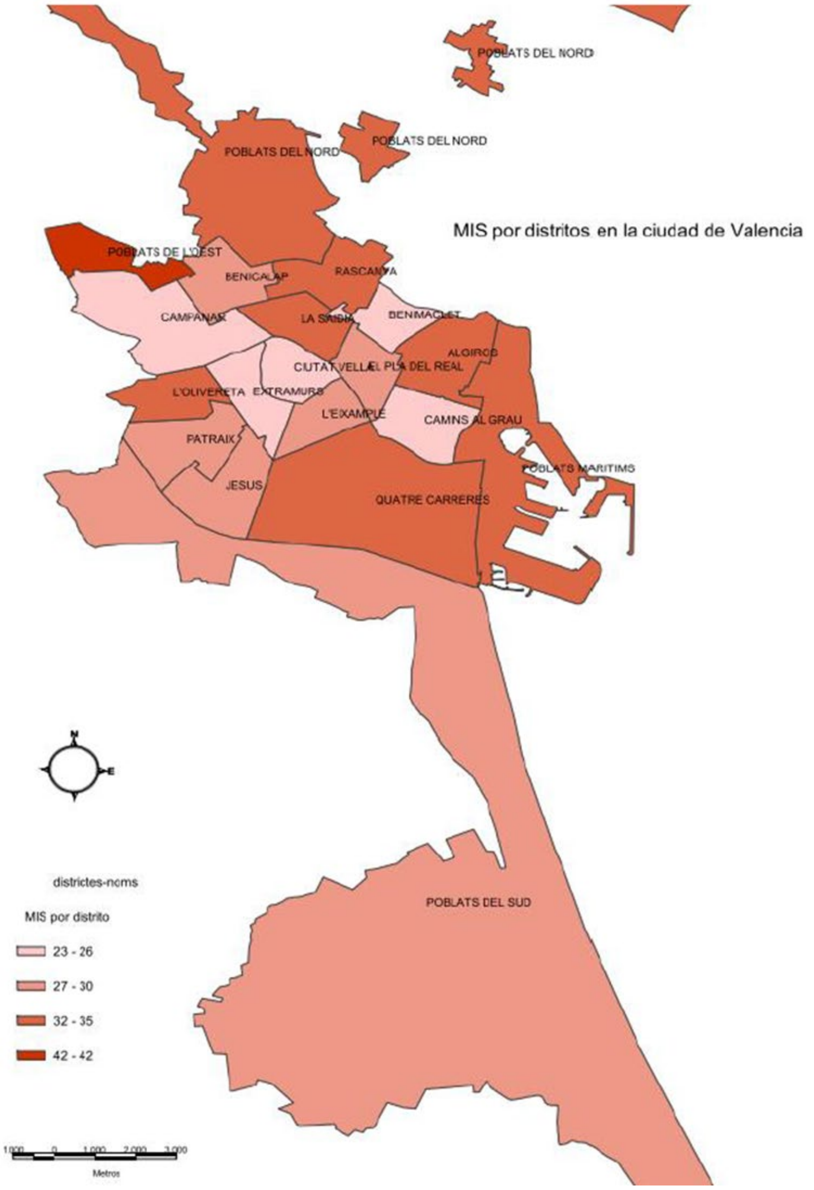

Figure 9. MIS in Valencian districts

Numbers have worsened in all districts. Poblats Marítims (district containing Natzaret and La Malva-Rosa) is one of the most affected ones. This is worsened especially due to the fact that most houses are still old, inefficient and unrenovated - facing serious problems of humidity, mould and damp, being very difficult to keep the house at an adequate temperature, both in summer and winter.

Figure 10. Natzaret and La Malva-Rosa houses

Several efforts are being made taking into consideration the rise of energy poverty across the city of Valencia:

- Municipal agreement between Social Services and Energy Offices (OSS)
- Energy Poverty Plan (currently under development)
- Municipal Energy Poverty follow up commission, with representatives from all sectors involved
- The update of municipal indicators and statistics to include energy poverty data
- Energy poverty mapping
- Conversations between València Clima i Energia Foundation and other municipal delegations, especially education, consumer and health, to raise awareness among energy poverty and establish a protocol for energy poverty detection.
- Social Bonus Discount for vulnerable consumers (state aid)
- Requiem In Power (RIP) project linking PV deployment in cemeteries and vulnerable households
- Other European projects addressing energy poverty such as WELLBASED and Power-Up, with the participation of VCE.

2.2 Thematic analysis results Croatia

Normative dashboards

The development of pilot Renewable Energy Communities (RECs) in Pula and Novigrad is significantly influenced by Croatia's national legislative framework. The regulatory legislative offers both opportunities and barriers that affect the successful implementation of REC initiatives. There are two types of energy communities: energy communities of citizens (EZG), which are defined by the Law on the Electricity Market (OG 111/2021, 83/2023, ZOTEE) and communities of renewable energy sources (ZOIE) and their kind of subset, consumers own renewable energies that work together, defined by the Law on renewable energy sources and high-efficiency cogeneration (OG 138/21, 83/2023, ZOIEiVUK). This legal recognition of RECs allows them to operate as independent legal entities, enabling them to generate, store, and share renewable energy that is produced in production units owned by it. However, out of three registered RECs in the register of the Croatian Energy Regulatory Agency, none of them are active. Although a significant step forward was made regarding the regulatory and legal framework, there are still barriers in relation to the development of RECs. For EZG it is necessary to form an association or cooperative, with elaborated statuses and other segments in accordance with the Law. It is necessary to establish a management and operational structure, which include bookkeeping, opening a business account and collecting a fee of 2,655€ for community registration in the Croatian Energy Regulatory Agency (HERA) register and additional 1000€ for operational approval. These costs pose a significant financial barrier for small communities and non-profit organizations. EZG must establish a website, business permises and other professional and technical capacities. It is particularly important to highlight the obligation that EZG has a permanent employee based on a permanent employment contract. It is not possible to ensure the profitability of the investment or provide funds for one employed person. Proving professional, technical and financial ability for small projects in which the primary shareholders/members are natural persons, small and micro entrepreneurs and representatives of the public sector is challenging and often unachievable. The Law also recognizes the need and obligation of the co-called sharing key within the energy community, but at the same time, the competent authorities do not currently have the necessary software at their disposal. Several project of energy communities are functioning with a so-called static sharing key, but it is not known how these projects will be realized in practice. The current prices of electricity, gas and thermal energy represent a barrier to the establishment of REC.

Spatial Planning

The pilot action will take place in cities Pula and Novigrad located in Istria County. Both the Monte Zaro area in Pula and the Bikokere and Marketi areas in Novigrad are categorized as mixed- use zones that permit residential, public, and social functions.

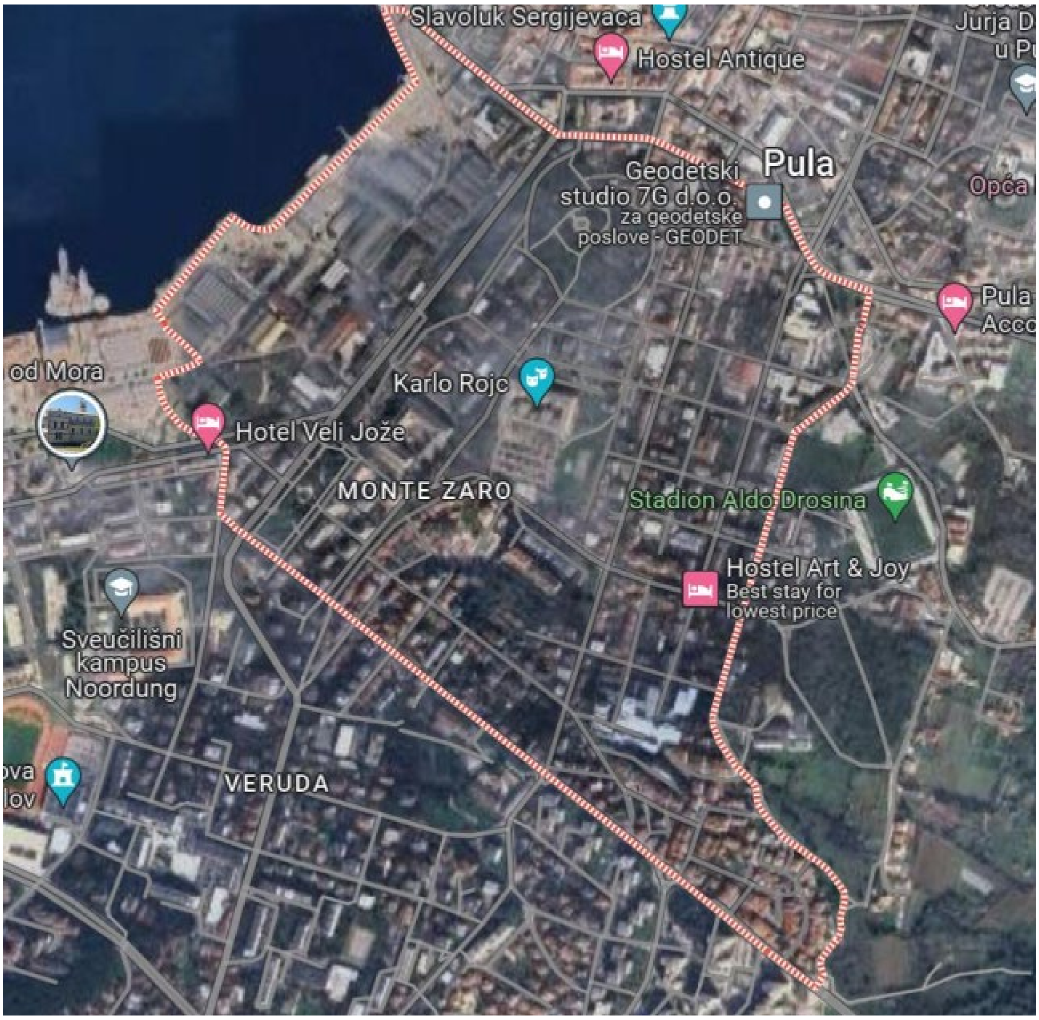

Figure 11. Neighbourhood boundaries of the city district Monte Zaro

The Urban planning framework for Pula (Monte Zaro) allows for the integration odf renewable energy infrastructure in residential and public areas. The area is classified as a mixed-use urban zone, allowing for residential, social and public service activities. The existing Children's Creative Center has undergone an energy refurbishment, which included roof replacement, improving its suitability for the installation of PV system. This makes the building a strategic site for the development of REC. The flat, south facing roof on this building provides optimal conditions for solar production. Opportunities exist to use rooftops on public housing and residential blocks within Monte Zaro, which would enable energy sharing within the REC model. The concept of shared energy production would benefit low-income and energy vulnerable households. Urban planning for public recreational areas and green spaces creates the potential for dual use public systems, such as solar canopies in public areas.

Figure 12. Children's Creative Center, Monte Zaro district, Pula; Source: www.pula.hr

A significant number of the important public infrastructure is situated in the targeted area of the city district Monte Zaro:

1. One community centers: Karlo Rojc Community Center, Down Syndrome Center, COOworking space.
2. Three schools, one faculty and one home: School of upbringing and education, Elementary school Monte Zaro, School of Economics, Faculty of Informatics, Home for Upbringing.
3. Other important national regional offices: Croatian Health Insurance Fund, Land Registry Department of the Municipal Court.
4. One park Park Monte Zaro and one sport center Patinaggio Sports Center.

Listed objects, except the Children's Creative Center are located within the protected historical complex, or have some kind of protection defined by the cities responsible department, require the roof replacement for the PV installation or ownership issues have not been resolved.

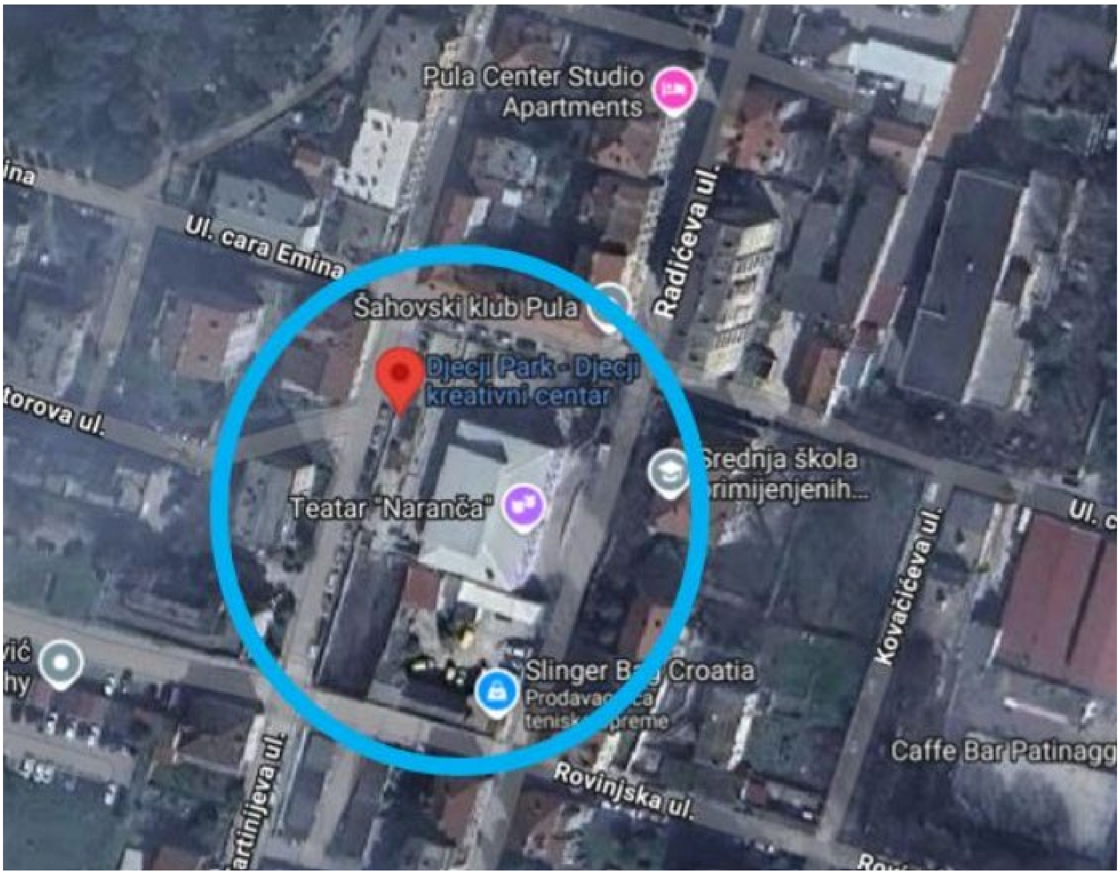

Figure 13. Children's Creative Center, Pula

The building consists of an unheated basement, and heated ground floor and first floor. The net area of the heated part of the building is 1.138,39 sqm, while the gross area of the heated part is building equal to 1.421,10 sqm. The subject non-residential building is free-standing, that is, it is not in contact with neighboring buildings. The building has a rectangular floor plan and consists of an unheated basement and a heated ground floor and first floor. Object was built in 1930. The building houses the Center for creative activities of young people with different spaces for creative activities, a library, classrooms for music, dance and the holding of various workshops, a large hall for performances and productions, and corridors, offices and sanitary areas. Energy use and purposes were also analysed. Energy in Monte Zaro is used for heating, cooling, lighting, and appliances in residential homes, with older buildings relying on inefficient systems, increasing energy costs for elderly and low-income households. Public buildings like the Children's Creative Center consume energy for heating, cooling, and lighting, with rooftop PV systems proposed to reduce grid dependency. Energent mainly used cooling is electrical energy.

As for Novigrad, planned pilot location for PV installation is home for elderly in Novigrad.

Figure 14. Home for elderly Novigrad, Source: Google maps

Novigrad, in the past recognizable as a small fishing town, is a port city, located on the west coast of Istria. It covers an area of about 26,22 sqkm and according to the 2021 census had 3.889 inhabitants.

