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R2M: R2M SOLUTION SRL

INOVA+: INNOVATION SERVICES, SA

APE FVG: AGENZIA PER L ENERGIA DEL FRIULI VENEZIA GIULIA

AREAM: AGENCIA REGIONAL DA ENERGIA E AMBIENTE DA REGIAO AUTONOMA DA MADEIRA

PTA CM: REGIONAL DEVELOPMENT FUND OF CENTRAL MACEDONIA

CRES: CENTRE FOR RENEWABLE ENERGY SOURCES AND SAVING FONDATION

SVI.MED.: CENTRO EUROMEDITERRANEO PER LO SVILUPPO SOSTENIBILE - ETS

FAEN: FUNDACION ASTURIANA DE LA ENERGIA

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ABREVIATION AND ACRONYMS

Plan4COLD - Supporting South Europe municipalities in the definition of Sustainable Local Heating and Cooling Plans

RED: Renewable Energy Directive

RES: Renewable Energy Sources

DHC: District Heating and Cooling

DHW: Domestic Hot Water

H&C: Heating and Cooling

RH&C: Renewable Heating and Cooling

SE&R: Sustainability, Exploitation and Replication

MS: Member State

COP: Community of Practice

EAB: European Advisory Board

EE: Energy Efficiency

GHG: Greenhouse Gases

KPI: Key Performance Indicator

RESHC: Renewable Energy Sources for Heating and Cooling

NGO: Non-Governmental Organizations

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ABSTRACT

WP2 main objective is to outline the enabling framework paving the way to the development and implementation of effective SLHCPs. Within WP2, in Task 2.1 the ground has been prepared by scouting the local H&C dynamics, assessing the reference policy and strategic context and detecting main target groups in the local H&C value chain within 17 municipalities with more than 45.000 inhabitants in Portugal, Italy and Greece.

The scope of D.2.1 is to report the results and outcomes from T2.1 activities that can be summarised as follows:

- In none of the project countries article 25 of the EED has been transposed in national laws yet.
- The national and regional policy and strategic frameworks are aligned to the EU 2050 climate transition and decarb targets, but the role of H&C is not always clearly identified and defined along with specific related regulations and supporting measures.
- The 17 municipalities provide a wide range of framework conditions related to territorial, socio-economic climate and energy features and trends, highly representative of the Southern Europe context thus allowing the creation of a more complete and widely applicable methodology for SLHCPs development.
- Almost all the municipalities have prepared and adopted a SEAP and/or SECAP, but their awareness and knowledge on the H&C sector, as for energy consumptions, plants and final uses, trends and criticisms are still quite limited and specific targets, measure and tools supporting the decarb of the local H&C sector are not included in the proposed strategies.
- All municipalities provided a quite detailed mapping of possible key actors and local stakeholders to engage in the SLHCPs development. More or less all municipalities selected among most relevant target groups: Regional authorities and local authorities' associations, Business support and trade associations, Academia and research organisations, Energy utilities and energy providers, Financing bodies and institutions, Consumers associations.

Results and outcomes from Task 2.1 will be complemented in T2.2 by mapping stakeholders' engagement and H&C data availability and quality assessment, so as to detect main barriers, challenges and opportunities in each involved municipality and provide concrete input for the selection and customization, in Task 2.3 and T3.2, of most suitable approaches, methodologies, tools and resources for the development of effective SLHCPs.

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Within WP2, in Task 2.1 the ground has been prepared by scouting the local H&C dynamics, assessing the reference policy and strategic context and detecting main target groups in the local H&C value chain within 17 municipalities with more than 45.000 inhabitants in Portugal, Italy and Greece:

- **Portugal**: Guimarães (Ave subregion), Loulé (Algarve region), Setúbal, Sesimbra and Palmela (Lisbon region), Evora (Alentejo region), Villa Real (Douro region), Funchal (Madeira).
- **Italy:** Udine and Pordenone (Friuli Venezia Giulia region), Ragusa, Vittoria and Modica (Sicily region)
- **Greece:** Menemeni – Ampelokipi, and Thermi (Central Macedonia region), Heraklion and Chania (Crete)

D2.1 presents the results and outcomes from T2.1 activities focusing on:

- The existing EU, national and regional framework (legislations, regulations and policies)
- The local territorial context
- The existing local strategies and plans
- The energy and H&C local demand and supply
- The mapping of key local actors and relevant stakeholders.

D2.1 directly contributes to Plan4Cold specific objectives:

1. Support South European municipalities to develop Sustainable Local Heating and Cooling Plans that address their specific climate, infrastructural, economic and social contexts.
2. Guarantee the alignment of the Sustainable Local Heating and Cooling Plans with the national plans, strategies, targets and supporting instruments in place.
3. To actively engage key stakeholders in the project through a dynamic Heating and Cooling Community that can discuss the needs, challenges and opportunities in the municipalities and support the consideration of their specificities in the Sustainable Local Heating and Cooling Plans

Results and outcomes from Task 2.1 will be complemented in T2.2 through mapped stakeholders' engagement and H&C data availability and quality assessment, so as to detect main barriers, challenges and opportunities in each involved municipality and provide concrete inputs for the selection and customization, in Task 2.3 and T3.2, of most suitable approaches, methodologies, tools and resources for the development of effective SLHCPs.

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2. The reference national policy and strategic context

The European Green Deal establishes the European Commission efforts to fight against climate change, mitigate its impacts and define a clear pathway towards a climate-neutral Europe by 2050. The key goal is the reduction of greenhouse gas emissions by at least 55% by 2030 relative to 1990 levels. To operationalize the European Green Deal, the Fit for 55 legislative package was set in July 2021, establishing key instruments to ensure a fair, cost-effective and competitive transition. (source: https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/delivering-european-green-deal_en).

A pillar of the Fit for 55 legislative package are the three directives that closely deal with energy efficiency and renewable energy: the Renewable Energy Directive, the Energy Efficiency Directive and the Energy Performance of Buildings Directive.
These Directives, that should be transposed into the national law of each Member State, establish key points and initiatives that need to be in force for the energy transition to be effective in the different sectors of the EU' economy. One of the sectors that is tackled in is the heating and cooling sector for which specific proceedings are set, regarding the incorporation of renewables in the heating and cooling sector, the need for perform local heating and cooling planning and consider an extend definition of efficient district heating and cooling and guarantee new energy performance standards for buildings considering a gradual phase out of fossil fuel heaters, a detailed assessment on the performance conditions of heating, ventilation, air conditioning and domestic hot water systems and increased deployment of solar technologies.

In T2.1 an analysis has been developed on the national reference policy and strategic frameworks supporting or influencing the H&C sector and its decarbonization and, more in general, targeting energy transition, climate change, environmental sustainability etc. A specific focus concerned:

- The level of implementation of the EU Directives;
- The H&C role and the H&C demand and supply foreseen scenarios in the current energy and climate legislations or strategies such as the NECP, the national Climate Change Mitigation and Adaptation Strategy etc.;
- Available or expected incentives, supporting mechanisms and financial tools targeting energy transition and, particularly, the decarbonization of the H&C sector.

In the following paragraphs, an overview of the reference framework in each of project countries is presented.
To be noted that none of the three project countries has transposed Article 25 of Energy Efficiency Directive concerning Local Heating and Cooling in national laws yet.

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2.1 Portugal

In Portugal there are 65 municipalities with more than 45.000 inhabitants that need to ensure the preparation of LHCP. Of these, 54 are signatories of the Global Covenant of Mayors for Climate and Energy.
In the national context, total final energy consumption (TFEC) for the H&C sector was almost 6.2 Mtoe in 2018, representing 36 % of Portugal's final energy consumption (FEC). The share of renewable energy in FEC in the H&C sector was 41.2 % in 2018. Estimated trajectories for FEC in the H&C sector show a decrease of 7.4% from 2020 to 2030 (source: Portuguese NECP/2024).
Bioenergy is the dominant renewable energy in the sector and its consumption is expected to remain stable until 2030. The energy supplied by heat pumps and solar thermal remains constant over the next decade, while renewable gases are expected to play a larger role by 2030.

Portugal's main climate and energy objectives are set out in the Portuguese Climate Change Framework Law, approved by Law No. 98/2021, the National Energy and Climate Plan 2021-2030 (NECP 2030) and the updated draft NECP submitted in June 2023.
Portugal does not expect to develop district heating networks, as indicated in the detailed assessment of district heating options in the NECP (source: Portuguese NECP/2024, p. 142).
The draft plan includes an indicative renewable energy share target for the H&C sector at 63 % by 2030. Promoting the development of municipal and regional climate action plans is proposed as a new measure (1.6.7 "Promote the development of municipal and regional climate action plans") in the draft plan. It states that these plans should be aligned to other planning documents, and that appropriate support networks should be established. No reference is however given to heating and cooling or energy planning in general.
Regarding local planning it is also worth noting that there are two relevant obligations for the Municipalities, one concerning the development of local adaptation plans, within the context of the Basic Law of the Environment (Lei n.98/2021) and another concerning the definition of Efficiency and Decarbonization Plans for public infrastructures (RCM n. 150/2024).
The specific targets for RES in heating and cooling, up to 2030, are presented in the following table.

Targets (NECP, 2024)	2025	2030
RES in H&C	46 %	63%

Main policies promoting RES in the H&C sector:

- Promotion of RES-H&C systems, such as solar thermal systems, renewable boilers, and hybrid systems combining two or more technologies.
- Promotion of the uptake of more efficient technologies, including ventilation, combustion, heat recovery and industrial cooling.

The updated Portuguese NECP (2024) takes much more account of the local and regional dimension of the energy and climate transition than the 2019 version of the plan.

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It includes a new measure to "promote municipal climate action plans" and develop a national network of cities for this purpose, as well as highlighting the importance of local authorities and local associations and cooperatives.
From the NECP data, Portugal shows a positive trend with a share of renewable energy sources of around 42% of the heating and cooling sector consumption (in 2020).
Regarding the different technologies for H&C, biomass and heat from cogeneration account for about 60% of the renewable energy supply. Heat pumps and solar thermal are expected to account for around 30% and 7% respectively in 2030. On the other hand, the estimate for renewable gases corresponds to a 6% share of renewable energy supply in 2030. Overall, 64% of the total bioenergy (biomass, CHP and renewable gases) is expected to be used in the H&C sector by 2030.
However, the lack of available data is a bottleneck and makes it impossible to obtain detailed breakdowns of sector-specific needs. This highlights the urgent need for comprehensive data to identify policy priorities/added value proposals that will assist public authorities in their decision-making process.
Portugal has one of the highest rates of thermal discomfort reported by its citizens. According to the Energy Poverty Observatory, https://onpe.pt/pobreza-em-numeros/, 2023 data, 20.8% of the Portuguese population cannot keep their homes warm and 38.3% say their homes are uncomfortable during the summer season.
It is therefore appropriate that the updated NECP includes various measures to tackle energy poverty. The NECP promises the implementation of a national long-term strategy as well as local strategies to combat energy poverty. It also mentions the promotion of more structural programmes, measures and support mechanisms to combat energy poverty, such as incentives to change consumption patterns, targeted measures for investment in energy efficiency, renovation of buildings and programmes for the integration of renewable energy. These support mechanisms will be developed together with municipalities in order to better reflect reality and promote proximity to energy poor consumers.