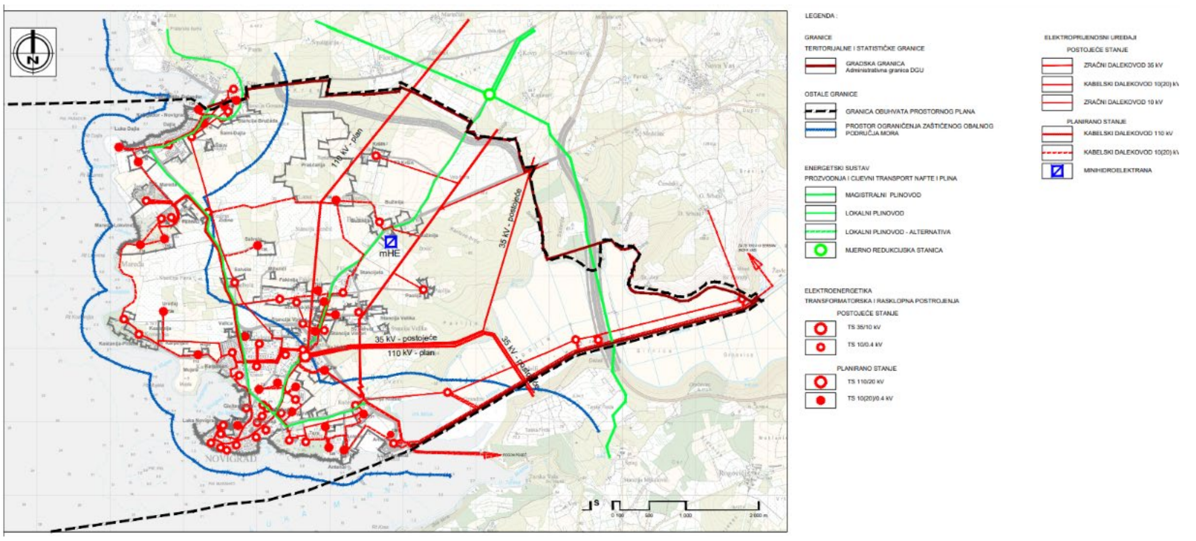

Figure 15. Energy infrastructure-Novigrad; source: Model (novigrad.hr)

The plan above shows locations of the important energy infrastructure: gas pipes (green), transformer and switching facilities (red dots), transmission lines (red) and mini hydroelectric power plant (blue square).

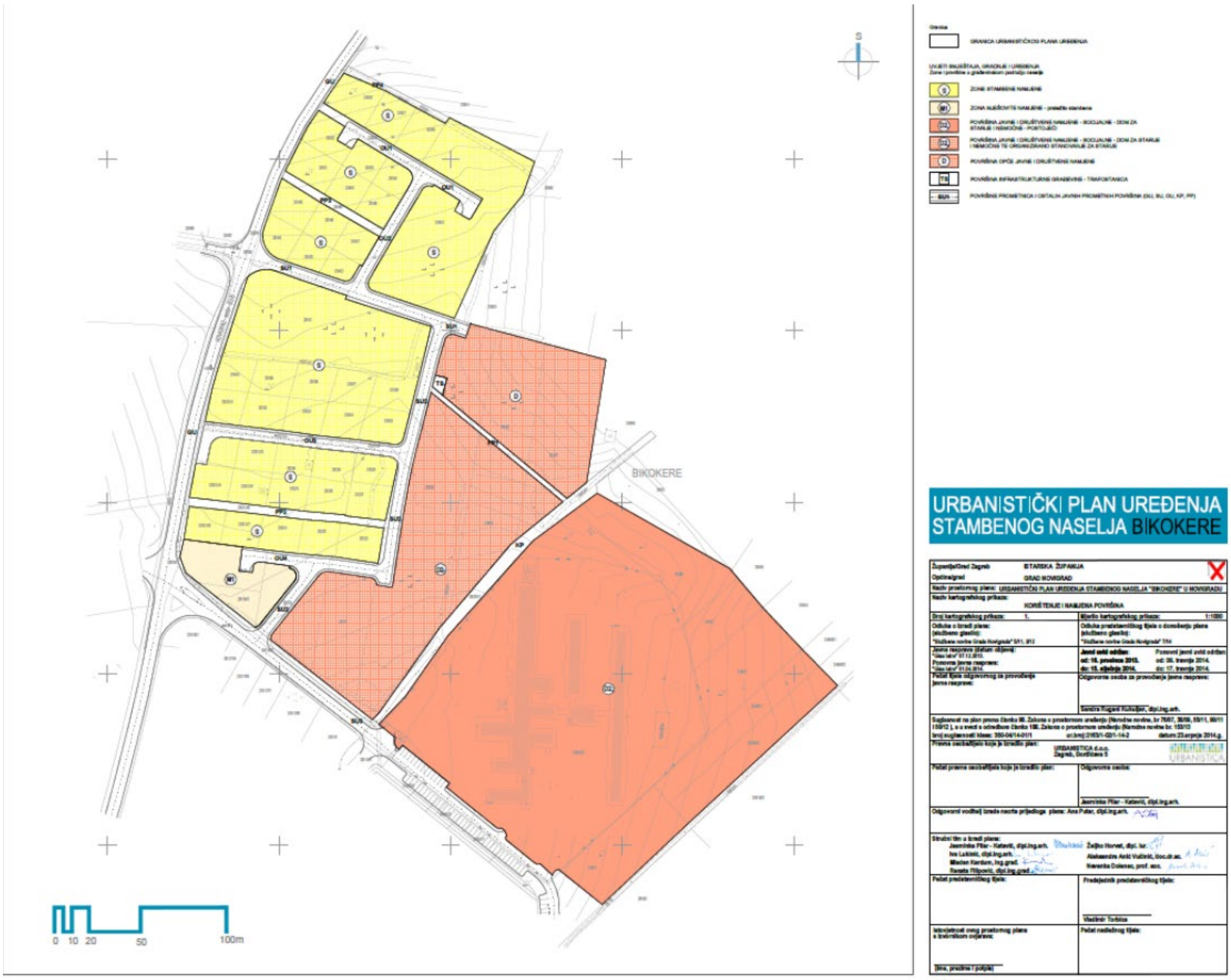

Figure 16. UPU Bikokere

Figure 17. DPU Sportska Zona Marketi

The Urban Development Plan (UPU) for Bikokere and Marketi defines both areas as multi-functional zones, which allows for the integration of renewable energy infrastructure. The zoning regulations support the construction of rooftop solar PV systems, parking solar canopies, and public charging points for electric vehicles (EVs). The neighbourhood where the PV plant will be located is not subject to specific landscape constraints in relation to this type of intervention. Therefore, no significant impacts on the urban and spatial environment are expected. Home for Elderly is located in Bikokere district, where 150 PV system installation is planned, while the planned space for NBS solutions is public area in the district, where tree planting is planned. Novigrad City recognizes the importance of NBS solutions, so the parking lot in Marketi district represents a great opportunity for PV canopies combined with NBS solutions, providing shade and energy from renewable sources. The building of the retirement home in Novigrad is a split-level building consisting of three interconnected units that stretch in the north-south direction. The roof is slanted, built mainly on two roofs that are oriented towards the west and the east. The western and central wings also have parts with more water, some parts of which are oriented to the south or north. Parts of the roof that have an east/west (equal surface area) or south orientation can be used for the installation of a photovoltaic power plant. Vegetation on the plot is relatively low. Despite some permitting, aesthetic, and rooftop space limitations, the alignment with local urban development plans and Croatia's SECAP objectives offers a clear path toward the successful implementation of RECs.

UHI & Microclimate analysis

The primary goal of the analysis is to identify UHI (Urban Heat Island) effects and micro-climate factors at the neighbourhood level. The term "urban heat island" refers to the fact that cities tend to get much warmer than their surrounding rural landscapes, particularly during the summer. This temperature difference occurs when cities' unshaded roads and buildings gain heat during the day and radiate that heat into the surrounding air. As a result, highly developed urban areas can experience mid-afternoon temperatures that are 8°C to 12°C warmer than surrounding, vegetated areas. High population density and energy use, along with closely built structures that restrict airflow, further intensify heat.

Pula

The City of Pula is located in the southern part of the Istrian peninsula in Croatia, bordered by the Adriatic Sea. Monte Zaro, urbanized and high-density area experiences significant UHI effects due to its narrow streets, high density buildings and limited green spaces. This configuration restricts airflow and causes heat retention, especially during the summer. The area has a population density of 10.818 inhabitants per square kilometre, further supporting UHI effect due to dense human activity and heat generation. Temperature records indicate that, on average, summer temperatures in Pula are 2-3 °C higher in urbanized areas like Monte Zaro compared to surrounding rural zones. During heatwaves, this difference increases, placing children, elderly residents, and low-income groups at greater risk of heat-related illnesses.

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Figure 18. Daytime and nighttime SUHI comparison for the summer of 2020; source: https://yceo.yale.edu/research/global-surface-uhi-explorer

Figure above shows how Monte Zaro is a part of the port area that is exposed to the UHI effect. Most surfaces in the area are made of asphalt and concrete, which retain and accumulate heat during the day, which contribute to the urban heat island effect, especially during summer months.

The Pula City stakeholders recognize this problem, so some UHI mitigation methods already exist around the city. Pilot activity consists of implementing NBS solutions such as greening the canopies of bus stations. As shown in the figure below, Pula City has a lot of green areas, but there aren't many in the Monte Zaro district or in the port area overall.

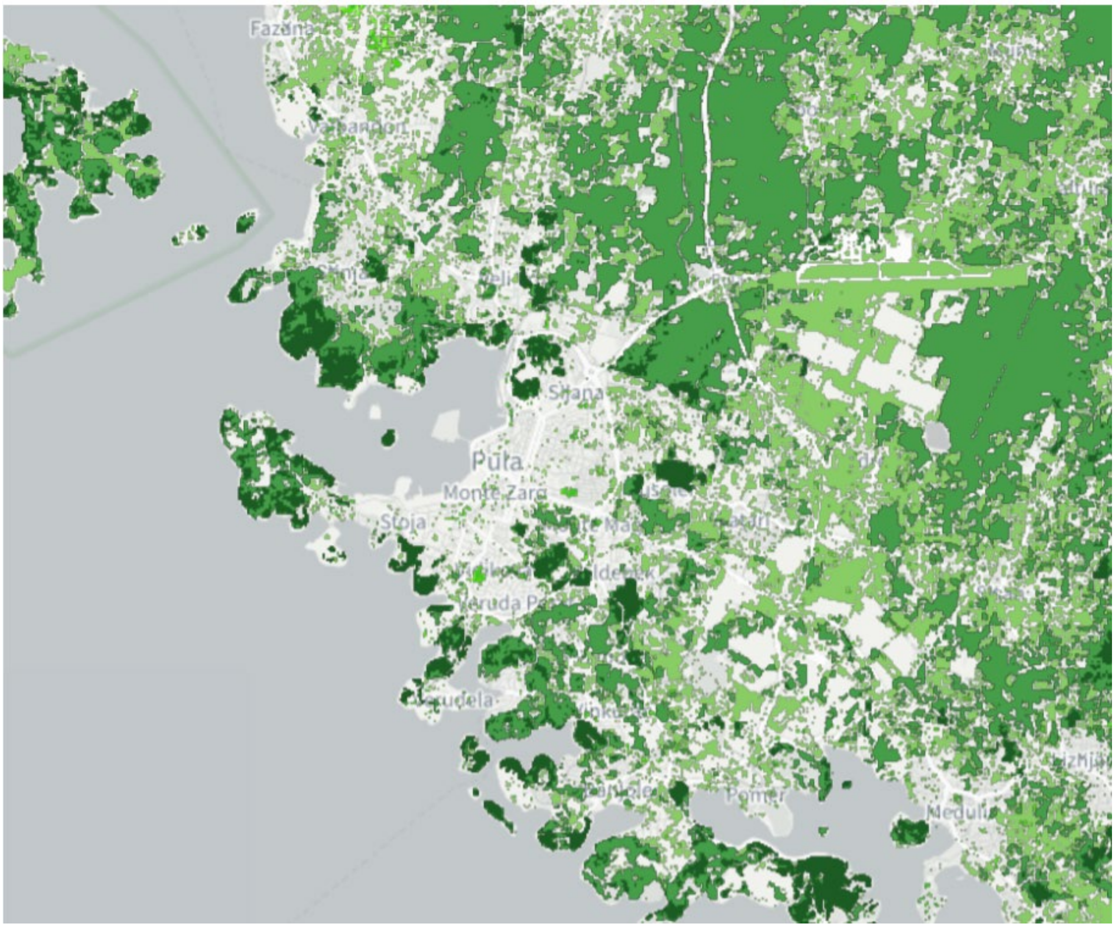


Figure 19. Distribution of green spaces, including parks, gardens and street trees; source: CLMS

The City of Pula has great potentials for establishing a permanent network of green infrastructure. The great potential of green infrastructure lies in the connection of existing green area, and the significant potential for the development of green infrastructure should be highlighted construction of green (pre)gardens, roofs and facades in buildings. Implementing Nature-Based Solutions (NBS) such as green roofs and green walls on buildings and public infrastructure could effectively help in lowering urban temperatures. Types of green roofs are extensive and intensive green roofs. Extensive green roofs tend to be simpler, with hardy plants and a growing medium depth of two to four inches, they need a little maintenance, and require the least amount of added structural support since they are lightweight, while intensive green roofs tend to be more complex, with conventional gardens or parks. Implementing green roofs on Pula city bus stations would significantly mitigate the UHI effect by lowering surface temperatures. Green roofs have many advantages over ordinary roofs, they act as thermal insulation, reducing heat and cooling costs by around 20%. They also filter the air and create a better microclimate. Pula already has some NBS solutions implemented, like rainwater gardens on roundabouts (1) and green oasis (1) around the city, but more actions need to take place to successfully mitigate the UHI effect.

Novigrad

The environmental characterization of Novigrad city is presented showing the factors that influence the recurrence of the UHI effect, such as the distribution of rural and urban areas, presence of bodies of water and green areas, as well as the demographic picture of the city.

Novigrad is located on a small peninsula on the western coast of Istria and has retained its medieval structure and layout, with narrow, winding streets and small shops. Bikokere district is suitable for PV implementation, because it is a public building, with big roof capacity. The area around the home for elderly has a lot of green spaces, however, UHI effect is still present during the summer, putting elderly people at risk.

The bigger heat island concern is the parking lot in Marketi sports zone which lacks with green areas and shade, located just a few meters away from the Home for elderly.

Most surfaces in the area are made of concrete and asphalt which retain and accumulate heat during the day. These surfaces cool down during the night, which further retain heat in the urban area. To address these issues, the city of Novigrad and Istria County decided to take certain actions to mitigate the UHI effect and implement more NBS solutions. Novigrad has a population of around 3.889 residents, with an average 531,4 inhabitants per square kilometre. Building density is high in port area, which creates an impervious layer which can lower air flow and support heat accumulation, especially during the summer, creating heat pockets.