In addition, Portugal has focused on promoting the training and skills needed to decarbonise the heating and cooling sector, including through the uptake of renewables. Importantly, these programmes promote the synergies between energy efficiency gains and renewable energy deployment.

In terms of incentives, the increase of renewable energy in the building sector (individual, multi-family and public buildings) is addressed through different types of incentives for the implementation of RES, together with the modernisation of the energy efficiency of buildings, namely, grant programmes such as *'Programa de Apoio a Edifícios mais Sustentáveis*' (PAES) and '*Vale Eficiência*' (PT). Incentive programmes have also focused on promoting the specific use of renewable technologies and the replacement of inefficient renewable heating technologies. Finally, the electrification of heating and cooling is also promoted via the purchase and use of heat pumps for domestic hot water and space heating and cooling.

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Regarding the uptake of renewable energy in industrial heating and cooling, the *Recuperar Portugal* programme provided incentives to support innovation projects in four areas: low-carbon technologies and processes, energy efficiency measures, integration of renewable energy and storage infrastructure, and definition of decarbonisation roadmaps, including capacity building initiatives. These funding lines are now closed.

The analysis of the uptake of renewables in other sectors focused on the issue of energy poverty, as there is a link between measures to combat energy poverty and support for the uptake of renewables in the heating and cooling sector, as well as in the area of skills and public awareness, as this is a prerequisite for the energy transition in the heating and cooling sector.

2.2 Italy

In Italy there are 173 municipalities with more than 45,000 inhabitants that will need to define their H&C plans until 2030, and of which, 159 are signatories of the Global Covenant of Mayors for Climate Energy. In Italy, the H&C sector accounts for around 50% of the final energy consumption, 20% of which from renewable sources. This value is expected to increase to around 40% in 2030, already considering the compliance with the new RED Directive.
As far as the EU Directives are concerned, the Renewable Energy Directive III (RED III) imposes binding targets for the annual increase in the share of renewables in the H&C sector. Specifically, Italy must guarantee a growth of 0.8% per year until 2025 and 1.1% from 2026 to 2030. In addition, a 49% share of renewable energy in buildings is planned by 2030.
Furthermore, the Energy Efficiency Directive (EED) obliges Italy to reduce energy consumption by 11.7 % by 2030 compared to 2020 levels. For the H&C sector, measures such as high-efficiency cogeneration, the integration of renewable energies and the use of waste heat should be adequately promoted, together with a more diffuse use of district heating and cooling solutions.
The Italian National Energy and Climate Plan (NECP), defining the long-term energy and climate strategic policy, indicates a value of around 12,000 ktoe/year for the final consumption of RES in H&C. This value should increase to almost 18,000 ktoe in 2030. By 2030, then, the share of total energy consumption for H&C covered by RES should be 35.9% starting from around 23% in 2024. It should be noted that the RED III leads to identifying for Italy a sectoral target to 2030 equal to 29.6%, which rises to 39.1% if we consider the indicative increases envisaged in Annex 1a of the same Directive. To reach the target, the contribution of waste heat recovery and of the renewable share of electricity consumed for heating purposes is to be used, under the conditions envisaged by the RED III directive.

The NECP stresses some priorities for the correct development of RES for H&C:
- Higher quality and emission standards for biomass boilers
- Promote the use of agricultural residues
- Foster short supply chains for biomass
- Increase the use of biomethane, especially in the industrial sector
- Increase the use of heat pumps

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- Foster the use of solar thermal in hybrid systems and for large-scale applications, such as district heating, also in combination with seasonal storage
- Promote the synergy between the use of RES and the energy efficiency retrofit of buildings

About the last point, decarbonisation strategies for buildings are one of the key elements since buildings account for 42% of national energy consumption, with 75% of them built before 2000. In fact, the majority of buildings are still on energy category E or below. Italian policies aim at improving the energy efficiency of buildings through minimum energy performance standards, incentives for energy retrofitting and the phasing out of fossil fuel boilers by 2040. National incentives, such as the Superbonus and Ecobonus, play a crucial role in encouraging investments in sustainable energy technologies for the residential and commercial sector.
In addition to that, the Strategy for the Energy Regeneration of the National Housing Stock (STREPIN) establishes measures to improve the energy efficiency of buildings by reducing energy demand in the H&C sector through thermal insulation, installation of more efficient air conditioning systems and progressive elimination of fossil fuel boilers.

The main incentives and support mechanisms also related to the H&C sector can be listed as follows:
- Superbonus 110%: Scheme, already expired, aimed at promoting energy retrofitting in buildings, including the installation of heating and cooling systems based on renewable sources.
- Conto Termico: It provides grants for the installation of heat pumps, biomass boilers, solar thermal plants and energy efficiency measures in the thermal sector.
- Ecobonus: Tax reduction for energy efficiency interventions in existing buildings.
- European and National Funds: Through the National Energy Operational Programme and the 2021-2027 Structural Funds programming, Italy supports innovative decarbonisation projects.

Another crucial topic for the H&C sector is district heating and cooling. Though Italy is making good progress in the transition to efficient district heating systems, to meet the ambitious decarbonization targets set by the European Union for 2050, the country will need to take further steps, maximizing the use of valuable sources like RES and waste heat, in line with Art. 26 of the Energy Efficiency Directive (EED).
This transition is supported by the implementation of Directive RED III, which introduces a clear definition of waste heat, based on strict criteria: The heat must be unavoidable, a by-product of industrial processes or generation plants, and must be recovered for district heating. For example, heat produced by waste treatment plants, beyond the biogenic fraction, is considered waste heat. These principles, integrated into national legislation through Legislative Decree 199/2021, represent a milestone for the sector.
The NECP also aims at increasing the use of RES and recovered heat, particularly from industrial processes and shopping centers. The regulations are structured around key tools such as the DM OIERT, which introduces the obligation to increase the share of renewable thermal energy, and the DM FER Thermal Incentives, which provides incentives for small systems and connections to district heating networks.

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In parallel, the EPBD Directive (2024/1275) highlights the contribution of district heating to energy efficiency in buildings, including the connection to efficient district heating among the necessary technologies to meet the zero-emission building standard. This represents an additional stimulus to integrate district heating into urban strategies.
On the incentive side, the national system offers concrete measures to promote the decarbonization of the district heating and cooling sector.

These include the extension of the social bonus for vulnerable district heating users, proposed by ARERA, which ensures an economic contribution based on the ISEE index without the need to submit an application. Additionally, Directive (EU) 2022/542 allows for the application of a reduced VAT rate for efficient district heating systems, which will be activated from January 1, 2025.
Together, these measures – incentives, regulatory obligations, and urban integration strategies – form a coherent framework to accelerate the energy transition and decarbonization of the H&C sector in Italy, while providing economic and environmental benefits for citizens and communities.

2.3 Greece

In Greece there are 72 municipalities with more than 45.000 inhabitants, and of those 63 are signatories of the Covenant of Mayors. Greece's national framework for energy transition, decarbonization, and climate change mitigation is largely guided by the National Energy and Climate Plan (NECP). The most recent update of the NECP in 2024 highlights several key challenges in the Heating and Cooling (H&C) sector. Notably, 60% of Energy Performance Certificates (EPCs) in Greece fall within the lowest efficiency categories (E and G). Furthermore, over 50% of buildings were constructed before 1980, the year when the first insulation regulations for buildings was introduced, creating a significant gap between the energy efficiency of Greece's building stock and the EU average.

These factors contribute to substantial vulnerability for many households, exposing them to the risks of extreme weather events, climate fluctuations, and rising energy costs. The outdated building stock is inefficient, which exacerbates energy poverty, with many households struggling to afford the energy needed for heating and cooling. Energy poverty remains a key challenge, with significant numbers of people unable to afford adequate heating and cooling solutions.
In response, Greece has set ambitious targets to decarbonize the H&C sector. By 2025, the goal is for 48.7% of energy consumed for heating and cooling to come from renewable sources, with this share increasing to 62.1% by 2030. Achieving these targets requires a focus on energy efficiency, as well as the transition to renewable energy sources. The NECP identifies energy savings and combating energy poverty as key priorities, particularly in the context of the country's aging building infrastructure.

The National Climate Law (no. 4936/2022) Transition to climate neutrality and adaptation to climate change, emergency provisions to address the energy crisis and protect the environment, consisting of 45 articles, aims at creating a coherent framework for improving the adaptive capacity and climate resilience of the country and for ensuring the gradual transition of the country to climate neutrality

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by the year 2050, in the most environmentally sustainable, socially fair and economically efficient way. To achieve this long-term goal of climate neutrality, the Law provides for net reduction of greenhouse gas emissions, taking into account the projections of the National Energy and Climate Plan, drawn up in accordance with article 3 of Regulation (EU) 2018/1999 of the European Parliament and of the Council on the governance of the European Union and Climate Action.

The Law provides for the establishment of specific measures: to strengthen adaptation to climate change at the lowest possible cost; to mitigate emissions from power generation, the building sector, transport and business; to define indicators for monitoring progress towards achieving the relevant objectives and procedures for evaluating and readjusting the objectives. The Law defines the following relevant terms: greenhouse gases; emissions; decarbonisation; climate neutrality; mitigation of climate change; green infrastructure; adaptation to climate change; carbon budget; vulnerability; governmental committee for climate neutrality.
The Law concerns the drafting of the National Strategy for Adaptation to Climate Change, as a text of strategic orientation, with the aim of drawing up: guidelines on climate change adaptation, assessment of the expected climate changes in the country, based on the effects of climate changes on the various sectors of economic and social activity, identification of the priority sectors that need adaptation measures for climate change; and of the Regional Plans for Adaptation to Climate Change, including assessment of the immediate and long-term impacts of climate change on various sectors, proposed measures and actions for the priority sectors and areas.
The Law provides for revision of climate goals; definition of five-year sectoral carbon budgets; definition of general policy measures in order to achieve: energy savings and the increase of energy efficiency in all sectors of the economy; the gradual elimination of all fossil fuels and their replacement by renewable energy sources in all the sector of the economy, to avoid impacts on the natural environment, biodiversity and the landscape; the gradual substitution of natural gas by renewable gases such as biomethane and green hydrogen; promotion of sustainable urban mobility and the use of public transport; the reduction of greenhouse gas emissions from waste management and the promotion of the circular economy; the increase of greenhouse gas absorptions by natural ecosystems; sustainable urban development planning and the promotion of sustainable agriculture, animal husbandry, fishing and food production.
The Law focuses on measures to promote zero emission vehicles; municipal emission reduction plans and measures to reduce emissions from buildings; the use of natural resources, in particular land, soil, water and biodiversity, according to the sustainable availability of these resources; assessment of impacts of emission of pollutants, and assessment of risks to human health, cultural heritage or the environment. Matters covered by this Law include: transformation of the development model of the islands and their transition to climate neutrality; financial resources and incentives; public participation and monitoring; roles of committees on climate change; international cooperation on climate change; emergency environmental provisions; provisions to address energy crisis, protection of forests and waste management.
Article 16 of this National Law refers to the obligation of the Greek municipalities to submit their Municipal Plans for Emissions reduction by March 31, 2023 (ΔΗΣΜΕ).