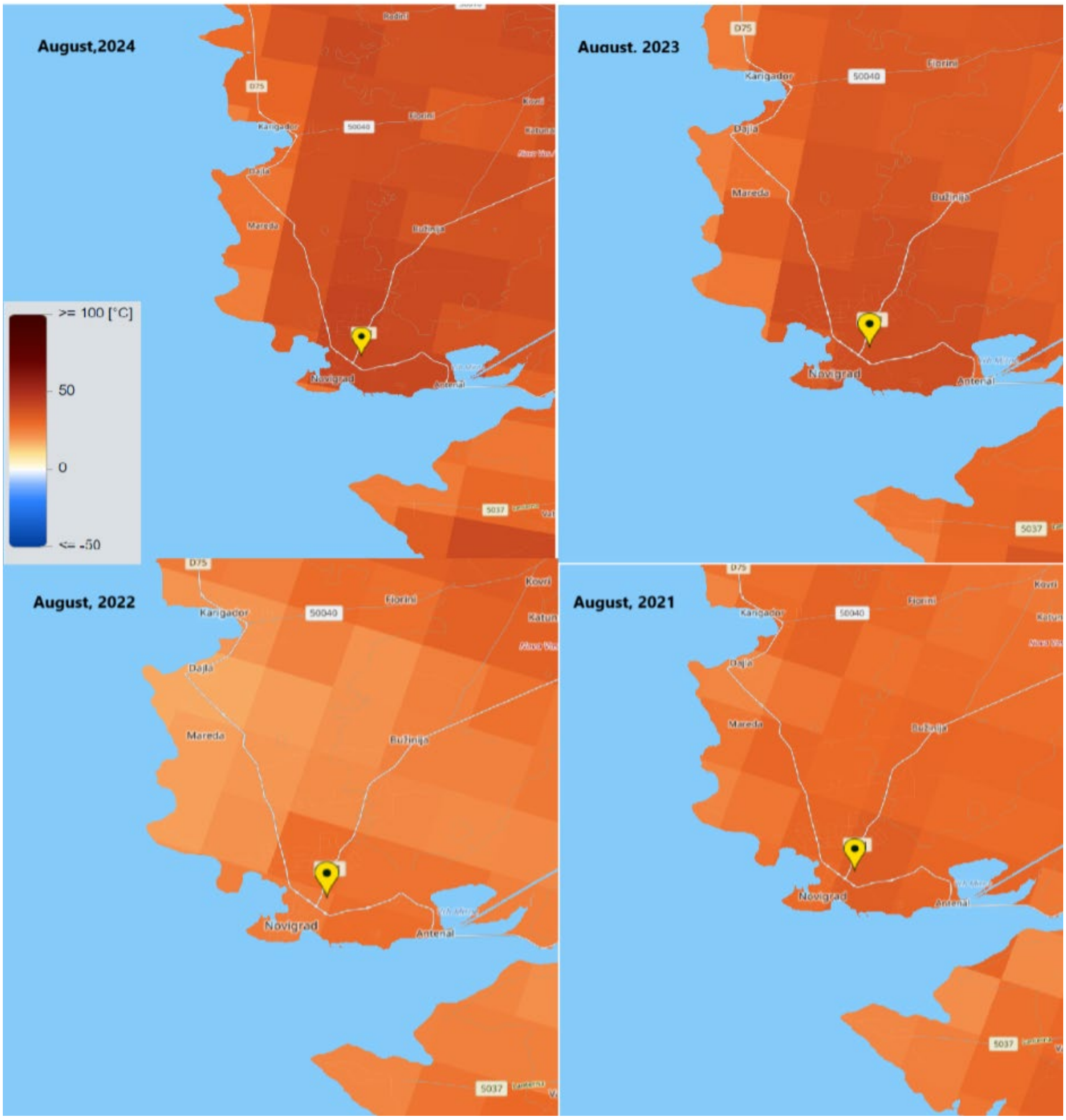


Figure 20. Thermal IR fire emission bands, by S-3 (F2 Channel) showing daily temperature of different August days from 2021 to 2024

As shown on Figure 10, summers will be warmer and warmer, which means that UHI effect will be more and more visible and extreme in the near future if some actions are taken. It is also shown how Bikokere and Marketi districts are located in the area that shows higher temperatures than the rural areas surrounding it. One way of mitigating the UHI effect is implementing NBS solutions such as planting trees, green roofs or green facades.

The city of Novigrad doesn't have many NBS solution, however the city stakeholders and urban stakeholders recognize the need to mitigate climate change and heat island effects. Bikokere district is a part of Novigrad and has tree alleys, grassy areas, and various vegetation, especially in Monte Zaro Park area. Novigrad city utility company Neapolis d.o.o has started creating a register of green infrastructure. Currently in the making is the Green Plan for the city of Novigrad and Green Renewal Strategy.

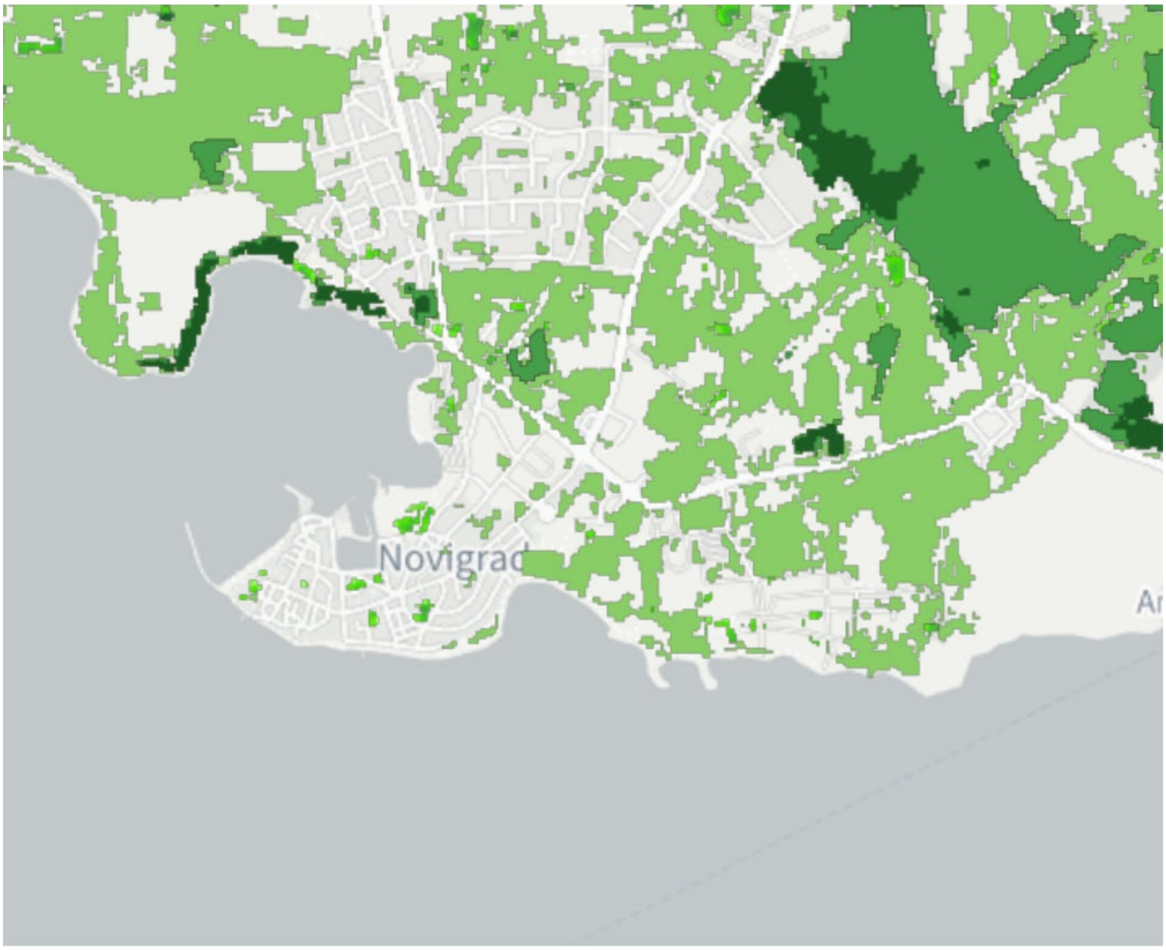


Figure 21. Distribution of green spaces, including parks, gardens and street trees

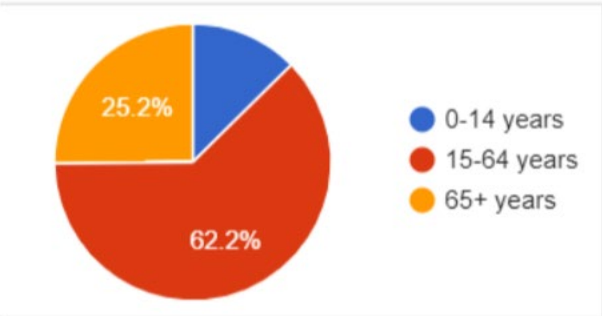
Green space distribution is shown in the Figure above, showing how Novigrad has a lot of green areas, however there aren't many in the port area. Marketi sports zone has a parking lot with 277 parking spots and electric vehicle charger. The parking lot is owned by the city and it presents a great potential area for installation of PV canopies, combined with green canopies for parking spaces.

Social composition & energy poverty

An in-depth analysis was conducted on the social and economic context of Pula and Novigrad, especially targeted pilot areas. From a demographic point of view, the population size and density, the age distribution and household and family composition were considered.

Pula

As of the 2021 census, Pula had a population of approximately 52.411 residents. The overall density for Pula is around 1.000 inhabitants per square kilometre (sqkm). However, this can vary within different parts of the city, with central urban areas being more densely populated than the outskirts. Monte Zaro is part of the central urban zone of Pula, which generally has a higher population density compared to suburban areas Monte Zaro covers an area of 323.720 sqm, with a population of 3.502 residents. The population density is 10.818,0 inhabitants per square kilometre. The age distribution in Pula, like in most cities, is divided into key demographic groups: children, working-age adults, and the elderly. According to the latest census data (2021), Pula's population reflects trends seen in much of Croatia, with an aging population and a declining birth rate.



Age Groups (C 2021)	
0-14 years	6,580
15-64 years	32,502
65+ years	13,138

Figure 22. Demographics of Pula

The city of Pula has a diverse range of household structures, with statistics reflective of both urban and aging population trends common in Croatia. The most recent census data (2021) and other sources provide some insights into average household size - the average household size in Pula is around 2,3 to 2,5 persons per household. This is slightly below the national average in Croatia, which has also been declining due to lower birth rates and the aging population. Many households consist of fewer individuals, reflecting a trend of smaller family units and an increase in single-person households. In Pula, as in the rest of Croatia, single-parent households make up a significant portion of family structures. Although specific numbers for Pula are not always directly available, it is estimated that around 10-15% of households are led by single parents, typically mothers.

The average monthly salary in Croatia as of 2023 is around €1,100 (gross), with regional differences. Istria, being a coastal and tourism-driven region, has slightly higher average incomes due to seasonal tourism jobs, compared to inland areas. However, Pula has a mix of industries, including tourism, shipbuilding (historically), and services, which causes variability in incomes. While Pula has a relatively low unemployment rate compared to the national average, some workers are engaged in seasonal or part-time jobs, particularly in tourism. These workers are more vulnerable to income fluctuations and lower wages, especially in the off-season when tourism jobs are scarce.

Like many cities, income distribution in Pula follows a pattern where a small percentage of households earn significantly more, while a larger proportion earns below the national average. The wealth gap in Croatia has been slowly increasing, with certain groups, particularly the elderly and those in rural areas, facing higher risks of poverty. The pilot location is planned in the Monte Zaro district, and is planned to be focused on the group most exposed to energy poverty risk, social benefit users and single persons that are beneficiaries of the guaranteed minimum fee. Minimum fee beneficiaries are receiving compensation of 53€ per month, which is insufficient to cover their monthly living expenses. Because that, the category is on the very edge of poverty. Users are located in condominiums scattered throughout the city, mainly situated in detected neighbourhood of Monte Zaro. In the city area it is estimated that there is a total of at least 200 such users. Neighbourhood is characterized by the deterioration of buildings, narrow streets, traffic jams, which are mostly the characteristics of smaller Mediterranean towns that, after the decline of a certain economic branch, turn to tourism, which is in Pula's case the declination of shipyard Uljanik.

The educational attainment of the population in Pula reflects the city's demographic structure and economic development. Overview based on the current situation in Pula is presented in the table below.

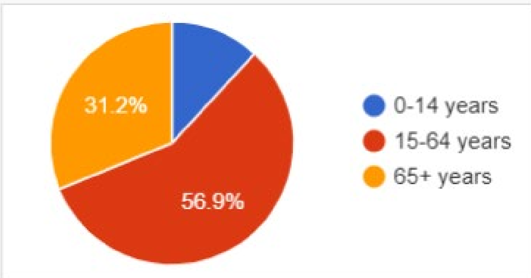
No schooling	161
1-3 grades of basic education	74
4-7 grades of basic education	449
Basic education	5.702
Secondary education	26.193
Professional study	4.796
University study	8.054
Doctorate of science	192
Unknown	19

Table 3. Education structure in Pula

The types of housing available in Pula vary but consists of apartments which are mostly located in the city centre, detached houses, semi-detached houses, public housing and modern apartments appealing to younger residents and tourists. Pula has a well-developed electrical grid, providing reliable access to electricity for residential, commercial, and industrial users. The electrical infrastructure is maintained by Hrvatska Elektroprivreda (HEP), the national electricity provider. City of Pula does not have an extensive district heating system, however, some areas may have access to localized heating solutions but most residential buildings rely on individual heating systems. While there are challenges related to energy efficiency in older buildings, ongoing initiatives and a growing emphasis on renewable energy opportunities for improvement. The city's future energy strategies will likely focus on enhancing energy efficiency, increasing the use of renewables and ensuring that all residents have access to affordable energy. The proportion of household income spent on energy varies significantly across different income groups. On average, energy costs constitute about 5% to 10% of gross income for most households, with lower-income households facing a disproportionately higher burden. The average cost of electricity in Croatia is about 0,13 € to 0,15 € per kWh, as energy prices fluctuate, continued attention to energy affordability and support programs will be crucial in ensuring that all households can manage their energy expenses effectively, which is the same for both Pula and Novigrad.

<u>Novigrad</u>

The city of Novigrad-Cittanova is located on the western coast of Istria, Croatia, along the Adriatic Sea. It is a small coastal town known for its medieval architecture, historic charm and tourism. Selected pilot location for PV installation is Bikokere district, spacifically Home for Elderly building. According to the 2021 census, Novigrad had a population of around 3.889 residents, counting the people living in surrounding buildings. Novigrad's population density is lower, with an average of 188 inhabitants per square kilometer (km^2). Given Novigrad's smaller size and rural surroundings, the density is notably less compared to larger cities like Pula. The city of Novigrad, like much of Istria and Croatia, exhibits household structures that reflect broader demographic trends, including smaller households, an aging population, and shifts in family dynamics. While specific data for Novigrad may not always be publicly available, estimates can be made based on regional and national trends. The average household size in Novigrad is estimated to be around 2,3 to 2,5 persons per household, similar to the national and regional averages. This relatively small household size reflects the aging population, a low birth rate, and an increase in single-person and elderly households.



Age Groups (C 2021)	
0-14 years	272
15-64 years	1,305
65+ years	715

Figure 23. Demographics of Novigrad

Single-parent households are present in Novigrad, though in smaller numbers due to the town's size. While specific data for Novigrad is not readily available, across Croatia, about 10-15% of households are headed by single parents, most often mothers. Novigrad likely follows this national trend, with single-parent households forming a notable but minority portion of family structures. The income distribution and identification of low-income households in Novigrad, like much of the Istrian region, are influenced by the town’s economic structure, which relies heavily on tourism, agriculture, and small-scale industry. Novigrad is a smaller city, and its local economy reflects seasonal employment patterns and a mix of income levels typical of smaller coastal towns. Novigrad, like many Istrian towns, experiences significant income fluctuations due to its dependency on tourism, which peaks during the summer months. Many workers may face underemployment or job insecurity during the off-season, leading to irregular income and increased financial pressure on families during the winter. While some individuals working in skilled positions or tourism management earn higher wages, many workers in hospitality, retail, and seasonal jobs typically earn less. A significant portion of Novigrad's population is elderly and retirees often live on low pensions insufficient to meet living costs, especially for those who previously worked in low-wage sectors. The pilot location for Novigrad was selected as solution to a problem of constantly raising prices in the homes for elderly people that are faced with low-income status. Usually, this kind of users are situated in the public homes for elderly people. In the Region of Istria it is estimated that there are 513 current users of such accommodation. It is well aware that the needs are much higher, given that the population of the county has entered in a deep aging process and a significant share of that population cannot cover basic living costs with their pension income. Waiting lists for such accommodation in some cities reach up event to 10 years. According to the Population census from 2011, in the Region of Istria the share of the population over 60 years old makes 24% of the total population. Accommodation of that type is available in 4 cities across the Region. Novigrad is one of those locations under the direct jurisdiction of the Region. Income status of the targeted group is additionally threatened due to electricity prices increase. Namely, the increase in electricity prices affects the increase in the prices of their accommodation.

Regarding the educational attainment of the population reflects the town's size, economy, and regional characteristics. Novigrad has a mix of education levels, presented in the table below.

No schooling	14
1-3 grades of basic education	24
4-7 grades of basic education	98
Basic education	588
Secondary education	1.882
Professional study	318
University study	446
Doctorate of science	11
Unknown	5

Table 4. Education structure in Novigrad

In Pula and Novigrad, the most vulnerable groups facing energy poverty include elderly residents, single-parent households, low-income families, unemployed individuals, people with disabilities, and those with lower educational attainment.