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According to this article, Municipal Plans should calculate the carbon, identify and prioritize the necessary measures and actions to reduce the emissions of the municipality which should also be compatible with the objectives and policies of the National Energy and Climate Plan (NESP).

These municipal plans should be reviewed at least every five years. In particular, they should includes an inventory and emission reduction targets for the buildings, equipment and infrastructure that consume energy, used not only by the municipalities, but by the legal entities supervised by them. Moreover, these Municipal Plans should include a detailed inventory, with a base year of 2019, of energy consumption and emissions for buildings, public facilities, especially for sports, culture, lighting of municipal streets and public spaces, as well as municipal water supply, sewage, irrigation facilities and municipal vehicles and should also take into account the Building Energy Performance Plan that each municipality should have according to the article 7 of law 4342/2015 (National Gazete A' 143) and should be in accordance with the specifications of the «2006 IPCC Guidelines for National Greenhouse Gas Inventories»,.

The above national legislation for emission reduction is followed and completed by the Governmental Decision (ΚΥΑ) 68315/2022 which foresees measures for energy efficiency and reduction in buildings and public installations. According to this Gov. Decision Municipalities should monitor the implementation of the energy efficiency measures in each public building and collect and provide data, the relevant Minister. In line with the above Greek legislation, Ministries and other central government authorities have appointed Energy Managers for their public buildings. They are responsible for collecting & monitoring energy data for the buildings under their responsibility, including energy efficiency measures applied or planned to be applied, and report annually to the Ministry of Environment and Energy using specific monitoring tools provided by the Ministry.
Even though there is a requirement for public authorities to appoint designated Energy Managers for their public buildings to monitor the energy consumption of public buildings in their responsibility, set improvement targets, and regularly re-port to the Ministry of Environment and Energy using a provided Excel-based tool, there have been delays by public authorities in appointing these designated per-sons, and since appointed, only some of them have been undertaking the process of regular collection, monitoring and reporting. Information from the Excel-tools is not collected centrally by each Region, for all Regional and Municipal buildings.

To support these goals, Greece is leveraging resources from the Recovery and Resilience Fund (RRF), the Operational Programme for Competitiveness (ESPA), and EU funds. Programs that provide financial support to households, to business and to public sector are designed to enhance energy efficiency, promote building renovations, and improve the quality of life for households. These initiatives also aim to reduce energy costs, with a particular focus on protecting vulnerable groups.
A critical component of the decarbonization strategy for the H&C sector is the transition to heat pumps, which are central to achieving the renewable energy targets for heating and cooling.

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In contrast, the use of biomass is not expected to expand, and the number of systems relying on biomass will remain at current levels. Additionally, the gradual phase-out of fossil fuel-based boilers is planned to be completed by 2040.

In terms of addressing energy poverty, the government will continue providing heating allowances. In 2023, €237 million were allocated to heating subsidies, with slightly higher expenditures in 2022 (€269.2 million). However, as the adoption of cleaner and more efficient heating technologies increases, these costs are expected to gradually decrease.

These efforts reflect Greece commitment to improving energy efficiency, transitioning to renewable energy, and supporting vulnerable households. However, the challenges remain significant, especially in upgrading the existing building stock and ensuring that energy transition benefits are felt across all segments of society.

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3. The reference regional policy and strategic context

In T2.1 an analysis has also been developed on the reference policy and strategic frameworks in the project target regions, namely:

- **Portugal:** Ave subregion, Algarve region, Lisbon region, Alentejo region, Douro region and Madeira.
- **Italy:** Friuli Venezia Giulia region and Sicily region.
- **Greece:** Central Macedonia region and Crete.

The main contents of the current energy and climate legislations, regulations and strategies at the regional level have been scouted, with a specific focus on the regional Climate Change Mitigation and Adaptation Strategies, highlighting the H&C role and the H&C demand and supply foreseen scenarios within them where and if possible.
Furthermore, also the available or expected supporting mechanisms and financial tools targeting energy transition and the decarbonization of the H&C sector have been detected and assessed.

The results of the analysis in each target region are reported in Annex 1.

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4. The reference local context

Finally, in T2.1 an in-depth analysis has been developed on the local context in the 17 municipalities, mainly basing on desk research and the direct interaction with representatives (technicians and politicians) to complement and validate them.

As a first step, the existing framework of local strategies and plans has been faced, concerning both energy, climate transition and urban development more in general.
The **local energy strategies** and **action plans** (e.g. SEAP/SECAP etc.) have thus been assessed, with a focus on specific targets, key sectors and fields of intervention, level of implementation and objective already reached, any revisions and updates, possible H&C demand and supply scenarios, actions and tools promoting efficiency increase and RES diffusion.

Then, the **adaptation policies** and **measures** along with **urban** and **territorial plans** and **regulations** (*i.e. spatial plan, building code, building renovation plans, permitting procedures etc.*) have been considered, detecting possible interaction with and influence on local mitigation strategies and measures, and on the decarbonisation of H&C sector.

As a part of the analysis, the local energy system was also scouted as for main trends, dynamics and critical aspects, with a specific focus on H&C if and where possible.

More in detail, data and information have been collected and evaluated concerning:
- The level and type of energy consumption, detailing which energy sources/fuels are used in which sectors;
- The level and type of consumptions and the share of RES in the H&C sector;
- Main H&C final uses (*climate control in buildings, hot water, industrial processes, etc.*) and the most H&C diffused plants technologies/equipments;
- The number and type of plants producing heat, cool or electricity on the territory, highlighting the share of RES and waste heat;
- The local energy and H&C demand and supply trends.

For each municipality, the analyses have been integrated with a general description of the municipality/area where the SLHCP will be developed, as for main geographic, territorial and socio-economic features, with a specific focus on the climate framework, relative trends and critical issues.

A mapping of the main target groups in the local H&C value chain has been included in the survey and the relevant local actors and key stakeholders identified and selected by each municipality, so as to engage them in T2.2 and prepare the set-up of the Communities of Practice in Task 4.2.

The results of the local context analysis in each involved municipality are presented in Annex 1.

Co-funded by the European Union

5. Conclusions

- In none of the project countries article 25 of the EED has been transposed in national laws yet.
- The national and regional policy and strategic frameworks are aligned to the EU 2050 climate transition and decarb targets, but the role of H&C is not always clearly identified and defined along with specific related regulations and supporting measures.
- The developed analyses among the 17 municipalities showed a wide range of framework conditions related to territorial, socio-economic climate and energy features and trends, highly representative of the Southern Europe context. Exactly this diversity will allow the creation of a more complete and widely applicable methodology for SLHCPs development.
- Almost all the municipalities have prepared and adopted a SEAP and/or SECAP, but their awareness and knowledge on the H&C sector, as for energy consumptions, plants and final uses, trends and criticisms are still quite limited and specific targets, measure and tools supporting the decarb of the local H&C sector are not included in the proposed strategies.
- All the 17 involved municipalities were activated and confirmed their commitment in the project, providing relevant contributions for the initial survey implementation
- All municipalities provided a quite detailed mapping of possible key actors and local stakeholders to consult in T2.2 and afterwards engage in the SLHCPs development. More or less all municipalities selected among most relevant target groups: Regional authorities and local authorities' associations, Business support and trade associations, Academia and research organisations, Energy utilities and energy providers, Financing bodies and institutions, Consumers associations.

Results and outcomes from Task 2.1 will be complemented in T2.2 through:

- The collection, analysis and understanding of data regarding local energy needs and energy demand in the H&C sector;
- The mapped stakeholders' engagement and consultation to finalise the context analysis, the H&C data availability assessment and to trigger empowerment and engagement for the setup of the Communities of Practice in Task 4.2.

It will then be possible to detect main barriers, challenges and opportunities in each involved municipality and to provide concrete inputs for the selection and customization, in Task 2.3 and T3.2, of most suitable approaches, methodologies, tools and resources for the development of effective SLHCPs.

Co-funded by the European Union

Supporting South Europe municipalities in the definition of Sustainable Local Heating and Cooling Plans

Date: 31/01/2025

Grant agreement No: 101167534 – LIFE23-CET-Plan4Cold

Project start date: 1st October 2024

Duration: 36 months

D2.1

LOCAL CONTEXT TO DEVELOP SLHCPS

ANNEX 1

D2.1

LOCAL CONTEXT TO DEVELOP SLHCPS

PORTUGAL

MUNICIPALITY OF GUIMARAES

1. The local territorial context

Guimarães is located on Braga's district, on the Northwest of Continental Portugal, on the subregion of Ave, belonging to the North region (*vide* Figure 1). It stands on the hydrographic basin of Cávado, Ave and Leça Rivers, on a valley region surrounded by mountains. The municipality has 241,05 km^2 of extension. The urban area – the city of Guimarães – is 23,5 km^2.

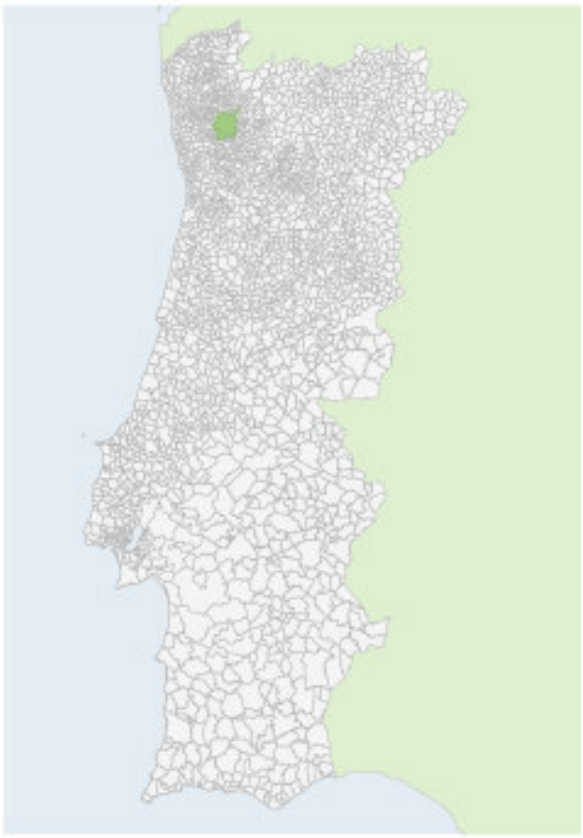


Figure 1 - Location of Guimarães' municipality (PASEC 2019)

The municipality had 156.789 residents in 2023 (GEE 2024). The population density was 649,4 inhab/km^2, much higher than the Portuguese average of 115,4 inhab/km^2 for the same year (GEE 2024; PORDATA 2024). Furthermore, it has a young population, with 35% of it being under 30 years old (after Census 2021). The average annual growth rate of population (2011/2023) is -0.1%, so slightly negative (GEE 2024).