2.3 Thematic analysis results Italy

Normative dashboards

The CACER Decree and the Operational Rules define a set of promotional measures for CACER in the form of valorisation of self-consumed energy and National Recovery and Resilience Plan (PNRR) funds. The CACER Decree in art. 6 "Cumulation of the incentives", paragraph 1, and the Operational Rules, point 1.2.1.6 "Cumulation of the incentive tariff", specify that the incentives can be cumulated with CAPEX to the maximum extent of 40% of the eligible investment costs (design, purchase of equipment and construction costs). In the occurrence of CAPEX contribution exceeding 40% the premium rate to the self-consumed energy will not be recognized. Being the incentive tariff the only economic benefit for a consumer in a CACER, the lack of it makes the energy community unattractive for the potential participants and unable to mitigate their potential energy poverty.
However, CACER definition includes and promotes different self-consumption configurations, in particular remote ISC is described as self-consumption by a sole end customer (in this case the Municipality of Genoa) utilizing the existing distribution network to connect production and consumption sites within the area of the same primary substation (art. 2, paragraph e).
Also, this kind of self-consumption configuration will not be eligible for incentivised valorisation of self-consumed energy, but, creating an ISC configuration, will allow maximising benefits for public building, and therefore freeing resources for social use and providing increased flexibility to the local distribution grid.

Spatial Planning

The pilot action will take place in the Cornigliano urban planning unit, within the Municipality of Medio Ponente (Municipio VI) in the western part of Genoa. Cornigliano, originally a rural settlement in the XII-XIII centuries and later a leisure destination for Genoese aristocracy in the XVII and XVIII centuries, was known for its villas, which remain an important historical heritage. In the 19th century, as infrastructure expanded and industrialization progressed, Cornigliano became a key site for manufacturing, particularly in textiles. By the 20th century, it grew into an urban area and officially became part of Genoa in 1926.

The industrial transformation, marked by the development of heavy industry (steel plants) and land reclamation along the seafront, severed the area's connection to the sea and deteriorated its urban quality. Despite valuable built heritage, such as the villas and new residential blocks, the neighbourhood became a working-class area with poor living conditions. Cornigliano's urban fabric developed in a narrow space between industrial zones and steep hills, and it suffered from the industrial crisis, leading to the closure of most factories.

Since 2003, Cornigliano has been part of a redevelopment plan to repurpose abandoned industrial areas, managed by Società Per Cornigliano S.p.A. The goal is to improve the neighbourhood's quality of life, though the process is still ongoing. Recent interventions include the redevelopment of Via Cornigliano, the neighbourhood's main commercial street, and the creation of a new urban linear park, which will offer spaces for walking and cycling near the railway.

Public services, especially schools, a library and municipal centre located along Via Cornigliano, play a crucial role in this context. In a neighbourhood lacking green spaces and gathering areas, these services serve as important community hubs that significantly enhance residents' quality of life. The Istituto Comprensivo Cornigliano, an educational institution comprising a kindergarten, three primary schools, and a secondary school, serves around 1,000 students.

The two schools targeted by the pilot are classified in the Urban Planning Plan (PUC) as follows:

- "Volta" Secondary School in Via Cornigliano 9 (Shown in Figure 1) is classified as SIS-S "Territorial and neighborhood public services." It is located in the first part of Via Cornigliano, near the river, but separated from the street by a basement. It is surrounded by residential buildings with no particular architectural value.
- "Ferrero" Primary School in Via Cervetto 42 (Shown in Figure 2) is classified as SIS-S "Territorial and neighborhood public services of historical and landscape value." The school is located near the historic Villa Serra and its park. In these areas, according to the urban plan, interventions must preserve and enhance the historical, architectural, and environmental features. If buildings have been altered, historical elements must be restored. Specific guidelines for photovoltaic panels apply only to pitched roofs, which does not apply to Ferrero school.

Figure 24. "Volta" Secondary School

Figure 25. "Ferrero" Primary School

The choice fell on these two schools because they present excellent conditions for the installation of photovoltaic systems: they offer large roofs, with an area of 440 sqm for Volta and 770 sqm for Ferrero, have an excellent exposure without shading and are in good condition.

Moreover, the buildings are fed from the same Primary Substation, thus they can be included in the so-called "Remote Individual Self-Consumption" Configuration (ISC).

UHI & Microclimate analysis

Genoa, home to over 560,000 residents, is Ligurias's largest coastal city, shaped by extensive human activity altering its landforms. Nestled between sea and hills, it features diverse microclimates. Cornigliano, a pilot area, faces urban, social, and environmental challenges, exacerbated by demographic and economic dynamics. Cornigliano and nearby Sampierdarena in fact, are heavily influenced by transportation infrastructure, including the A7 motorway, Lungomare Canepa, Guido Rossa Road, and the railway connection Terzo Valico dei Giovi. Elevated infrastructure acts as physical and visual barriers, further disconnecting the area. Industrial and logistical facilities, such as the public transport company vehicle depots and warehouses, disrupt the urban fabric and diminish accessibility to environmental assets like the sea, river, and hills.
Such factors affect a population with several potential vulnerabilities; in fact, the population density 55% higher than the city average, with numerous condominiums and houses

concentrated in a relatively small area, and is characterized by a high number of residents of foreign origin.
Cornigliano's population includes 23.7% elderly and 16.8% youth under 20. Despite Genoa's relatively high average income, Cornigliano and Sampierdarena have the city's lowest income levels, reflecting post-industrial challenges. Unemployment, particularly among less qualified individuals, remains a major issue.
Considering these factors, Cornigliano is therefore one of the districts of the city of Genoa with more groups sensitive to difficult climatic conditions. In addition, the urbanized areas of the Municipality of Genoa develop exclusively along the coast and in the valley bottoms, where most of the territory is urbanized and occupied by buildings and where the majority of the people live. These areas, according to the results of a study on Urban Heat Island (UHI) effect in the city of Genoa[7], are also the most affected by UHI phenomenon, as shown in Figure 26.

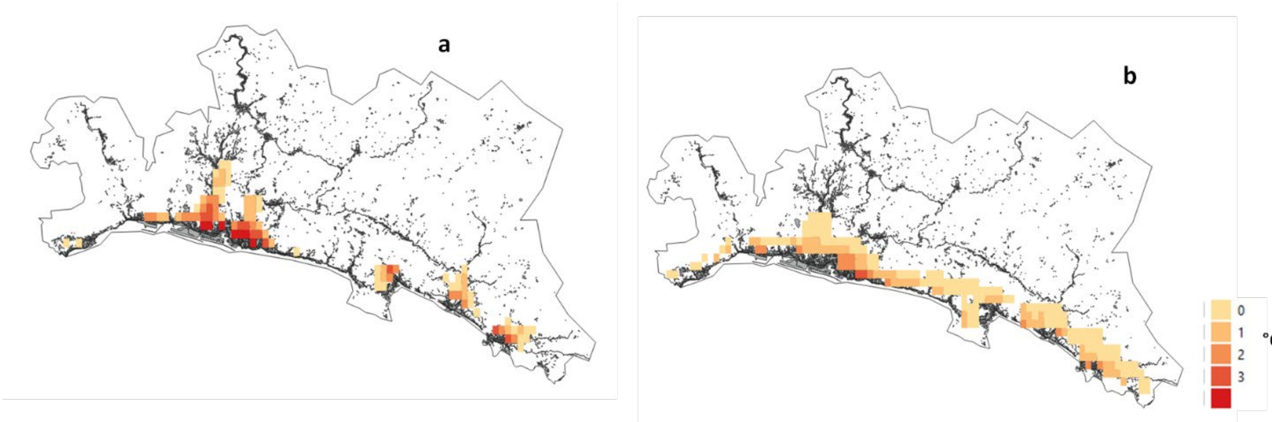


Figure 26. UHI daily (a) and nightly (b) average for summer 2020 in metropolitan area

To address these issues, agreements between the Municipality, the Port Authority, and private operators aim to redevelop abandoned industrial areas, reorganize road systems, and restore liveable spaces for residents.
In this context Cornigliano neighbourhood has been chosen for the development of the Pilot activity, with which an ISC will be developed in conjunction with the implementation of Nature Based Solutions (NBS), which aims to mitigate the effects of the UHI effect.

In the past years, the Municipality of Genoa has produced a wide and ambitious Action Plan (Genoa 2050 – Action Plan for a Lighthouse City) which identifies the main drivers and actions to foster a sustainable urban development of the city and to improve locally tailored mitigation and adaptation strategies. More specifically, in the past year, the new Green Plan of the city is under development. It has the objective to work on multiple dimensions of the city to positively affect the quality of living and the health of both people and natural environment. To do so, indeed, the plan not only considers the development and re-development of green spaces but

[7] https://link.springer.com/book/10.1007/978-3-030-86611-2

also, more broadly, public spaces, as well as water and soil management, are part of the plan. To protect the most sensitive groups, indeed, such a Plan must work not only on the large-scale green areas (that characterize mostly the peri-urban areas, due to the morphology of the city), but on small scale project and public spaces scattered throughout the urban fabric, especially in the mostly densely populated and more fragile neighbourhoods. Nature-based solutions also play a fundamental role in the Green Plan, as they are identified as one of the main drivers that will support, in the coming years, the green development of the city. On the one hand, therefore, the Municipality is strongly collaborating with the University of Genoa especially regarding NBS related to the water management and flooding prevention which constitute a very critical problem for the city. With Urca project (just concluded last year) as well as Green Storm Project (just started in 2024), both involving the Municipality as a partner, the University of Genoa is producing a fundamental risk analysis and related design of possible solutions based on water related NBS. On the other hand, as far as concerns UHI, the Municipality is currently involved in the Interreg ReMED project (started in 2024), which will specifically produce and test tools that will provide an accurate analysis of UHI at a neighbourhood scale, to raise the capacity of public authorities in developing, implementing and monitoring adaptation measures at building and urban scale. The project specifically combines the analysis of UHI with the presence of fragile populations in a certain area, to tackle the most vulnerable parts of the city. Within the wider strategic framework of the Green Plan, these specific tools and approaches will allow the Municipality to develop more effective climate-related interventions.

Social composition & energy poverty

An in-depth analysis was conducted on the social and economic context of the city of Genoa and in particular of the Cornigliano area.

From a demographic point of view, the population size and density, the age distribution and the household composition were considered.

The population of Genoa is 564.657 inhabitants (year 2023), with a density of 2.350 inhabitants per square kilometer, varying across different areas. Cornigliano, with 13.800 residents, has a higher density of 3.660 inhabitants per square kilometer, 55% above the city average.

The city’s population is aging, with 27,6% over 65 years old, while 15% are under 20, as shown in Figure 27 Cornigliano reflects this trend with 23,7% of its population over 65, but also has a significant proportion of young people, 16.8% under 20.

The average family size in Genoa is 1,91 members, while in Cornigliano the value is slightly higher at 2,06. In Genoa, 48,2% of households consist of one person, in Cornigliano, the value is 44,6%, as shown in Figure 28.

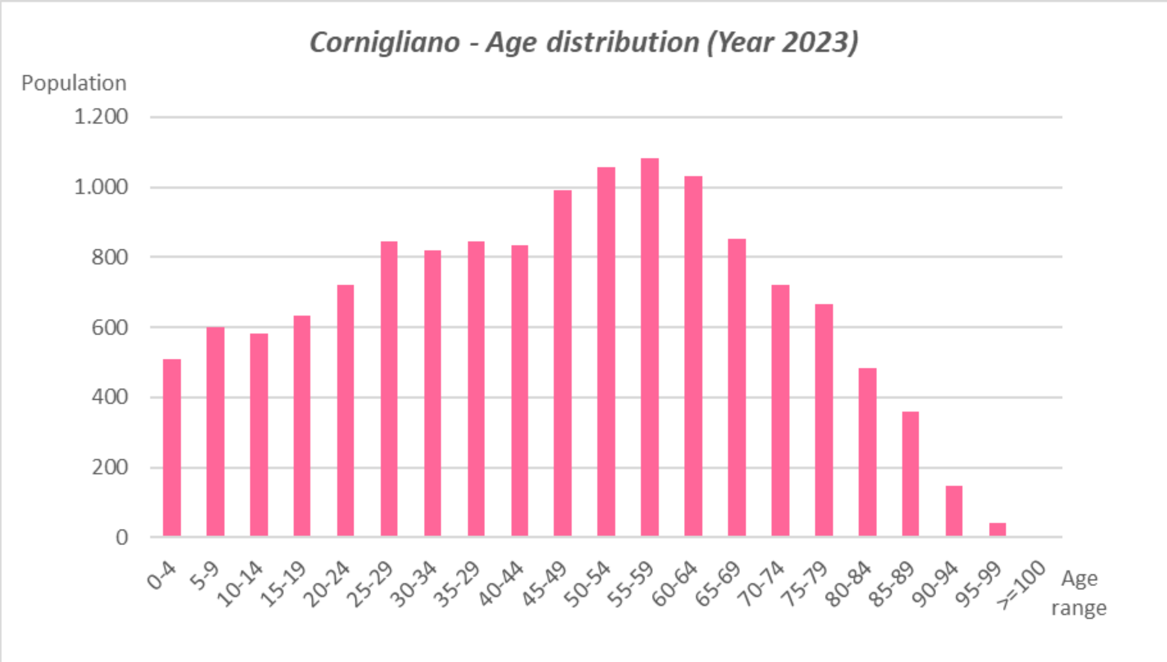


Figure 27. Age distribution of population in Cornigliano (year 2023)

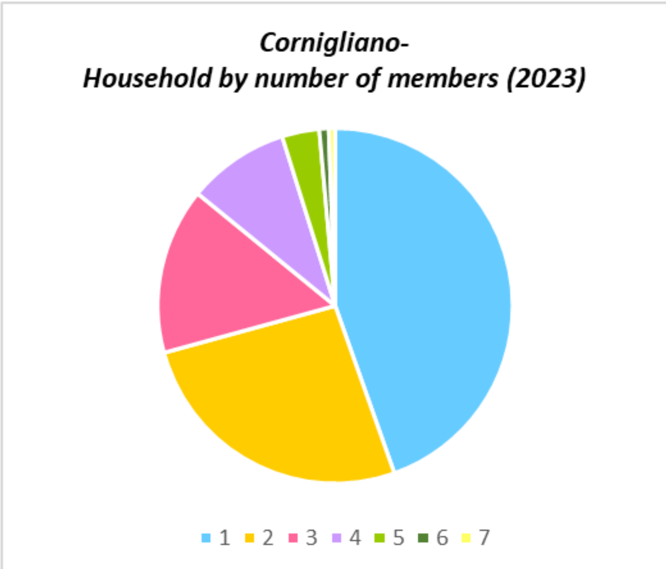


Figure 28. Resident families by number of members in Cornigliano (year 2023)

From a socio-economic point of view, the indicators relating to the income levels, the employment status, and educational levels were investigated.

In Genoa, around 25% of the population earns between 0-10.000 €, with similar percentages in the 15.000-26.000 € and 26.000-55.000 € income brackets. The 10% of the total city income is held by approximately 1% of the city population, reflecting a growing economic gap. From 2018 to 2021, the number of low-income earners rose by 45,3%. Employment dropped in 2020 due to the COVID-19 pandemic.
Cornigliano has a high unemployment rate (1,4) and a high rate of low education (1,2) compared to other neighborhoods.

Regarding education, 43% of Genoa residents have a secondary school diploma, and 24% have a tertiary education. In Genoa, 27,2% of residents hold a tertiary degree, while this percentage is lower in the first and second urban belts, at 20,5% and 20,3%, respectively. The index of low education in Cornigliano has a high value (1,2) if compared to other neighborhoods, as shown in Figure 29.

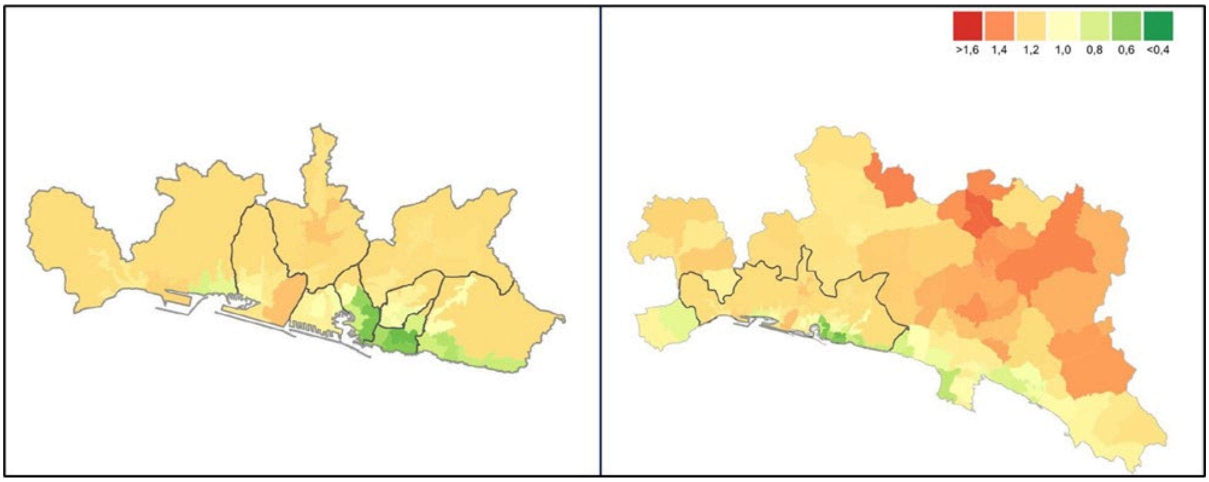


Figure 29. Map of index of low education for Genoa (left) and Metropolitan area (right) - NUVAP PovertyMaps 2017

In addition to the above, in 2022 energy prices surged, significantly impacting household spending. Italian households' annual energy expenditure rose by 32% from 2021, with the average household spending 1.915 €, about 500 € more than in 2021. Eurostat reported a 50% increase in electricity costs and a 34,7% rise in natural gas prices. Government interventions on final prices mitigated these increases. Although energy costs rose for all households, poorer households experienced a smaller increase compared to those around the median expenditure level[8].

Investigating the level of energy poverty requires the analysis of multiple data for which the space of this deliverable is not sufficient to exhaust the topic.

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[8] Source: https://www.istat.it/it/files//2024/05/Rapporto-Annuale-2024.pdf#page=130

However, it is significant that the Diocesan Caritas, starting from the experience of the Listening Centers of the Diocese of Genoa, highlights that in the neighborhoods whose social composition is comparable to the Cornigliano neighborhood during 2022 the Listening Centers provided economic aid for a total amount of 1.022.281 €; the 62,6% of the money was allocated to living expenses, mostly for the payment of utilities domestic and rentals[9].

Another factor that contributes to increasing energy poverty is the poor level of efficiency of residential buildings. The Figure 30 shows that from 2017 to 2024, nearly 85% of residential buildings in Genoa fall into the three lowest energy classes, with 40% in class G.

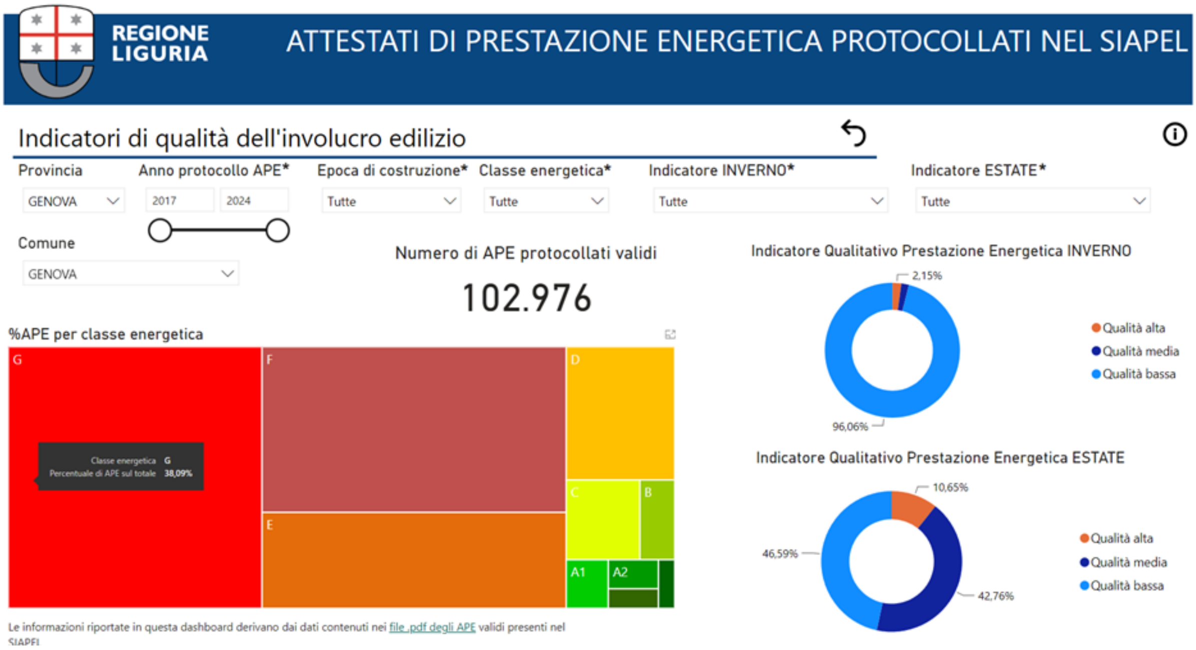


Figure 30. Data on energy efficiency of buildings in Genoa, years 2017-2024.

As regards the energy bonuses that have been made available over the years, despite being a useful tool for combating energy poverty, they have not always been used both due to a lack of resources in anticipating expenses and due to bureaucratic procedures, and finally due to lack of information.

2.4 Thematic analysis results Greece

[9] Source: https://www.caritasgenova.it/5574-2/

Normative dashboards

In Greece, the legislative framework for Renewable Energy Communities (RECs) is anchored in *Law No. 4513/2018* and *Law No. 5037/2023*, which implement the European Directives 2018/2001 and 2019/944. This framework establishes three distinct types of energy communities: **Renewable Energy Communities (REC)**, **Citizen Energy Communities (CEC)**, and **Energy Communities under Law No. 4513/2018**.

Key Features of the Normative Framework:

1. **Eligibility and Participation:** RECs and CECs in Greece are open to individuals, local and regional authorities, SMEs, agricultural cooperatives, and non-profit entities. Specific locality requirements ensure that at least 50% of REC members are connected to the area of operation.
2. **Activities:** Both RECs and CECs engage in renewable energy production, storage, self-consumption, and the sale of energy. Additional functions, such as energy efficiency services and electric vehicle charging, are unique to CECs.
3. **Surplus Distribution:** RECs and CECs must allocate at least 70% of their financial surplus to reserves, which are reinvested to support the community's sustainability.

Key Local Normativity: While the national framework applies uniformly across Greece, specific provisions address the unique needs of island communities, where renewable energy plays a critical role in reducing dependence on fossil fuels.

Challenges and Opportunities:

- **Challenges:** The establishment of RECs is hampered by complex administrative processes and high grid connection costs. Moreover, limited access to financing remains a critical barrier.
- **Opportunities:** The adoption of virtual net metering enables RECs to offset energy consumption across various locations, improving their financial viability.

Regional Highlights: Western Greece

The **Region of Western Greece** has emerged as a leader in REC initiatives, with seven non-profit RECs formed through collaborations between municipalities, water supply companies, and land reclamation organizations. A landmark project involves the construction of a 118 MW photovoltaic park in Messolonghi, one of the largest virtual net metering projects in Europe. The project aims to meet the energy needs of more than 306,000 residents, 139,000 professional farmers, and over 5,000 households experiencing energy poverty.

The environmental benefits of this initiative include a near-total reduction in CO_2 emissions, transitioning from 152,217 units to just 1,733 CO_2 units annually. The project's financial backing combines 25 million euros from the Territorial Operational Program of Western Greece with additional funding through energy performance contracts.

Benefits of RECs in Greece

- **Environmental:** Substantial reduction in greenhouse gas emissions and preservation of natural resources.
- **Economic:** Reduced energy costs and increased resilience to price fluctuations.
- **Social:** Enhanced community participation and energy independence.
- **Technological:** Adoption of innovative renewable energy technologies and smart grids.
- **Climate Adaptation:** Strengthened local resilience to climate impacts through sustainable energy supply.

Spatial Planning

The spatial planning framework in Greece plays a crucial role in facilitating Renewable Energy Communities (RECs) by integrating renewable energy projects within existing land use and zoning policies. This alignment ensures that energy infrastructure development is both sustainable and compatible with the surrounding urban and natural environments. The Municipality of Patras exemplifies this approach through targeted initiatives that blend renewable energy integration with urban resilience planning.

Urban Planning Context:

- The urban masterplan of Patras identifies the designated area for intervention as part of the "Protection of the Peripheral Green Areas of Dasillio - Vlatero & Diakou Hill." This zone, while characterized by significant residential and traffic development, is adjacent to one of the city's largest green spaces, emphasizing the need for balanced development.

- The designated land use for the project is classified as **educational**, enabling the integration of renewable energy systems into public infrastructure, such as schools.

Critical Infrastructure Audit:

- The selected site, a school complex in Patras, has a high energy footprint with aging electrical infrastructure and limited compliance with modern environmental regulations. The absence of sufficient green spaces within the complex further underscores the need for sustainable energy interventions.

Regulatory and Planning Framework:

- **Zoning and Land Use Regulations**: Greek land use policies permit the integration of photovoltaic systems in educational zones, subject to compliance with *Law No. 4067 (2012)* and related amendments under *Law No. 5069 (2023)* and *Law No. 4759 (2020)*. These regulations define the parameters for RES installations in urban settings, ensuring compatibility with existing urban landscapes.

- **Permitting Requirements**: Photovoltaic installations up to 100 kW on building rooftops are exempt from extensive permitting procedures. Larger systems require structural adequacy studies and environmental impact assessments based on their scale and location. This streamlined process supports quicker deployment of renewable energy projects.

- **Environmental Impact Considerations**: Projects under 1 MW are generally exempt from environmental licensing unless located in protected areas, such as the Natura 2000 network or coastal zones. Compliance with environmental impact assessments ensures that REC projects align with sustainability goals.

Case Study: Patras School Complex:

- The intervention in Patras involves the installation of a **50 kW photovoltaic system** on the school complex roof, capable of producing approximately **74,000 kWh annually**. This installation will reduce the school's energy footprint and contribute to local climate resilience.
- The project incorporates **Nature-Based Solutions (NBS)**, such as integrating green infrastructure around the school, to enhance urban biodiversity and mitigate climate change impacts. These solutions align with the broader goals of the EnerCmed project by fostering community engagement and sustainable urban planning.

Technical and Spatial Analysis:

- **GIS Integration**: Geographic Information Systems (GIS) are being employed to optimize the site selection and design of photovoltaic installations. GIS tools help assess parameters like slope, orientation, and estimated energy production, ensuring that systems are both efficient and environmentally compatible.
- **Grid Connectivity**: The photovoltaic system is designed for seamless integration with the local grid, pending coordination with the public electricity provider. This ensures that surplus energy can be efficiently utilized or distributed

UHI & Microclimate analysis

The Urban Heat Island (UHI) effect and microclimate characteristics in Patras provide critical insights into the interplay between urbanization, environmental dynamics, and energy consumption. A detailed analysis of these phenomena highlights key areas for intervention, emphasizing the role of nature-based solutions (NBS) and spatial planning in mitigating UHI effects and supporting Renewable Energy Communities (RECs).

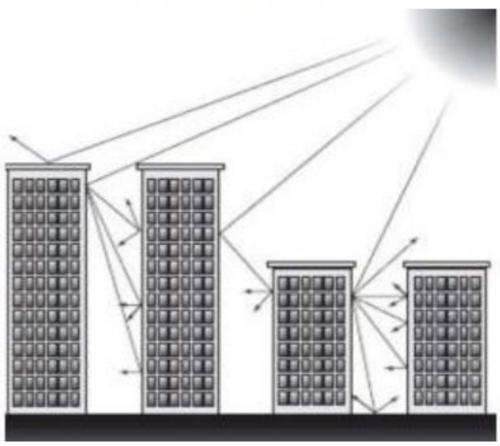
Temperature Distribution and UHI Dynamics

Patras exhibits a well-defined UHI pattern, with urban areas retaining significantly higher temperatures compared to their rural counterparts. This effect is most pronounced during the early morning hours (02:00–06:00), when urban zones maintain **1.5–2.0°C higher temperatures** due to the thermal inertia of impervious materials like asphalt and concrete. Satellite imagery and ground-based measurements confirm these differences, illustrating a stark contrast between densely built-up neighborhoods and vegetated rural zones (Figure 1).

Είδος επιφάνειας	Συντελεστής απορροφητικότητας ηλιακής ενέργειας (α)[1]	Συντελεστής εκπομπής θερμικής ακτινοβολίας (ε)
Άσφαλτος	0,05 – 0,20	0,95
Τσιμέντο	0,10 – 0,35	0,71 – 0,91
Αστικές περιοχές	0,10 - 0,27	0,85 – 0,96
Χώμα (υγρό προς ξηρό)	0,05 – 0,40	0,98 – 0,90
Γρασίδι	0,16 – 0,26	0,90 - 0,95

Figure 1: Heat map showcasing urban-rural temperature differences during early morning hours.

The intensity of UHI in Patras is directly linked to its urban morphology. The city's low-rise, high-density building stock, predominantly constructed with heat-absorbing materials, contributes to poor ventilation and prolonged heat retention. Streets designed without adequate airflow pathways create "urban canyons" where heat accumulates, further intensifying the local microclimate.



(Allaby, 2007)

Figure 2: Urban structure analysis indicating heat-retentive materials and airflow constraints.

Microclimate Characteristics

1. **Surface Properties and Materials**:

   Urban surfaces in Patras, dominated by asphalt and concrete, exhibit high solar absorption and low emissivity, leading to elevated daytime and nighttime temperatures. These materials exacerbate UHI effects, particularly in areas with limited shading or reflective roofing.

2. **Green and Forested Areas**:

Significant green spaces, including **Dasyllio**, **Eschatovouni**, and **Kavoukaki**, provide a natural buffer against UHI effects. These forests, composed predominantly of pine species, play a crucial role in:

- Reducing ambient temperatures through shading and evapotranspiration.
- Acting as wind barriers, modulating airflow and enhancing thermal comfort in adjacent neighborhoods.

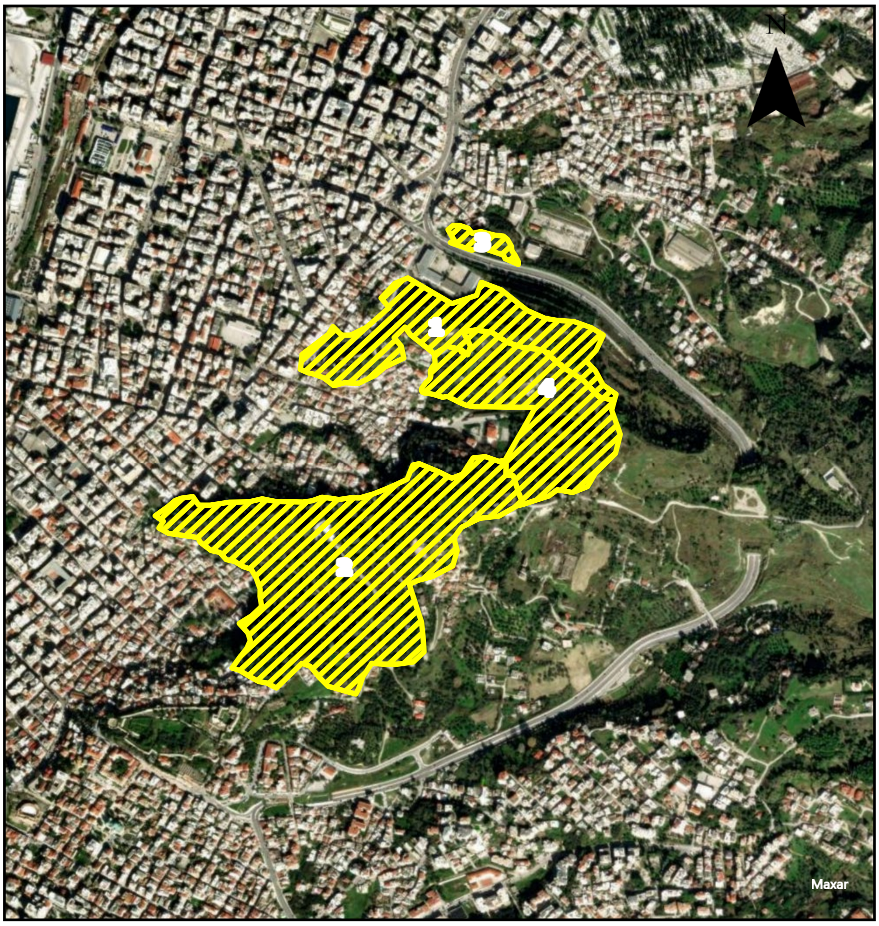


Figure 3: Map detailing green spaces and their cooling effects.