The city of Guimarães is a medieval historical city, founded in the 10th century, and known as the *cradle of Portuguese nationality*, for its association to the emergence of Portugal and of the Portuguese identity. In the 12th century, several political and military events that lead to the birth and independence of the Portuguese nation took place in Guimarães (https://www.cm-guimaraes.pt/municipio/viver-guimaraes/dados-historicos). Guimarães became, in the 12th century, the first capital of Portugal.

Currently, the Historical Centre of Guimarães and Couros Zone is, due to the integrity of its historically authentic building stock, an UNESCO's World Heritage Centre (https://www.cm-guimaraes.pt/municipio/viver-guimaraes; https://whc.unesco.org/en/list/1031).

The municipality of Guimarães is one of the most industrialised municipalities in Portugal, with dominance of the textile, cutlery and tannery manufacturing industries. In 2022 there were in the municipality a total of 17.159 enterprises that employed 71.895 workers and moved a total business volume of 6.875 million euros (PMAC 2024:34). Around 70% of the enterprises belong to the textile industry (https://www.cm-guimaraes.pt/municipio/viver-guimaraes). Along with the municipality of Vila Real, Guimarães belongs to the industrial region of the Ave River valley. In fact, the secondary sector in 2021 in Guimarães employed 64% of the employed population of the municipality (GEE 2024). The tertiary sector, with emphasis on services for the support of enterprises, banking and insurance sectors, commerce, social, recreational, cultural services and tourism, employed 35,4% of the employed population of the municipality. Only 0,6% of the working population was employed in agriculture.

As presented on the Plano Municipal de Ação Climática – PMAC (Municipal Climate Action Plan), according to the Köppen-Geiger Climate Classification, and considering the historical reference period of 1971-2000, the climate in Guimarães is predominantly temperate with temperate and dry summers – classification Csb (PMAC 2024:35-48). Guimarães is in one of the regions with the lower average annual temperatures in Portugal - these vary between 10ºC and 15ºC. The higher temperatures occur in July and August (27ºC) and the lowest in December, January and February (3,5ºC – 5ºC). The municipality has high average annual precipitation, which varies between 1400 and 1800 mm per year, and has one of the highest number of days per year of intense precipitation of the Iberian Peninsula (between 10 to 20 days). Precipitation is more intense in autumn and winter (from October until February), and scarce during summer (in July and August). In summary, Guimarães presents a well- defined climate seasonality, with cold winters with recurring precipitation, and hot and dry summers.
According to the PMAC, between 1971 and 2000, the frequency of occurrence of extreme heat events in the spring and summer increased, while the frequency of cold extreme events in the winter decreased. The tendency for precipitation extreme events is of decrease of the precipitation and decrease of the number of days with intense precipitation, in all seasons, except in the autumn. Average wind velocity also decreased in the period 1971-2000. Furthermore, in the municipality, with the projected future continuous increase in temperature, it is predicted that the area that suffers with urban heat island effect will increase.

To characterize the building stock, Figure 2 shows the different construction periods for existing buildings in Guimarães in 2021.

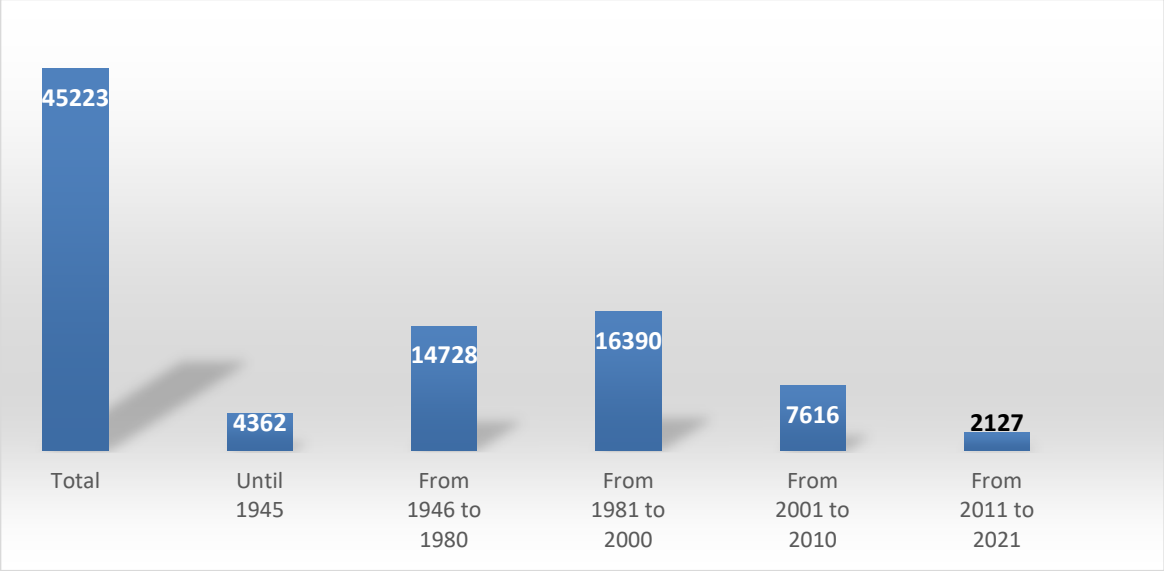


Figure 2 - Construction periods for existing buildings in Guimarães in 2021. (source: INE 2021)

Regarding the state of its buildings in the last available year (2021), as can be seen in Figure 3, the Municipality of Guimarães has a total of 45 223 buildings built, of which 3,3% need deep interventions, 7,7% need medium interventions, 21,8% only minor interventions and 67% need no interventions.

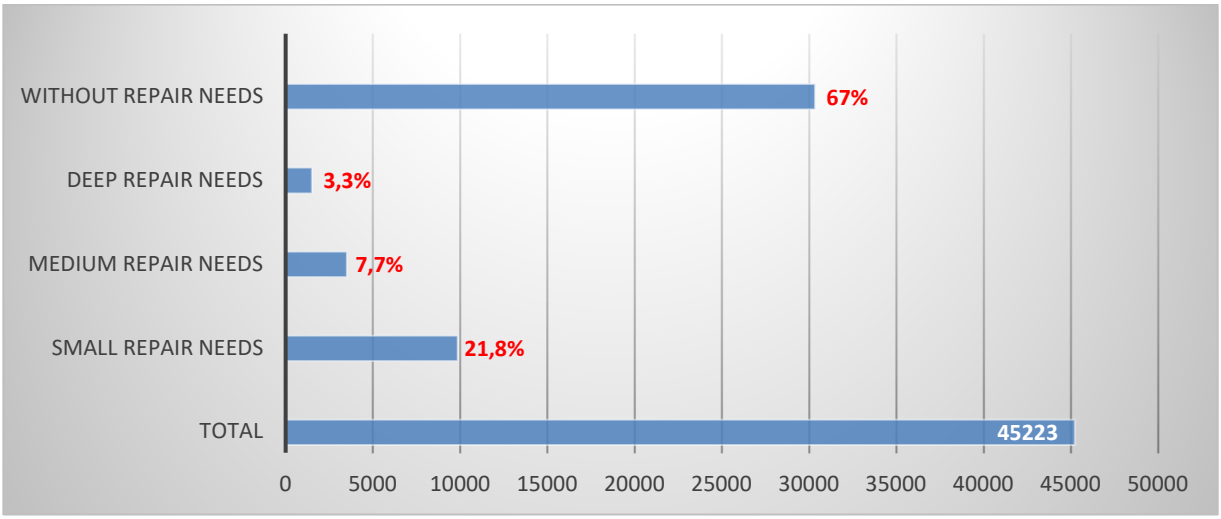


Figure 3 - Total number of buildings built and repair needs (INE 2021)

It is also relevant to analyse the total number of energy certificates issued between 2014 and 2024 in the municipality of Guimarães, by energy class, for all types of buildings (Figure 4). The predominant classes are A, C and D with 17,5%, 17,5% and 15,8% respectively. The total number of certificates in Guimarães is 25.811. The energy certificate is a mandatory document in many countries that assesses the energy efficiency of a property, classifying it on a performance scale (for example, from A+ to G). It identifies the expected energy consumption and suggests improvements to reduce costs and emissions. It comes from the EPBD (Energy Performance of Buildings Directive), a European directive aimed at improving the energy efficiency of buildings. In Portugal, it has been mandatory since 2009 for new and existing properties in cases of sale, rental or major renovation.

Implementation follows the rules of the Energy Certification System for Buildings (SCE), managed by ADENE (Energy Agency).

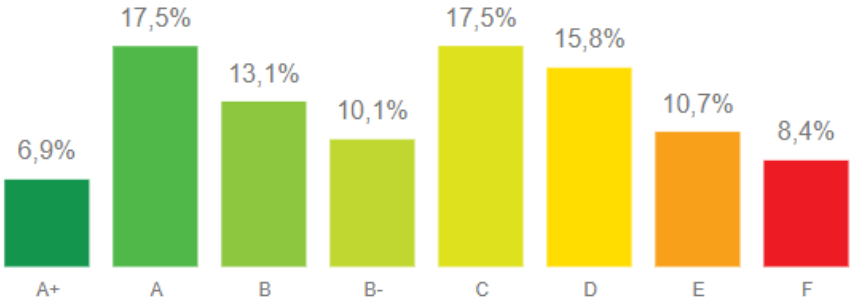


Figure 4 - Total energy certificates issued in the municipality of Guimarães between 2014 and 2024, by energy class (SCE 2024)

2. The reference policy and strategic context [max 3 pages]

The regional context

Regionally there are, in Continental Portugal, Comissões de Coordenação e Desenvolvimento Regional – CCDR (Regional Coordination and Development Commissions). These are peripheral services of the direct administration of the State, endowed with administrative and financial autonomy (but devoid of legal personality), which have powers in the fields of coordination and articulation of the various sectoral policies at regional level, implementation of environmental policies and spatial and urban planning, technical support for local authorities and their associations and management of European funding programmes (https://diariodarepublica.pt/dr/lexionario/termo/ccdr-comissao-coordenacao-desenvolvimento-regional).
There are currently 5 CCDRs in Portugal (Decree-Law No. 228/2012) that correspond to the 5 regions of Continental Portugal (North, Centre, Lisbon and Tagus Valley, Alentejo, Algarve). Furthermore, sub-regionally, there are intermunicipal entities (Law No.75/2013). These can take the form of Intermunicipal Communities or of Metropolitan Regions and correspond to the NUT III territorial units. There are currently 21 intermunicipal communities and two metropolitan areas in Continental Portugal. Intermunicipal entities are free associations of municipalities, non-territorial, with their own budget and management, and clear objectives, to which the associated municipalities delegate part of the functions or competences conferred on them by law, with the aim of provide services to all its members. According to Law No. 50/2018, intermunicipal entities have, amongst other, power to appoint members representing municipalities on river basin district councils, manage projects financed with European funds and manage investment caption programmes.