Green Spaces

AA	AREA
1	68.939

https://gissrvweb.geopatras.gr/publish_t/webapps/dp/	2	197.920
	3	5.430
	4	80.603

GREEN TOTAL AREA:352.892

3. **Water Bodies and Hydrology**:

The presence of water features such as the **Meilichos River** and **Karavas Stream** creates localized cooling zones. These water bodies enhance humidity levels and reduce surrounding temperatures through evaporative cooling, significantly mitigating the UHI effect in nearby urban areas.

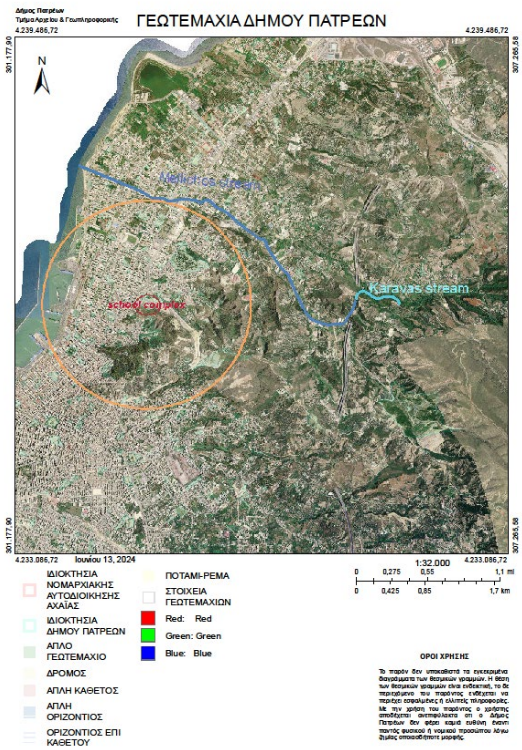


Figure 4: Hydrological features contributing to microclimate regulation.

4. **Wind Patterns and Climatic Influences**:

Coastal breezes and the strategic positioning of green zones create favourable wind patterns that alleviate heat buildup in central Patras. These interactions between natural and built environments contribute to a more balanced urban microclimate, particularly during peak summer months.

Energy Consumption and Cooling Needs

The UHI effect significantly impacts energy consumption patterns in Patras. Approximately **67% of households** rely on air conditioning during peak summer months, with usage concentrated between May and September. The cooling demand is disproportionately higher in older buildings, which often lack adequate insulation or modern cooling technologies.

The reliance on air conditioning not only increases household energy bills but also contributes to secondary heat emissions, exacerbating the UHI effect in densely populated areas.

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Nature-Based Solutions (NBS) for Mitigation

The integration of NBS into urban planning is a key strategy for mitigating UHI effects in Patras. These solutions focus on enhancing green infrastructure and improving the thermal efficiency of urban spaces.

- **Green Roofs**

  Extensive and intensive green roofs have been shown to reduce rooftop temperatures by **0.4–0.7°C** and decrease building cooling demands by up to **73%** during summer. These installations not only lower indoor temperatures but also provide insulation during winter, improving year-round energy efficiency. *Figure 6: Green roof installations reducing rooftop temperatures and energy demands.*

- **Green Walls**:

  Vertical greenery systems, such as climbers or modular green facades, have demonstrated significant reductions in exterior surface temperatures, particularly during peak daylight hours. These systems improve indoor comfort while reducing the reliance on artificial cooling systems.

Case Study: Patras Pilot Project

A flagship initiative in Patras involves the implementation of green infrastructure within the urban fabric to combat UHI effects. Key features of the pilot project include:

- **Photovoltaic Installations**:

  The integration of renewable energy systems, such as a **50 kW photovoltaic array** on public buildings, aims to reduce reliance on conventional energy sources while addressing cooling needs through sustainable power generation.

- **Urban Reforestation and Green Corridors**:

  Expanding existing forested areas and connecting them through green corridors to enhance ecological continuity and thermal regulation.

- **Urban Cooling Nodes**:

  Strategically placed cooling nodes combining water features and shaded seating areas to provide thermal comfort in high-traffic urban zones.

Technical and Spatial Considerations

Advanced tools such as **Geographic Information Systems (GIS)** were employed to optimize the placement of green infrastructure and renewable energy systems. These analyses considered factors such as:

- Solar exposure and shading patterns.
- Wind flow dynamics.
- Proximity to existing cooling nodes and public utilities.

Outcomes and Recommendations

The UHI and microclimate analysis of Patras underscores the importance of integrating spatial planning with energy and environmental strategies. Key recommendations include:

- **Scaling Green Infrastructure**: Prioritize green roofs, walls, and urban reforestation to address thermal hotspots and reduce energy consumption.
- **Upgrading Energy Systems**: Promote energy-efficient technologies in older buildings to complement cooling interventions.
- **Enhanced Data Utilization**: Leverage GIS tools for ongoing monitoring and optimization of urban climate mitigation measures.

Social composition & energy poverty

The analysis of social composition and energy poverty in the Municipality of Patras highlights the intricate relationship between socioeconomic factors and energy access. This section focuses on the demographic, economic, and social characteristics of the target study area, alongside an assessment of energy poverty and its implications.

Study Area

The target area for the study is a school complex located between the municipal forest of Dassilio, the old port of Patras, and a high-traffic perimeter road. The area’s strategic location, combined with its proximity to the Eschatovouni hill and the North Pier, provides unique insights into the interplay between urban development and energy challenges.

Demographic Profile

- **Population Size and Density**: The area exhibits moderate population density, with a balanced gender distribution of 49.5% men and 50.5% women.
- **Household Composition**: Approximately one-third of households include at least one retired person. In larger households (2–3 members or more than 6 members), this percentage rises above 40%, indicating the significant role pensioners play in supporting family finances. The marital status distribution shows 50% married, 40% single, 6.5% widowed, and 2.3% divorced.

Socio-Economic Characteristics

1. **Income Levels**:
   - About 59% of the population earns up to 1,000 euros monthly, with 32.1% earning between 351–820 euros, highlighting the prevalence of low-income households.
   - Approximately 70% of respondents cannot manage an emergency expenditure of 550 euros, and this figure rises to 95% among the "risk group," defined by low income and socioeconomic vulnerability.
   - Families below the poverty line represent 37.7% of households, with a notable 42% earning less than 820 euros per month.
2. **Employment Status**:
   - Only 30% of the population over 18 years old is employed, while 23% are pensioners or students. Unemployment rates reach 11.5%, with jobless individuals accounting for nearly 29.7% of the economically active population.
3. **Education Levels**:
   - About 30% of residents have a university degree, while the majority (37%) are high school graduates. Among younger residents (25–34 years), university graduation rates exceed 40%, compared to lower educational attainment among older residents aged 55+.

Housing and Living Conditions

1. **Housing Types**:
   - The majority (85%) reside in flats or houses ranging from 46 to 150 m². About 13.5% live in smaller units under 45 m², and only 3.4% occupy larger spaces above 150 m².
   - Two-thirds of the population live in apartment blocks, with the remaining third in standalone houses.
2. **Ownership Status**:
   - Ownership without loans accounts for 35% of housing, reflecting inheritance or outright purchase. Rented accommodations represent a significant proportion, especially among low-income groups and "risk group" families, where this percentage exceeds 45%.
3. **Building Conditions and Energy Infrastructure**:
   - Poor insulation and outdated heating systems are prevalent, with nearly 100% of respondents citing issues related to heating efficiency, humidity, or insulation

quality. About 7.5% of households lack any form of heating, and this figure doubles to 14% among vulnerable groups.

Energy Poverty Assessment

Energy poverty remains a significant challenge in the study area, with 90% of respondents describing energy costs as high or very high. Specific findings include:

- **Energy Expenditure**: Energy costs account for 11.5% of total consumer expenditure, up from 7.7% in previous years. Electricity (59.8%) and heating oil (23.2%) are the primary contributors to high costs.
- **Heating Accessibility**: Nearly 32.9% of households were unable to maintain adequate heating during the economic crisis. While this figure dropped to 17.1% by 2020, it remains significantly higher than the EU-27 average of 6.5%.
- **Alternative Heating Methods**: Air heaters, stoves, and fireplaces are increasingly used, particularly by low-income families, while 0.3% report no heating use at all.

Identification of Vulnerable Groups

- Vulnerable households include those with elderly residents (17.7%), individuals with chronic conditions (12.2%), or dependents. The elderly population often resides either alone or in extended families, providing or receiving financial support.

Key Outcomes and Recommendations

- **Income Support**: Targeted policies should address income disparities, particularly for the 37.7% of families living below or near the poverty line.
- **Energy Efficiency Improvements**: Retrofitting buildings to improve insulation and heating systems could significantly reduce energy costs and mitigate energy poverty.
- **Support for Vulnerable Groups**: Expanding social programs for elderly residents and low-income families can enhance resilience against rising energy costs.
- **Alternative Energy Solutions**: Promoting community-level renewable energy projects, such as RECs, can help address systemic energy challenges and reduce dependency on fossil fuels.

3. Involved stakeholders

In the following the stakeholders involved in the project activities and the related methods of involvement are described.

3.1 Involved stakeholders Spain

Stakeholders mapping

Mapping potential stakeholder has been the very first step when planning the different activities and pilot interventions. VCE as an entity has been in touch with different social and energy related stakeholders that can have a key role when implementing EnerCmed.

First of all, the H2020 WELLBASED (2021-2025) project activities about energy poverty and health were taken in consideration. VCE staff has been working on site with vulnerable households in Natzaret and La Malva-Rosa, thanks to different neighbourhood entities, NGOs and local associations that served as intermediate actors for case referral. Thus, VCE is well-known in both areas and among the local entities. This allowed us to contact around 25 entities (charity, schools, social services, youth centres, municipal sports centres etc.) to start the definition of the REC. This dialogue also fosters citizen and community participation on the project, adding social value and engagement.

Moreover, the experience and support of the Municipal Energy Offices (OSS managed by VCE) is consideredon working together with citizens, Social Services and associations. The OSS service has an office really close to Poblats Maritims and knows very well the area and the social network. The Municipal Climate Change Observatory (also managed by VCE) is also a referent among schools and education activities in the Poblats Maritims district.

Finally, we will also take the chance of energy advisors and NBS experts that VCE has been working previously in other REC and NBS projects and climate change analysis.

Finally, it's worth to mention that the Municipality itself will play a key role on surface permissions, legal advisory and project promotion.

Involvement Methodologies

EnerCmed has a strong social compound, therefore, the way to approach the different stakeholders has to be consistent with the self-nature of the project.

About the different associations, NGOs and local entities, different face-to-face meetings have been arranged. It's worth to mention the Open Days and the follow-up meetings. Up to date, 3 meetings with Natzaret community have taken place in the Ausias March School and Virgen de los Desamparados School whilst one in Ballester Fandos School in La Malva-Rosa. In addition, several initiates to gather questions, comments and feedback have been established to ensure engagement and participation: creation of a Google Drive folder to share interesting documents on REC and NBS, the EnerCmed poster and the creation of a Whatsapp group with the interested members of Natzaret Association Community. In Ballester Fandos VCE project members have taken part in their internal assembly and their members completed the EnerCmed survey. Informative mails and phone calls have also been arranged across different entities and sectors to reach all the potential stakeholders interested.

Social Services is also aware of the EnerCmed project, and their collaboration will be key for the validation and criteria of families and beneficiaries of the REC. More face-to-face meetings and mail exchange are foreseen. In fact, the collaboration between the municipal social workers and VCE and the OSS has been fostered thanks to the recent approval of a collaboration agreement for case referral and information exchange.

Regarding the Municipality itself, VCE as municipal foundation, has direct contact with the departments involved in REC and NBS. This is key to ensure the compliance of all legal permits for surface rights.

As per general communication strategies, EnerCmed has been launched on the OSS monthly newsletter and VCE social media. Information will be updated accordingly to ensure families and citizens are aware of it.

Finally, in later stages of the project the objective is to involve the whole community, especially schools, students and NGOs in a collaborative process of definition and co-creation of the solutions through dedicated workshops and visits.

Open days: activities & results

The first Open Day event took place on the Colegio Virgen de los Desamparados of Natzaret (managed by Caritas charity association) on the 24-10-2024. 21 neighborhood associations were informed about the meeting. It counted with the assistance of 13 entities (including the directors of the 3 neighborhood schools) and 3 VCE technicians.

After the project presentation, the Ballester Fandos School director and the Sapiens energy consultancy director were invited to provide information about their experience in REC and vulnerable households.


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Figure 31. Photos of Open Days

After the presentations, the attendees were invited to take part in an activity to reflect on their potential role in the REC by thinking about their objectives, actions, roles and proposals for the project.

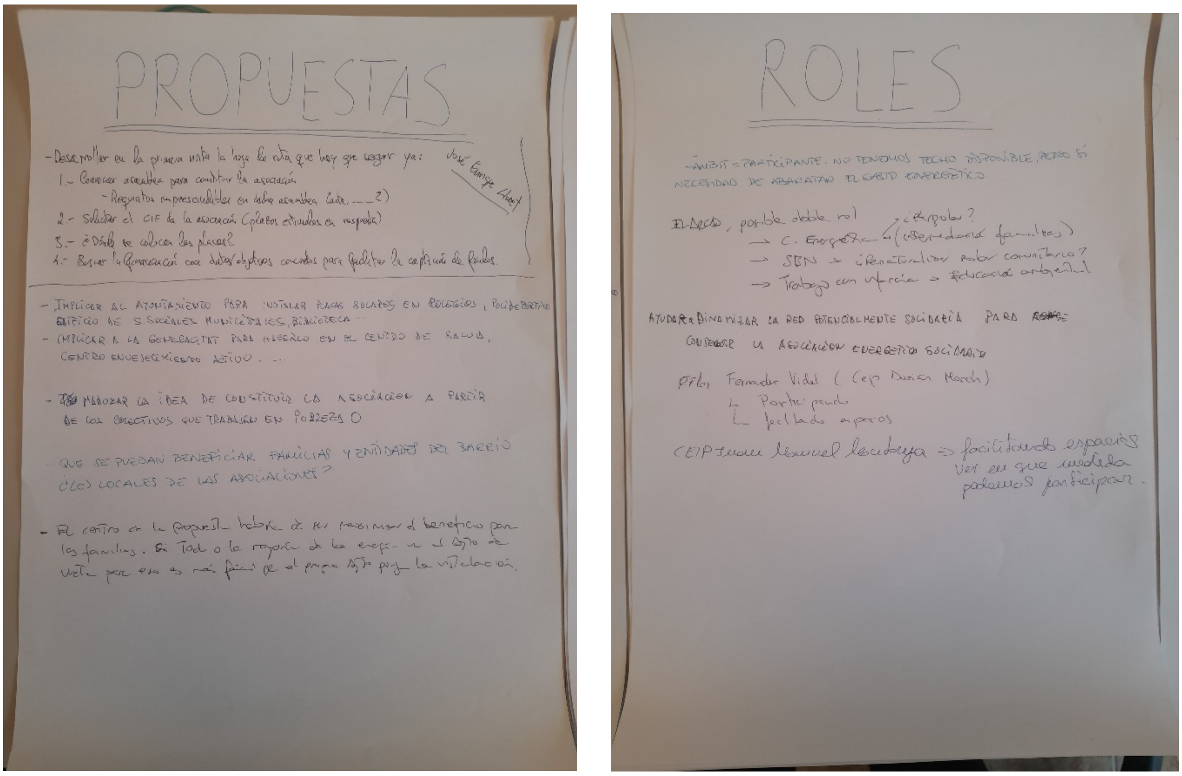

Figure 32. Activity with stakeholders

After this meeting, 2 more meetings with the Natzaret associations have taken place in the Ausias March School to gather information and feedback about the creation of the REC and their role in it. The second one was held on the 19th of November and the third one on the 4th of December.

Figure 33. Second meeting in Natzaret

Regarding the Ballester Fandos School, the director was invited to the Open Days held in October. However, a specific meeting with their teacher council was held on the 11th of December taking the chance of their internal assembly. They also answered to the EnerCmed survey to help with the co-creation process.

Figure 34. Meeting in Ballester Fandos School

Both schools are well-known in their neighbourhoods for their commitment with social inclusion, innovative actions and care for vulnerable families.

3.2 Involved stakeholders Croatia

Stakeholders mapping

The first step of the stakeholder's management process is the identification of possible subjects, followed by the analysis and the classification and priority definition, and a following management planning.

The successful implementation of one REC for Pula and Novigrad requires the active participation of diverse stakeholders. IRENA is regional energy agency in Istria, which allowed IRENA to contact a lot of different entities such as schools, hospitals, homes for elderly, different centres and offices, especially those in County ownership. One energy and technical stakeholder is Croatia's national electricity provider (HEP) , responsible for grid connections and approvals for PV system installations.

The main stakeholders in Pula are local stakeholders of Pula because they are owners of the building Children's Creative Center. City of Pula is responsible for spatial planning, zoning permits and support given the REC implementation.

In Novigrad, the local stakeholders (City of Novigrad- mayor) and the headmaster of the Home for Elderly represent main stakeholders. The Home for Elderly is owned partially by the County of Istria, partially by the City of Novigrad and partially by the Home itself, which is why it was important to include both local and regional stakeholders like head of health of Istria County.

The population of both cities is not directly involved, however, the school in Labin is informed about the project, since the project survey was conducted in the Labin highschool. Some students and professors have filled out the survey and some of them expressed interest to participate in REC founding. It is important to involve local community to create an energy positive paradigm considering NBS solutions and REC activation.

Involvement Methodologies

Stakeholder involvement is critical to ensuring the success of pilot REC initiatives. This section describes the methodologies used to engage stakeholders and ensure their active participation throughout the project lifecycle.

Different stakeholders seek different ways of engagement strategy. IRENA has decided to involve local stakeholders in the very beginning of the project to consult with them regarding the project pilot locations. IRENA has a main role in sharing information, consultation and co-creation of REC, however it is important that all stakeholder groups work together. In the initial phase of the project many face to face meetings were held, to inform the mayors of both cities, headmasters of the home for elderly and other authorities with the EnerCmed project and the idea of founding REC and implementation of NBS solutions. Local authorities are updated on the project progress by participating in certain activities, e-mail and phone call exchanges coordinated by IRENA.

Questionnaires and communications activities were established through the survey about NBS and RECs in highschool in Labin where 15 people did the survey, 5 professors and 10 students.

Open days: activities & results

The first open days event was organized on the 23rd of April, 2024 in Labin. The open day took place on the city square and in the city sports hall where the project was presented to various groups of people, such as local and regional stakeholders, energy advisors and research centers, high educational institutions, and others. The project objectives were described, energy communities and NBS solutions were presented to the wider public and wide group of stakeholders. The event within which the activity was carried out was the Green and Blue Energy Transition Days of the County of Istria.

Figure 35. IRENA presenting the EnerCmed idea to the public

The second open days activity was carried out in the Home for elderly in Novigrad where the project objectives were presented to the Home's headmaster, regional head of health and the city's mayor by IRENA staff.

In both cases, EnerCmed project got positive reactions from the public.

The final action taken was sending out the questionnaire to the Labin high school, where 15 people participated in the survey, 10 students and 5 teachers, to present the project objectives to a pattern of citizens to find out how much they know about NBS solutions and energy communities. Not many of them would like to participate in the process of forming an energy community, but a lot of them would like to experience benefits, such as lower electricity bills, NBS solutions like tree- lined avenues distributed around the city.

3.3 Involved stakeholders Italy

Stakeholders mapping

The first step of the stakeholder's management process is the identification of possible subjects, followed by the analysis and the classification and priority definition, and a following management planning.

Considering the kind of configuration chosen for the pilot activity ISC, the field of potential stakeholders is limited compared to the configuration of a REC.

Cornigliano Comprehensive Institute represents the main stakeholder, fundamental for sharing the project and directing the activities.

A second stakeholder is represented by the local Municipality "VI Medio Ponente" which has been already involved in a first phase, to support the implementation of the NBS interventions. Subsequently, meetings are also planned at a political level to promote the project.

The population of the Cornigliano area is not directly involved in the creation of the ISC configuration but indirectly, through the families of the students and of all the workers of the schools, is informed on the topic of energy communities and in general on different self-consumption configurations for renewable energy sharing and NBS. The involvement of the local community contributes to generates substantial social value, fostering environmental conscience and community engagement.

Involvement Methodologies

The methods of stakeholders' involvement vary, depending on the type of subject engaged. In particular, it is necessary to evaluate HOW to involve the stakeholder that it is to say the Engagement Strategy (e.g., information sharing, consultation, co-creation, collaboration, co-management, etc.) and the Engagement Approach (e.g., newsletters, meetings, workshops, surveys, etc.) and WHEN to involve the subject, defining in which phase of the project and with witch frequency the engagement is carried out.

Cornigliano Comprehensive Institute has a fundamental role, the Engagement Strategy foresees information sharing, consultation and co-creation for the implementation of the NBS interventions. Especially in the initial phase of the project, various face-to-face meetings were held, also with the aim of establishing human contact with the headmaster and school board members; once contacts have been established, other methods of communication have been added, such as emails and telephone calls.

The Engagement Strategy of the local Municipality "VI Medio Ponente" foresees information sharing, consultation and collaboration; meetings and emails are the main engagement tools, to be used during the duration of the project period whenever necessary.

The local community of Cornigliano, represented by the families of students and workers of the schools, is indirectly involved by adopting an Engagement Strategy aimed at information sharing and receiving feedback concerning the pilot activity. During all phases of the project, meetings will be organized involving teachers and parents' representatives, and it is planned to organize workshops for students with educational purposes. Furthermore, other methods of engagement are adopted such as questionnaires and communications from the school, to be able to reach all the students' families.

Open days: activities & results

The first event aimed at presenting the project activities was organized on the 10th of September, 2024. The Open Day took place at one of the two schools involved in the project, the Ferrero school, on the First annual school board.

Figure 36. Open Day presentation

During the meeting, shown in Figure 36, the members of the Municipality of Genoa and of the University of Genoa illustrated to the parents’ representatives, headmaster and school board members, the interventions planned for the schools within the scope of the possibilities provided by the recent Italian legislation concerning different self-consumption configurations for renewable energy sharing.

More generally, the project objectives were described, highlighting the willingness of disseminate actions implementing an extensive investment program in sustainable development and energy efficiency, social inclusion and care to vulnerable groups.

Following this first event the headmaster and the schools' staff supported the advancement of the project information activities. The school in fact sent an information circular to parents, also published on the institute's website, concerning the project EnerCmed and describing its main points.

Furthermore, by the end of 2024, a questionnaire has been sent to students, students' families and school staff, with the aim not only of informing but also of collecting feedback and suggestions on the project activities. The survey foresees the possibility of greater involvement, receiving information and updates via email on the configurations for self-consumption energy sharing and on the subsequent phases of the project.

On the occasion of the 10th edition of the Smart Week, during the event of the 27th of November "Fotovoltai-GIS", a geoportal at the service of energy sustainability, the EnerCmed project has been presented, contributing to the dissemination activities[10].

3.4 Involved stakeholders Greece

Stakeholders mapping

The Municipality of Patras engaged a wide array of stakeholders to ensure the EnerCmed pilot project is inclusive, sustainable, and impactful. Stakeholders were mapped based on their roles, influence, and relevance to the project's objectives, focusing on energy transition, urban resilience, and social inclusion. Key groups include:

Educational Institutions: The 6th High School Complex of Patras, hosting five school units, plays a central role as the pilot site. Teachers and students are not only users of the renewable energy and Nature-Based Solutions (NBS) but also act as advocates for environmental education and behavioral change.

Local Government and Authorities: The Municipality of Patras spearheads the project, ensuring regulatory compliance and fostering inter-departmental coordination for environmental and energy initiatives.

Renewable Energy Community (REC) Members: Local residents and businesses within the vicinity of the pilot site are pivotal for forming and sustaining the REC. Their participation ensures the relevance and acceptance of proposed solutions.

Non-Governmental Organizations (NGOs): These groups provide advocacy, expertise, and grassroots support, particularly in engaging vulnerable populations.

[10] https://www.genovasmartweek.it/

Technical and Scientific Experts: These stakeholders contribute to designing and implementing advanced technical solutions, including PV installations and NBS. Their input ensures the technological soundness and efficiency of interventions.

General Public: Broader citizen participation ensures that the project addresses community-wide concerns, such as energy poverty, environmental sustainability, and urban resilience.

The mapping process revealed overlapping interests and interdependencies among stakeholders, underscoring the need for coordinated, transparent engagement strategies.

Involvement Methodologies

Stakeholder involvement in Patras is anchored on participatory and inclusive approaches, ensuring that all voices are heard and integrated into the project's framework. The following methodologies were implemented:

Comprehensive Analysis: Initial assessments included demographic, socioeconomic, and cultural analyses to understand the community's composition and its unique challenges. This included mapping energy poverty hotspots and understanding migration and urbanization trends.

Structured Consultations: A series of face-to-face meetings were organized, covering diverse topics such as educational needs, energy infrastructure, and green urban planning. These consultations fostered trust, encouraged collaboration, and facilitated meaningful knowledge exchange.

Participatory Co-Design Workshops: Workshops were tailored to empower vulnerable groups, focusing on their active involvement in REC formation and NBS design. These sessions aimed to balance technical feasibility with community aspirations.

Feedback Systems: To monitor progress and adapt strategies, a feedback mechanism was established. This included distributing and analyzing detailed questionnaires on community perceptions and expectations for the pilot project interventions.

The engagement approach integrated equity, inclusivity, and adaptability, ensuring it aligns with local cultural dynamics and systemic challenges.

Open days: activities & results

An Open Day event, held on October 18, 2024, marked a cornerstone of public engagement for the EnerCmed pilot in Patras. This event was designed to serve multiple objectives:

Awareness Building: Attendees were introduced to the project's goals and methodologies, particularly the integration of PV systems and NBS at the pilot site. Presentations detailed the anticipated benefits of these solutions, including reduced energy costs, improved urban resilience, and enhanced community welfare.

Community Participation: Interactive sessions allowed attendees to voice their concerns and provide input on project implementation. This included discussions about potential challenges and collaborative strategies to overcome them.

Figure 377. Open day in Patras

Dissemination of Knowledge: The event featured educational materials such as posters, brochures, and live demonstrations. These resources aimed to simplify complex concepts and foster a deeper understanding of the project's relevance.

The Open Day also served as a platform for establishing ongoing dialogues between stakeholders and the project team. Attendees expressed strong support for the initiative, highlighting its potential to address energy poverty, leverage green spaces, and build community resilience.

The event concluded with actionable recommendations from stakeholders, emphasizing the importance of sustained communication, regular monitoring, and educational outreach to ensure the project’s success.

4. Maps of activable REC in port marginalized neighborhoods and hinterlands

4.1 Maps of activable REC in port marginalized neighborhoods and hinterlands Spain

Site-specific maps

As the project aims at addressing marginalized neighborhoods in port hinterlands, Natzaret and La Malva-Rosa were immediately considered for pilot sites. This decision was reinforced by several factors already discussed in this document:

- VCE previous experience in EU energy poverty projects such as WELLBASED, Power-Up and RIP
- the Municipal Energy Offices experience
- the Municipal Energy Poverty follow-up commission
- the collaboration agreement between VCE and the Municipal Social Services
- the energy poverty mapping and report
- the update of social indicators by the Municipal Statistics Office
- the UHI and climate shelter analysis report drafted by Fair Local Green Deals, Grow Green and Green Urban Data projects, with the participation of VCE.

The analysis performed in this deliverable, as well as the dedicated ones for Spatial Planning, UHI and micro-climate, Normative Dashboard and Social Composition proved the suitability of both neighborhoods, and the two selected schools, for the EnerCmed project pilot. Both are marginalized and deteriorated areas, with low incomes, old houses and high energy poverty rates, combined with a strong association movement and social network support. This is aligned with the EnerCmed core objectives.

The next phase will cover all legal aspects for the REC creation and the legal permissions needed from the Municipality according to the regulations for PV and NBS installation and deployment.

Discussion and conclusions

Both areas and schools for the EnerCmed pilot action and activities are suitable for project activities, as they match the environmental and socio-economic requirements: marginalized areas, close to the sea and port, high energy poverty rates, suffering from UHI and heat waves effects. At this stage, both schools can play a key role in inclusive renewable energy and access, promoting the energy transition, lowering temperatures and raising energy efficiency and sustainability awareness among families, students, teachers and, overall, the neighbourhood community.

4.2 Maps of activable REC in port marginalized neighborhoods and hinterlands Croatia

Site-specific maps

Different aspects have been considered in order to identify the area of the pilot action. This document summarizes the analysis of spatial planning, normative dashboard, UHI and microclimate analysis and social composition and energy poverty analysis. The decision to pick the Monte Zaro neighbourhood and the Bikokere neighbourhood for project pilot locations are various. Both are marginalized port areas, that were affected by businesses deteriorating throughout the years (shipyard in Pula and fishing in Novigrad). Both areas are low income (low income elderly people in Novigrad and social fee beneficiaries in Pula who mostly live in Monte Zaro). This is aligned with the EnerCmed criteria and objectives.

Discussion and conclusions

Both areas match the environmental and socio-economic requirement. Both Monte Zaro and Bikokere (and Marketi) district present low vegetation areas in the city, therefore are affected by the consequences of the Urban Heat Island phenomena. Most surfaces are made of asphalt and concrete which retain heat during the summer, which is hard to mitigate without appropriate NBS solutions. Both areas are inhabited by low income population, with lower education. In Pula, social fee beneficiaries live mostly in Monte Zaro neighbourhood and they are paid 53€/ month which is not enough to cover their monthly costs. In Novigrad, Home for Elderly, residents of the home are low income elderly people. Elderly people and other social sensitive groups are more likely to fall under risk of energy poverty. Health risks of vulnerable groups also played a critical role in selecting pilot locations, since elderly and children are the groups mostly subjected to the high heat risks.

4.3 Maps of activable REC in port marginalized neighborhoods and hinterlands Italy

Site-specific maps

Different aspects have been considered in order to identify the area of the pilot action.

The first point concerns the project requirements, the aim is to enable the energy regeneration of marginalized neighborhoods in port hinterlands, normally inhabited by people exposed to risks of energy poverty. Therefore, the peri-port districts were taken into consideration, such as Sampierdarena, Cornigliano, Multedo, Pra, Pegli.

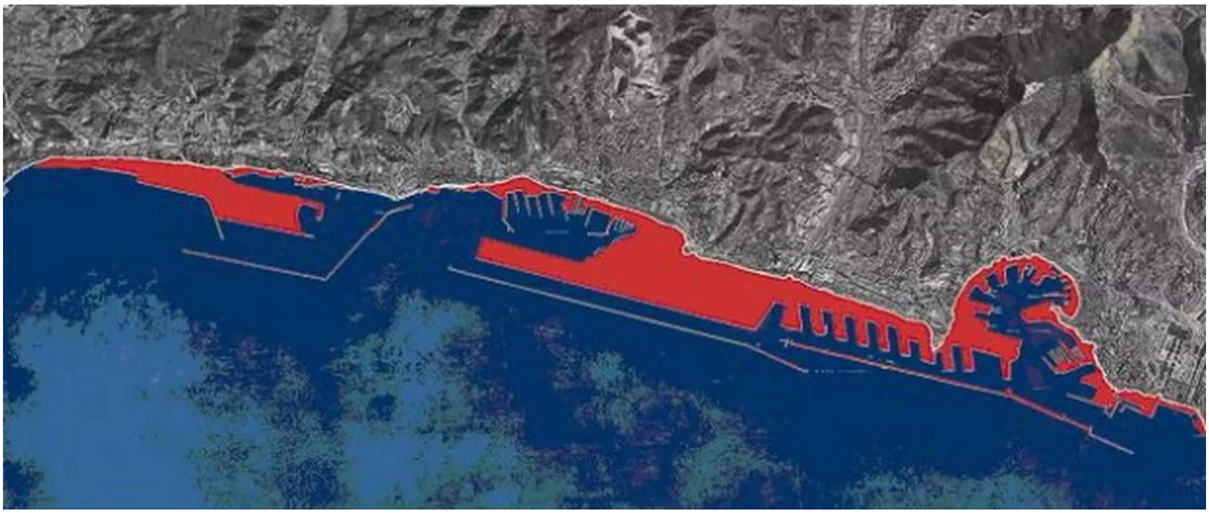

Figure 38. Map of the port of Genoa

The second step was to identify among these areas the most critical zones where the presence of families in a state of potential energy poverty is highly probable. As better described in the previous paragraphs, numerous indicators related to the demographic aspects (population size and density, age distribution, household composition) and to social and economic aspects (income levels, employment status, educational levels) were used. The results led to the identification of the neighborhoods of Sampierdarena and Cornigliano.