On the scope of the Portuguese Climate Framework Law (Law no. 98/2021) the CCDRs need to develop Planos Regionais de Ação Climática – PRACs (Regional Climate Action Plans), which should include the dimensions of mitigation and adaptation to climate change. CCDRs are also, for example, responsible for the development of the Estratégias Regionais de Especialização Inteligente – RIS3 (Regional Innovation Smart Specialisation Strategies), an approach created by the European Union in 2010. The RIS3 are regional strategies that aim to address regional challenges and support regional development through the identification and promotion of areas of innovative specialization. These strategies usually include lines of action related with the increase of sustainability and of territorial cohesion, decarbonization, the transition to a more circular economy and/or the sustainable use of resources/assets. These strategies are also closely linked to European Union funding, especially in the context of cohesion policies and structural funds. Both the RIS3 and other plans and strategies developed by the CCDRs and by the intermunicipal entities are not, in general, directly binding on municipalities. They rather serve as strategic guides for regional and sub-regional development, and municipalities are

encouraged to align their policies and actions with their guidelines. It is up to each municipality to integrate them in their local legal instruments and regulations, such as in the municipal-level Instrumentos de Gestão Territorial – IGT (Territorial Management Instruments). The IGTs are the legal and planning documents that regulate and guide land use and spatial planning that compose the Portuguese territorial management system. The Plano Diretor Municipal – PDM (Municipal Master Plan) is the primary urban planning instrument at municipal level. It is mandatory and defines the municipality's structure in terms of land use and regulates the urban conditions for new projects and developments.

In sum, there is no energy nor climate legislation at regional or sub-regional level in Portugal, nor regional or sub-regional incentives, supporting mechanisms or financial tools targeting energy transition or decarbonization targets. There are solely non-binding strategies and plans developed at regional and sub-regional level, that serve as guideline to the municipalities. Nevertheless, the active participation of the municipalities in these organizations condition the municipalities access to funding, including to national and European Union funding.

Guimarães is located in the North of Continental Portugal, therefore being under the jurisdiction of the Comissão de Coordenação e Desenvolvimento Regional do Norte – CCDR-NORTE (Norte Portugal Regional Coordination and Development Commission), that is responsible for the execution of regional environmental and land-use planning, and of regional development of the NUT II – North Region (https://www.ccdr-n.pt/pagina/norte2030). This entity is also responsible for the management of European programs and other regional development financial instruments in the North Region of Continental Portugal.

Guimarães also belongs to the Comunidade Intermunicipal do Ave – CIM-Ave (Inter-Municipal Community of Ave), an association of municipalities governed by public law, that was created in 2009 (https://cim-ave.pt/) which aims to promote intermunicipal projects at the NUT III region of Ave. The municipalities of Cabeceiras de Basto, Fafe, Mondim de Basto, Guimarães, Póvoa de Lanhoso, Vieira do Minho, Vila Nova de Famalicão and Vizela belong to this association. The CIM-Ave has developed the Plano Intermunicipal de Adaptação às Alterações Climáticas – PIAAC-Ave (Inter-Municipal Plan for Adaptation to Climate Change of Ave) in 2020, on the scope of the National Strategy for Adaptation to Climate Change (ENAAC). This plan focuses on the achievement of the carbon neutrality for the NUT III Ave region, reducing vulnerabilities and integrating mitigation and adaptation to climate change (https://cim-ave.pt/projetos/piaac-da-cim-do-ave/). Therefore, it encompasses four strategic axes, namely the promotion of ecological regeneration, the fostering of social and solidary economies, the integral development and the reinforcement of a transition governance. The heating and cooling sector is not directly mentioned on this plan. Nevertheless, urban planning issues relevant to H&C, such as the creation of regional ecological corridors and the requalification of the urban of cities and *vilas* to improve urban comfort and reduce the effect of heat islands are proposed within the ecological regeneration strategic axe, on the timeframe that ranges from 2020 until 2027 (PIAAC-Ave 2020:16-43). The rehabilitation of the building stock is also proposed, but there is no mention to H&C issues.

The local context

The municipality of Guimarães is signatory of the Covenant of Mayors for Climate and Energy since 2013 (https://eu-mayors.ec.europa.eu/en/signatory/17753). On that scope, it designed the municipal Plano de Ação para a Energia Sustentável – PAES (Sustainable Energy Action Plan) in 2013 and the Plano de Ação para a Sustentabilidade Energética e Climática – PASEC (Sustainable Energy and Climate Action Plan) in 2019. Furthermore, on the scope of the Portuguese Climate Framework Law - Law no. 98/2021 - Guimarães elaborated the Plano Municipal para a Ação Climática – PMAC (Municipal Climate Action Plan) in 2024.

Additionally, on the scope of project NetZeroCities (https://netzerocities.eu/), Guimarães developed the 2030 Climate Neutrality Action Plan, as part of the commitment to move closer to climate neutrality by 2030. This document included an Action Plan, that was collaboratively created with several stakeholders (e.g. citizens, associations, industry and business, public and private institutions and universities).

In 2019, in the PASEC, Guimarães already included, within the Sustainable Energy and Climate Actions, specifically within the Sustainable Buildings Actions, the promotion of energy efficient air conditioning and ventilation systems and of efficient boilers, with emphasis on the use of heat pumps, as a sustainable option, as well as the promotion of the gradual renewal of inefficient consumer appliances (PASEC 2019:106-8). The Sustainable Energy and Climate Actions are the actions that were defined, on the scope of the municipality of Guimarães' commitment to adopt an integrated climate change mitigation and adaptation strategy focused on promoting sustainable and resilient urban environment that mobilizes local, business, social and institutional agents. There are several types of sustainable actions, namely Sustainable Mobility Actions, Sustainable Buildings Actions, Sustainable Street Lighting Actions, Open Energy Management Systems, Awareness and Education Action, Other transversal Sustainability Actions and Renewable Power Actions. The Sustainable Building Actions are based on the idea that a sustainable and efficient building stock is essential for both minimizing environmental and climatic impacts and maximizing the comfort and health of its occupants. Besides the actions mentioned above, the Sustainable Building Actions encompass: 1) efficient lighting in buildings, 2) sustainable building, energy audits and building certification, 3) efficient office equipment, 4) efficient industrial equipment and processes and 5) efficient driving force equipment actions.

Guimarães PASEC strategy also included, within the Renewable Power Actions, specifically within the Integrated Renewable Generation actions, the promotion and encouragement of investment in energy production projects for self-consumption or sale of energy using renewable energy sources. On this scope, are mentioned cogeneration solutions (combined heat and power) for central heating and hot water production for the residential and industrial sectors, and the installation of thermal solar energy collectors in touristic accommodation, domestic buildings, human health activities and sports activities, amongst others, in order to reduce the consumption of fossil fuels and electricity used for hot water production and heating/cooling systems (PASEC 2019:121-5). On the scope of the Sustainable Building, Energy Audits and Building Certification actions, it is mentioned that the promotion of sustainable and efficient construction as well as audits in existing buildings, public services and industries should result in energy certification and interventions to improve the sustainability and energy efficiency of the buildings. The implementation of measures such as adequate insulation, in order to minimize heat losses, and the integration of green roofs with autochthonous species or species with reduced requirements, in order to reduce the "heat island" effect (PASEC 2019:105-6) is included. As informed by the municipality, both the PAES and the PASEC are nowadays no longer valid.

The PMAC of 2024, the plan currently in force, includes a mitigation and an adaptation component (https://guimaraes2030.pt/plano-municipal-de-acao-climatica/). Within the mitigation component, the priority areas of intervention and specific actions were determined in terms of their impact concerning their reduction of CO_2 emissions. The mitigation measures related with the H&C sector, along with the estimated final energy consumption and CO_2 emissions reductions are summarized in Table 2 (PMAC 2024:176-196). Each of these measures include several actions that are detailed in the plan.

Sector	Measure	Mitigation Measure	Reduction in the Use of Final Energy (MWh/year)	Reduction in Greenhouse Gases Emissions (tCO_2e/year)

Residential Buildings	M1	Building rehabilitation (reduction of heating and cooling and Domestic Hot Water needs)	152.969	24.138
	M3	Local production of electricity – thought self-consumption and Renewable Energy Communities (REC) in the residential sector	-	24.960
Service Buildings	M4	Building rehabilitation (reduction of heating and cooling and Domestic Hot Water needs)	63.739	13.764
	M6	Local production of electricity – thought self-consumption and Renewable Energy Communities (REC) in the service sector	-	18.438
Industry + Energy Production	M13	Local production of electricity from renewable sources	-	61.230
	M14	Replacement of energy sources (biomass, biomethane, green hydrogen, solar thermal, amongst others)	-	140.660

Table 1 - Mitigation measures related with the H&C sector present in the PMAC (PMAC 2024:176-196)

While mitigation measures M1 and M3 mention directly the reduction of H&C needs through building rehabilitation (e.g. by improving thermal insulation of the buildings and replacing H&C systems); measures M3 and M6 encourage the decentralized local production of renewable energy, without mentioning H&C. On their turn, measures M12 and M14 encourage the local energy production and the use of renewable sources of energy, as well as the production of thermal and electric energy per cogeneration in the industry and energy production sectors.

The adaptation strategy to climate change was based in the Municipal Strategy for Adaptation to Climate Change of 2015, that was developed on the scope of the project ClimAdaPT.Local, using the ADAM methodology, a multi-criteria decision-making method, that was adjusted to the Portuguese reality (PMAC 2024:196-201). It encompasses 52 measures, which include six measures related with the H&C sector (see Table 3).

Sector of Activity	Measure	Adaptation Option	Adaptation Measure	Execution Timeframe
Biodiversity	2.1	Valorisation of the ecosystems' services	Promotion of green infrastructure in the territory and valorisation of the ecosystems' services	2024-2030
	2.3	Restoration and rehabilitation of the biodiversity	Rehabilitation of blue and green corridors	2024-2030
Land-use planning and cities	4.3	Integration of the adaptation measures in the municipal territorial management instruments	Introduction of urbanistic guidelines that promote the resilience of the territory through bioclimatic design	2024-2026

Buildings	7.2	Promotion of bioclimatic architecture	Promotion of passive and bioclimatic construction of the built stock	2024-2030
	7.3	Buildings' adaptation	Promotion of the update of H&C systems (including the development of municipal H&C plans after the Energy Efficiency Directive)	2026-2030
Health	8.2	Evaluation of the risk of diseases associated to climate change	Implementation of measures to reduce the heat islands effects	2026-2030

Table 2 - Adaptation measures related with the H&C sector present in the PMAC (PMAC 2024:252-325)

All adaptation measures have details regarding objectives, implementation methodology, internal and external partners to involve, cost-benefit analysis, execution timeframe, financial sources and monitoring methodology. While measure 7.3 mentions directly the update of H&C systems, inclusively referring the development of municipal H&C plans according with the Energy Efficiency Directive, measure 7.2 addresses the use of passive solutions related with the building stock. In their turn, measures 2.1, 2.3, 4.3 and 8.2 address indirectly the H&C sector, at a territory planning level, by encouraging green and blue infrastructures and bioclimatic design at a municipal level and by instigating the study and implementation of actions that reduce the urban heat island effects.