It should be noted that the chosen ISC configuration does not foresees the direct involvement of the neighborhood population, but indirectly the inhabitants of the areas where the chosen schools are located will be informed of the project and made aware of issues related to renewable energy sources, fostering environmental conscience and community engagement.

Figure 38. Map of index of active unemployment for Genoa (left) and Metropolitan city area (right) - NUVAP PovertyMaps 2017

The next phase involved the investigation of the technical requirements dictated by current legislation, in particular the production and consumption energy sites must be connected to the same grid within the area of the same primary substation.
The perimeter of the primary substations in the rear-port areas already identified by previous analyzes was therefore investigated, GSE website makes available interactive map of the primary substations located in the national territory. Among the various perimeters the primary substation with code AC001E01097, covering the area of Cornigliano, has been identified.

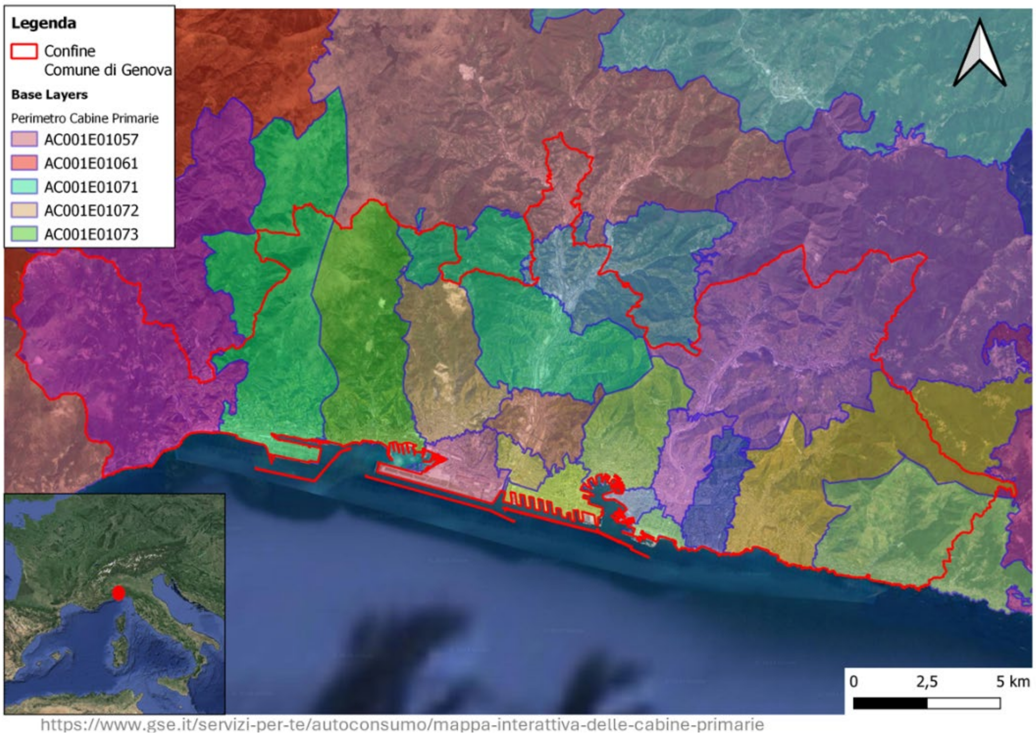

Figure 39. Conventional areas underlying the primary substations covering the Municipal territory

Figure 40. Primary substation position (Cornigliano area)

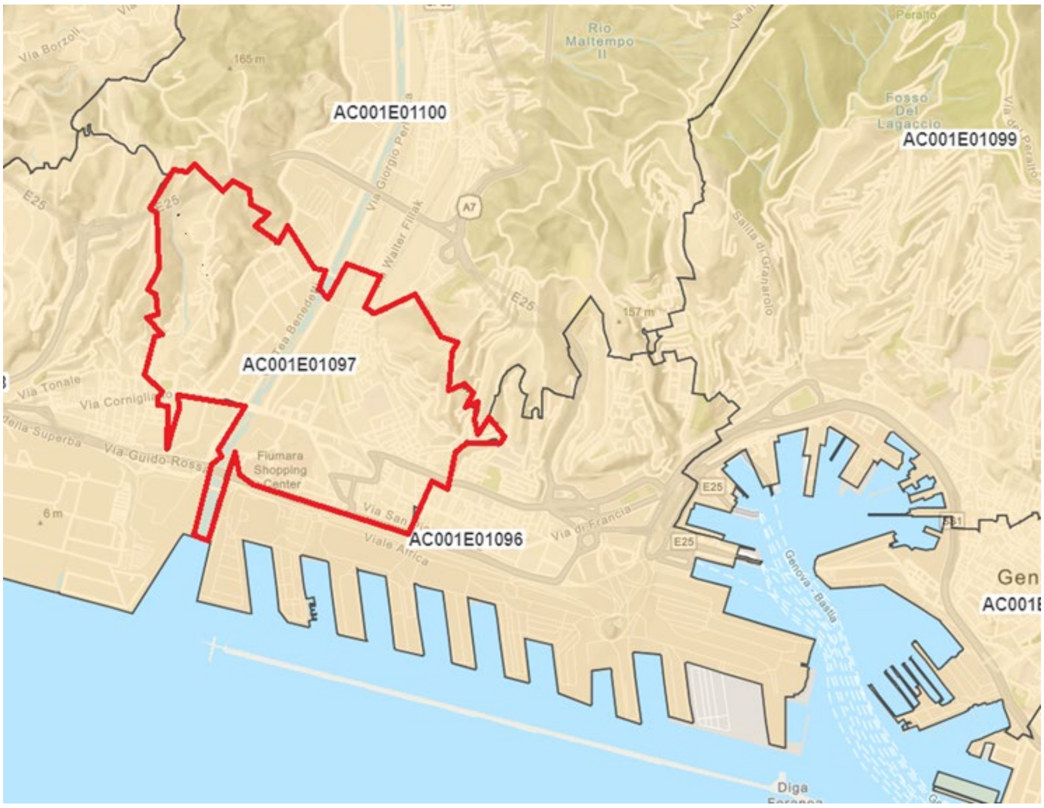

Figure 41. Map of primary substations located in port hinterlands and highlighted in red the primary substation of Cornigliano area

Finally, the evaluation focused on the analysis of the Municipality-owned buildings within the perimeter of the identified primary substation, investigating the available rooftops for PV plants, the new PV plants planned, and the possible roof renovation designs planned.

The result of the research identified the most suitable buildings, Primary School "Domenico Ferrero" and Secondary School "Alessandro Volta", belonging to the Cornigliano Comprehensive Institute.

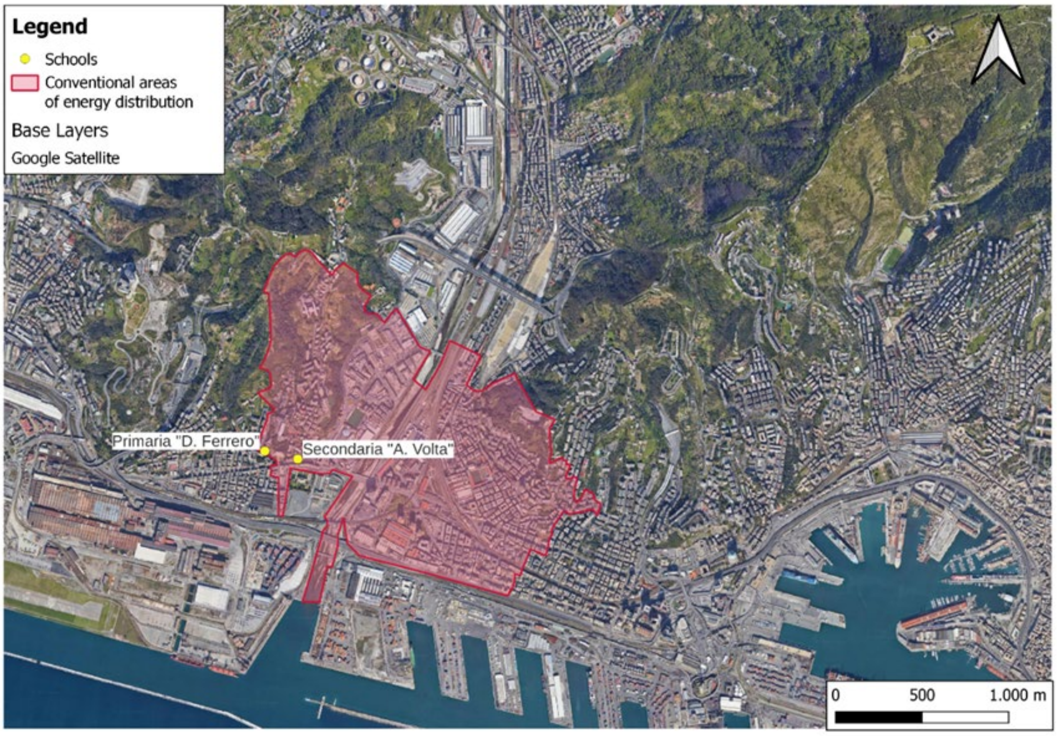

Figure 42. Identification of schools' buildings and conventional area underlying the primary substation covering the area of Cornigliano

Discussion and conclusions

The pilot activity of the EnerCmed project in the city of Genoa will therefore involve the Cornigliano district, which meets the project requirements with respect to its location in the port area. The project objectives have been directed towards this district, with the theme of energy aimed at improving access to energy resources, considering both environmental and socio-economic needs. As the selected buildings are schools, the project activities will also be directed towards educational and outreach purposes on energy and sustainability.

Furthermore, the photovoltaic installations, in future expansions, may constitute the seed and be included in new self-consumption configurations that, if developed without capital contributions exceeding 40%, will be able to distribute financial benefit and attract citizen and families. In the future, the Municipality aims to increase the number of configurations for sharing renewable energy; Figure 15 shows the municipal utilities distributed in the different primary substations, together with the location of existing Municipality's renewable energy production plants. This map aims at optimal resource management and to facilitate future interventions.

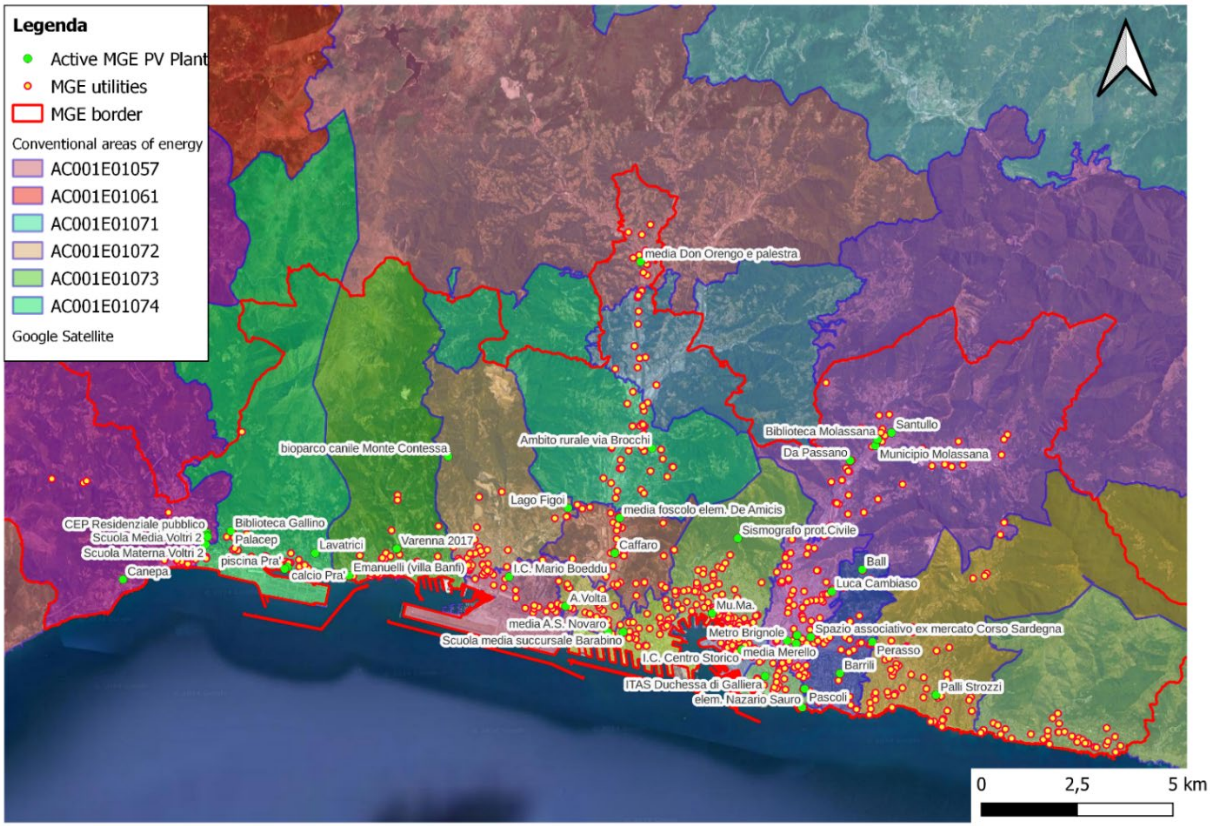

Figure 43. Municipal utilities distributed in the different primary substations, together with the location of existing MGE renewable energy production plants

4.4 Maps of activable REC in port marginalized neighborhoods and hinterlands Greece

Site-specific maps

The identification of Renewable Energy Community (REC) opportunities in Patras has focused on three distinct spatial categories: the port zone, marginalized neighborhoods, and the rural hinterlands. Site-specific mapping was conducted to pinpoint suitable locations for REC implementation, considering existing infrastructure, socio-economic needs, and regulatory frameworks.

1. **Port Zone**

   The port area of Patras is characterized by industrial and logistical facilities with high energy consumption. Mapping efforts have identified large warehouse rooftops and open spaces as potential sites for solar photovoltaic (PV) installations. These areas can support substantial energy generation, with opportunities to incorporate energy storage systems for increased resilience.

2. **Marginalized Neighborhoods**

   The urban neighborhoods near the city center, particularly those with aging infrastructure and concentrated socio-economic vulnerabilities, were identified as high-priority areas. Public buildings, including schools and social housing complexes, were highlighted as key assets for REC development. These buildings can host rooftop PV systems to directly benefit local residents struggling with energy poverty.

3. **Hinterlands**
   The rural outskirts of Patras present significant potential for community solar farms. The mapping exercise identified underutilized agricultural lands and open spaces suitable for large-scale PV projects. These projects could provide energy to nearby villages while reducing reliance on fossil fuels.

Discussion and conclusions

The mapping analysis for Patras reveals the diverse opportunities for REC development, tailored to the unique characteristics of the port, urban neighborhoods, and hinterlands. Each category presents distinct challenges and advantages:

1. **Port Zone**

   The port zone's energy-intensive operations align well with the objectives of RECs, which aim to reduce reliance on conventional energy sources while promoting sustainability. However, implementing REC projects in this area may require navigating complex industrial regulations and ensuring grid compatibility for large-scale installations. These factors must be addressed collaboratively with port authorities and energy providers.

2. **Marginalized Neighborhoods**

   Marginalized neighborhoods are the most socially impactful sites for REC implementation. Projects in these areas directly address energy poverty, providing financial relief and enhancing access to affordable, renewable energy. Engaging local residents and community leaders will be crucial to fostering trust and ensuring the successful uptake of REC initiatives.

3. **Hinterlands**
   The rural areas surrounding Patras offer ample space for large-scale solar farms, which can serve multiple purposes. These projects could:

   - Supply energy to nearby villages.
   - Foster regional sustainability by reducing greenhouse gas emissions.

- Support agricultural productivity through energy-sharing schemes. However, logistical challenges, such as ensuring grid connectivity and minimizing land-use conflicts, must be carefully managed.

Cross-sector collaboration between local authorities, businesses, and community stakeholders is essential for overcoming these barriers and realizing the full potential of RECs in these diverse settings.

The spatial analysis for Patras highlights the feasibility and strategic importance of activating RECs across three key areas: the port, marginalized neighborhoods, and the hinterlands. Each area offers unique opportunities and challenges:

- **Port Zone**: The integration of renewable energy into the port's industrial operations can enhance energy efficiency and sustainability while reducing operational costs.
- **Marginalized Neighborhoods**: REC projects in these areas address critical social needs, such as energy poverty, while fostering community participation and empowerment.
- **Hinterlands**: Large-scale solar farms in rural areas contribute to regional energy independence and sustainability, benefiting both local residents and agricultural sectors.

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