Presently, Guimarães does not have any municipal regulation regarding energy efficiency. Furthermore, due to the fact that the Historical Centre of Guimarães and the Couros Zone is a UNESCO's World Heritage Centre, interventions on the building stock and the placement of solar photovoltaic systems are limited due to legal provisions regarding the protection of historic buildings, including Law No. 107/2001 of 8 September, Decree-Law No. 115/12 of 25 May, and Decree-Law No. 309/09 of 23 October, and to legal provisions regarding town planning, including Decree-Law No. 38 382 of 7 August 1951, Decree-Law No. 555/99 of 16 December, Decree-Law No. 307/2009 of 23 October (https://whc.unesco.org/en/list/1031).

Guimarães is a proactive municipality concerning energy transition, sustainability, mitigation/adaptation to climate change and achieving climate neutrality issues. It belongs to several city networks: the Covenant of Mayors for Climate and Energy, NetzeroCities, ClimAdaPT.local, Municipal Platform on Sustainable Development Goals, Climate Alliance, ICLEI – Local Governments for Sustainability, the Green City Accord from the European Commission, Cities for Climate Network, amongst others. Furthermore, it has participated in several initiatives and projects related to sustainability, carbon neutrality and mitigation/adaptation to climate change over the years. From these, one can point out the participation in the Adapt4City, the RRRCiclo – recovery of green waste, the NetZeroCities, the DISTENDER and the Zero Waste City projects, as well as being a pilot city District C of the NZC pilot city project. Guimarães dynamizes the Guimarães Climatic Pact, a municipal initiative that aims to involve citizens, enterprises, institutions and schools in a collaborative action to decarbonize the territory aiming at climatic neutrality in 2030 (https://guimaraes2030.pt/). Guimarães participates on The Cities Heat Detox campaign from the Covenant of Mayors for Climate and Energy (https://eu-mayors.ec.europa.eu/en/The-Cities-Heat-Detox) and has applied to the 2025 Covenant of Mayors' Award on the scope of this campaign (https://eu-mayors.ec.europa.eu/en/2025-covenant-of-mayors-award).

For its role in terms of environmental, social and economic sustainability, Guimarães was a finalist of 2025 European Green Capital and a winner of 2026 European Green Capital. Due to these and to the fact of having the Mission Label for the Mission 100 Cities from NetZeroCities, Guimarães earned an easier access to financing

on the scope of participation on studies and projects, such as Horizon Europe and LIFE funding programmes for research and innovation.

It was focused by the municipality that the development of the Local H&C Plans should be dynamized in syntony with the municipal territorial management instruments, the PMAC and the Guimarães Climatic Pact.

3. The local energy system

The local energy demand

There is no specific data available at municipal level for Guimarães regarding energy consumption nor energy needs for the H&C sector. A diagnosis of the municipal energy situation was made on the scope of the Municipal Action Climate Plan, having 2019 as the reference year (PMAC 2024:89-146). The main source of data for this analysis were the statistics from the Portuguese Direção-Geral de Energia e Geologia – DGEG (Directorate-General of Energy and Geology).

To exemplify the type of analysis made and the type of data available, in Table 4, is presented the energy mix for primary energy per sector for Guimarães in 2019 and, in Table 5, the energy mix for final energy per sector and per vector for Guimarães in 2019.

Energy (toe)	Electricity	Natural Gas	Non Energy Use	Petroleum Products	Total	% Sectors
Agriculture	257	5	2	640	903	0,3%
Domestic	16 648	5 291	0	4 628	26 568	10,3%
Industry	29 934	44 158	2 552	3 524	80 168	31,0%
Public illumination	1 083	0	0	0	1 083	0,4%
Energy Production	128	51 149	45	0	51 322	19,9%
Residues	1 481	0	0	0	1 481	0,6%
Services	14 819	2 685	2	1 706	19 212	7,4%
Transports	7	0	187	77 472	77 666	30,1%
Total	64356	103 288	2 788	87 970	258 402	
% vectors	24,9%	40,0%	1,1%	34,0%		

Table 3 - Energy mix for primary energy per sector in Guimarães in 2019 (after PMAC 2024:111)

Energy (toe)	Electricity	Natural Gas	Non Energy Use	Petroleum Products	Total	% Sectors
Agriculture	2 987	54	23	7 443	10 507	0,3%
Domestic	193 618	61 540	0	53 826	308 984	10,3%
Industry	348 133	513 558	29 685	40 982	932 358	31,0%
Public illumination	12 597	0	0	0	12 597	0,4%
Energy Production	1 483	594 859	525	0	596 867	19,9%
Residues	17 219	0	0	0	17 219	0,6%
Services	172 341	31 231	24	19 839	223 435	7,4%
Transports	86	0	2 170	900 996	903 252	30,1%
Total	748 465	1 201 241	32 428	1 023 086	3 005 220	
% vectors	24,9%	40,0%	1,1%	34,0%		

Table 4 - Energy mix for final energy per sector in Guimarães in 2019 (after PMAC 2024:113)

The total consumption of final energy in the municipality in 2019 was 3.005.220 MWh.

Previously, on the PASEC of 2019, the calculation of energy consumption and production on the municipality, as well as respective evolutionary trends were made for 2016, 2020, 2030 and 2050, taking as reference the year of 2008. In Figure 5 are presented the projections of energy consumption per source in 2016 and 2050, and in Figure 6, the energy consumption per activity sector in 2016 and 2050.

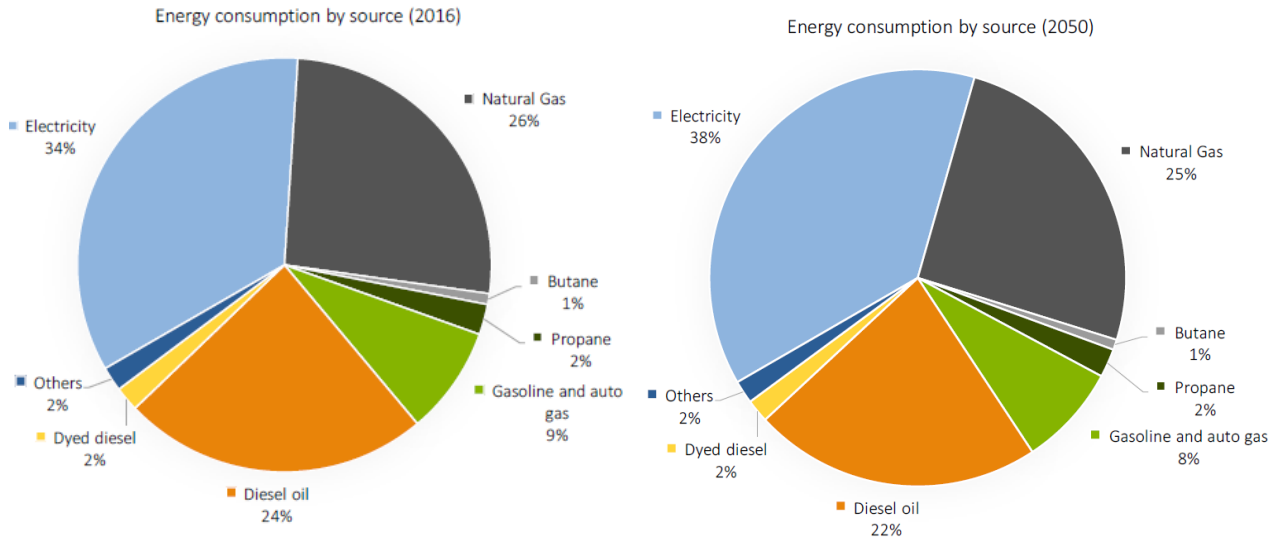


Figure 5 – Projections of energy consumption per source in Guimarães in 2020 and 2050 (PASEC 2019:40-2)

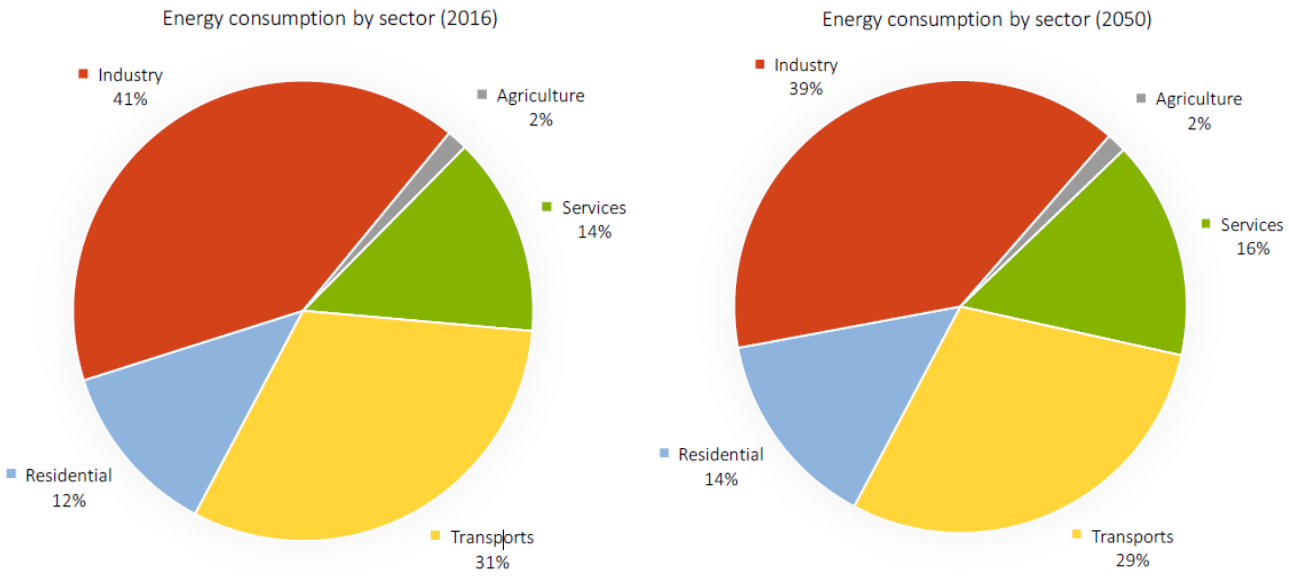


Figure 6 – Projections of energy consumption per energy sector in Guimarães in 2016 and 2050 (PASEC 2019:34-6)

The analysis made shows that electricity consumption will increase between 2016 and 2050, while the consumption of fossil fuels (natural gas, gasoline and auto gas and dyed diesel) will comparatively decrease. Also, an increase of the energy demand for the residential and the services sector is predicted, accompanied by

a decrease of energy demand for the industry and transport sectors. Final energy consumption is predicted to decrease to 2.115.169 MWh/year by 2050.

Other than this data, there are some statistical data from the census of 2021, regarding the existence of H&C systems in households, summarized in Table 5.

	Number of classic households	% of total classic households
With air conditioned	14584	25%
Without air conditioned	43140	75%
With central heating	10877	19%
With non-central heating - open fireplace	7740	13%
With non-central heating – heat recovery unit	5366	9%
With non-central heating – mobile unit (electric heater, gas heater, etc)	13056	23%
With non-central heating – fixed units (salamander heater, wall heaters, etc)	5208	9%
No heating	17477	27%

Table 5 - Type of H&C systems present in classic households in the municipality of Guimarães, according to the census of 2021 (INE 2024)

The local energy supply

According to the PMAC, almost the totality of the primary energy consumed in the municipality on the energy production sector is natural gas (99,7%), followed by electricity, with 0,2% (see Table 6). This consumption of natural gas for energy production is associated with the cogeneration groups installed in the textile industries.

Energy (MWh)	Electricity	Natural Gas	Non Energy Use	Petroleum Products	Total
Electricity, vapor, hot and cold water	1 483	594 859	525	0	596 867
% vectors	0,2%	99,7%	0,1%	0,0%	

Table 6 - Energy mix for final energy for the energy production sector in Guimarães in 2019 (adapted from PMAC 2024:118)

Regarding energy production in the municipality of Guimarães, according to DGEG data, in 2023 Guimarães had 54,2 MW of photovoltaic energy production, 4,8 MW from hydropower and 60,2 MW of thermal (1 MW from renewable source) (Table 7).

Municipality	Source	Installed power (MW)
Guimarães	Photovoltaic	54,2
	Hydropower	4,8
	Thermal	60,2
	from renewable source	1,0

Table 7 - Installed power in electricity generating plants in 2023 (DGEG 2024)

According to E-Redes (https://e-redes.opendatasoft.com/), Guimarães was, in the 3rd trimester of 2024, the Portuguese municipality with the highest number of self-consumption units (5.522 units), and with the highest installed capacity for self-consumption (48.551 kW). In Figures 6 and 7, one can see the cumulative number of self-consumption units and the total installed power for self-consumption per quarter, with the discrimination of the unit's installed power range.

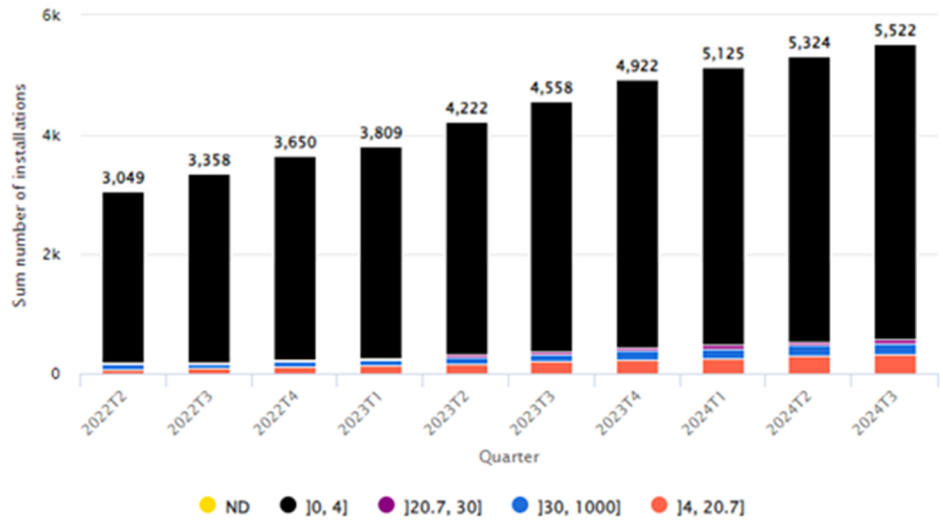


Figure 6 - Cumulative installed power for self-consumption for the municipality of Guimarães per quarter and per installed power range (E-Redes 2024)

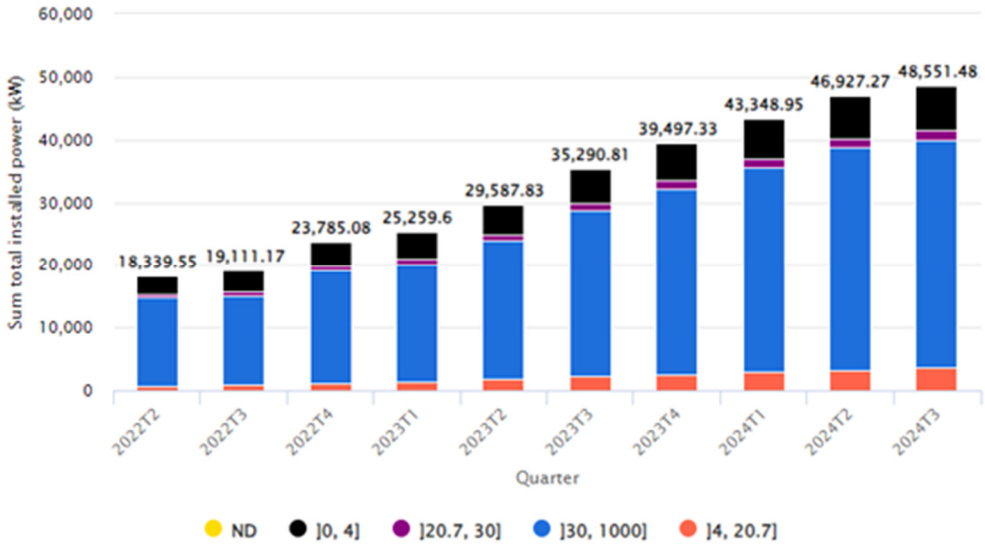


Figure 7 - Cumulative installed power for self-consumption for the municipality of Guimarães per quarter and per installed power range (E-Redes 2024)

4. Activation of H&C target groups

The current list of the stakeholders to engage in the Local Community of Practice (LCoP) on the scope of Pla4COLD was validated by the municipality and is as follows, composed of internal and external stakeholders to the municipality.

STAKEHOLDER	TYPOLOGY
Divisão de Habitação da Câmara municipal	Division of the city council
Coordenação de Âmbito Social e Financeiro das Habitações do Município de Guimarães – CASFIG	Municipal enterprise
Associação do Comércio Tradicional de Guimarães – ACTG	Industry and business associations
Associação para o Desenvolvimento Integrado do Vale do Ave	
Inter-municipal community CIM do Ave and the municipalities that belong to it	Inter-municipal community
To be determined	Financing/banking institutions
University of Minho and other local/regional research institutions	Local/regional research institutions
Associação para o Desenvolvimento das Comunidades Locais	Civil society associations, including associations of residents
Associação de Moradores da Zona Urbana da Conceição	
Associação dos Moradores Bairro São Gonçalo	
To be determined	Regional development institutions
Centro para a Valorização de Resíduos – CVR	Other relevant public and private institutions
Associação Vimaranense para a Ecologia – AVE	
Cooperativa Elétrica do Vale d'Este – CEVE	Electricity utility companies and associations
To be determined	Renewable energy and H&C enterprises
Laboratório da Paisagem (entity founded by the City Council of Guimarães, the University of Minho and the University of Alto Douro and Trás-os-Montes)	Other relevant entities
Subscribers of the Guimarães Climatic Pact (municipal initiative that aims to involve citizens, enterprises, institutions and schools in a collaborative action to decarbonize the territory aiming at climatic neutrality in 2030 - https://guimaraes2030.pt/)	

Table 8 - List of stakeholders in Guimarães

5. Summary in national language

O município de Guimarães está localizado no distrito de Braga no noroeste de Portugal Continental, na zona de vale da bacia hidrográfica dos rios Cávado, Ave e Leça, rodeado de montanhas. O município tem 241,05 km^2 de extensão, tendo a área urbana – a histórica cidade medieval de Guimarães – 23,5 km^2 de extensão. O clima é temperado com verões secos e temperados e invernos frios com precipitação recorrente. Prevê-se, nos próximos anos, o aumento da frequência de eventos extremos de calor na primavera e no verão, assim como o aumento da área urbana do município afetada pelo efeito de ilha de calor.

Guimarães é um dos municípios mais industrializados de Portugal, com um domínio das indústrias têxtil e metalúrgica e das cutelarias. O sector terciário, que inclui os serviços de apoio às empresas, o comércio e o turismo, também é expressivo no município. A população de Guimarães é jovem, sendo a densidade populacional cerca de cinco vezes superior à da média nacional. É assim, um município com características singulares. Destas, destacamos a alta densidade populacional, o parque edificado urbano antigo do centro histórico e o sector industrial relevante. Adicionalmente é de salientar a necessidade de aquecimento no inverno devido às baixas temperaturas, e a necessidade de arrefecimento no verão, num cenário futuro de maior frequência de ocorrência de eventos extremos de calor e do aumento da área afetada pelo efeito ilha de calor.

Guimarães é um município muito ativo no que se refere a temas como a transição energética, a sustentabilidade, a adaptação climática e a neutralidade carbónica. Tem participado, ao longo dos anos, em diversas redes de cidades e projetos relacionados com estas temáticas. No que se refere a redes de cidades, destacamos a participação no Pacto dos Autarcas para o Clima e Energia, na NetZeroCities, na ClimAdaptPT.local e na recém-criada Rede Cidades pelo Clima. No que diz respeito a projetos e iniciativas internacionais destacamos os projetos Adapt4City, DISTENDER, Zero Waste City e NZC Pilot City. De salientar, igualmente, a iniciativa municipal Pacto Climático de Guimarães lançada em 2023, que visa envolver os cidadãos, as empresas e as instituições numa ação colaborativa para a descarbonização do território, tendo em vista a neutralidade climática em 2030. O município recebeu recentemente, pelo seu compromisso com a sustentabilidade, o prémio Capital Verde Europeia 2026.

Guimarães desenvolveu vários planos nos últimos anos, de salientar o Planto Intermunicipal de Adaptação às Alterações Climáticas, o Plano de Ação para a Neutralidade Carbónica 2030 (no âmbito do projeto NetZeroCities) e o Plano Municipal de Ação Climática. Este último, que é o plano atualmente em vigor, estabelece diversas metas do setor do aquecimento e arrefecimento. De destacar medidas ativas e passivas no setor dos edifícios, o incentivo, em diversos setores, para a produção descentralizada de energias renováveis para o autoconsumo, e medidas de ordenamento do território para a redução do efeito de ilha de calor urbano e promoção de infraestrutura verde e azul.

Em termos do sistema energético local, não existem dados específicos para o setor do aquecimento e arrefecimento no município. O setor onde há mais consumo é a indústria (31%), seguida pelos transportes (30%) e pela produção de energia para a indústria (20%). A capacidade instalada em unidades de produção para o autoconsumo (UPAC) é, atualmente, a maior do país, com 48,6MW distribuídos em 5.522 unidades.

MUNICIPALITY OF LOULÉ

1. The local territorial context

The Municipality of Loulé is located in the Algarve region and covers an area of 763,67 km^2 (INE, 2018), which is distributed across 9 parishes: Ameixial, Almancil, Alte, Boliqueime, Quarteira, Salir, São Clemente, São Sebastião and União of Querença, Tôr and Benafim Parishes. The city of Loulé is part of the parishes of S. Clemente and S. Sebastião, however the most populated parish is Quarteira.

According to census information, in 2021, the municipality of Loulé had an overall population of 72.332 inhabitants (50% of which were between 25 and 64 years old), meaning an average population density of around 90 inhabitants/km^2.

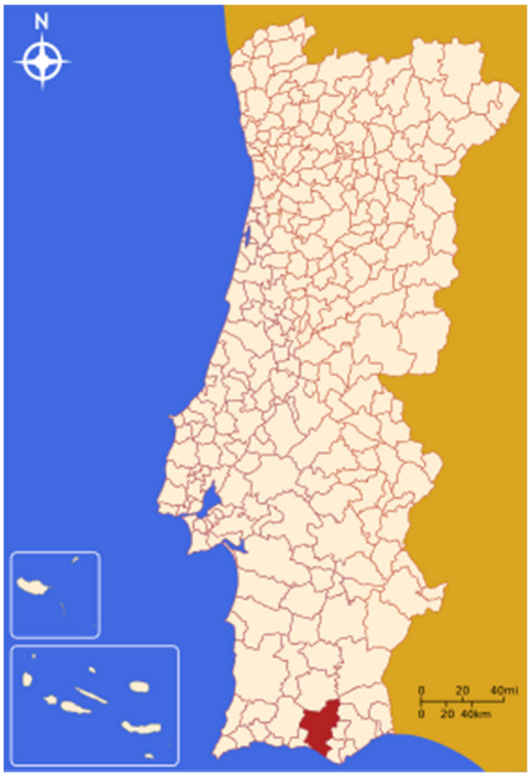


Figure 2 - Location of Loulé' municipality (Wikipedia 2024)

At the level of territorial units, the municipality covers 3 distinct zones: from south to north: coastal, barrocal and mountain, presenting a wide territorial diversity in terms of patrimony, landscape, ecological and environmental aspects, which constitute an important and differentiating added value.

Given its geographical location, the municipality of Loulé has a climate temperate with mediterranean characteristics, influenced by the proximity to the sea and the existence of mountainous elevations in the Northen frontier. With soft and moist winters and dry and hot summers, the average temperature ranges from 19ºC and 27ºC (summer) and 8ºC-14ºC (winter) (PASEC 2021). According to a study of climate projections for the municipality of Loulé presented in PMAC 2021, there will be a generalised increase in the average annual temperature, with more intense anomalies in inland areas, especially in mountain and barrocal. In summer, it is projected that maximum temperatures could rise by more than 3 °C by the end of the century. In addition, an increase in the number of tropical nights and very hot days is predicted, particularly in coastal regions. Extreme events, such as heatwaves, are expected to become more frequent and persistent, while the incidence of cold

waves is likely to decrease. In 2023 no heat waves were registered in the Loulé municipality (https://rea.apambiente.pt/content/ondas-de-calor-e-de-frio).

There is also great seasonal population variability mainly due to tourism: in the high season, the municipality substantially increases its population, between permanent residents, seasonal residents and tourists.

The Municipality of Loulé is one of the main economic centers of the Algarve region. The most relevant economic activities are the tertiary sector (83,4% with ~25% lodging, food and beverage services), industry (15,4%) and agriculture and fisheries (1,3%) (GEE 2023).

To characterize the building stock, Figure 2 shows the different construction periods for existing buildings in Loulé in 2021.

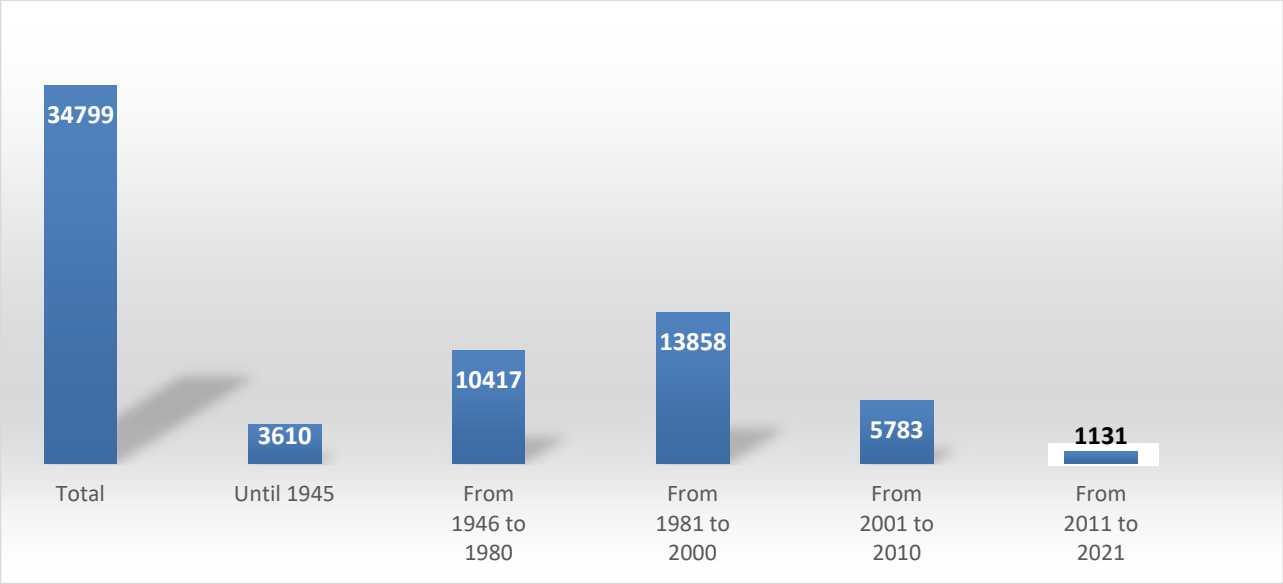


Figure 2 - Construction periods for existing buildings in Loulé in 2021. (source: INE 2021)

Regarding the state of its buildings in the last available year (2021), as can be seen in Figure 3, the Municipality of Loulé has a total of 34 799 buildings built, of which 3% need deep interventions, 5,9% need medium interventions, 17,3% only minor interventions and 73,6% need no interventions.

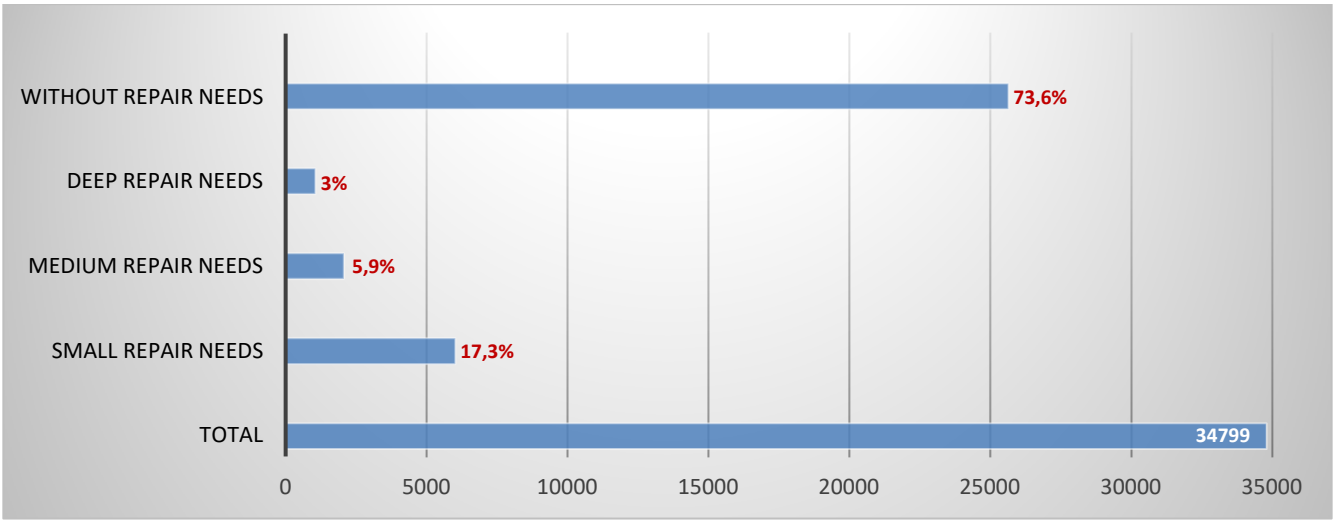


Figure 3 - Total number of buildings built and repair needs (source: INE, 2021)

It is also relevant to analyse the total number of energy certificates issued between 2014 and 2024 in the municipality of Loulé, by energy class, for all types of buildings (Figure 4). The predominant classes are C and D with 28,2% and 21,8% respectively. The total number of certificates in Loulé is 34.379. The energy certificate is a mandatory document in many countries that assesses the energy efficiency of a property, classifying it on a performance scale (for example, from A+ to G). It identifies the expected energy consumption and suggests improvements to reduce costs and emissions. It comes from the EPBD (Energy Performance of Buildings Directive), a European directive aimed at improving the energy efficiency of buildings. In Portugal, it has been mandatory since 2009 for new and existing properties in cases of sale, rental or major renovation. Implementation follows the rules of the Energy Certification System for Buildings (SCE), managed by ADENE (Energy Agency).

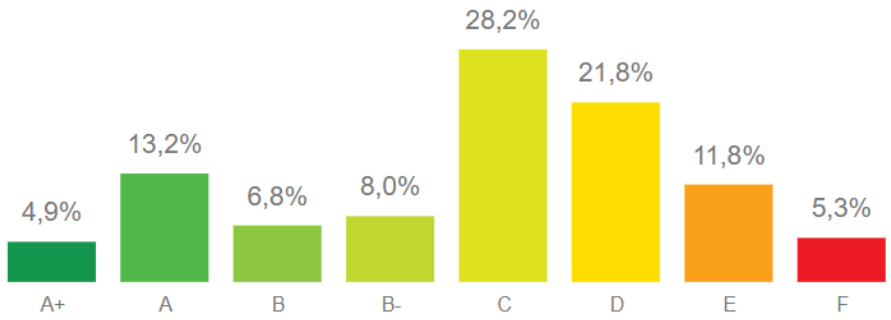


Figure 4 - Total energy certificates issued in the municipality of Loulé, between 2014 and 2024by energy class (SCE 2024)

2. The reference policy and strategic context

The regional context

Regionally there are, in Continental Portugal, Comissões de Coordenação e Desenvolvimento Regional – CCDR (Regional Coordination and Development Commissions). These are peripheral services of the direct administration of the State, endowed with administrative and financial autonomy (but devoid of legal personality), which have powers in the fields of coordination and articulation of the various sectoral policies at regional level, implementation of environmental policies and spatial and urban planning, technical support for local authorities and their associations and management of European funding programmes (https://diariodarepublica.pt/dr/lexionario/termo/ccdr-comissao-coordenacao-desenvolvimento-regional).

There are currently 5 CCDRs in Portugal (Decree-Law No. 228/2012) that correspond to the 5 regions of Continental Portugal (North, Centre, Lisbon and Tagus Valley, Alentejo, Algarve). Furthermore, sub-regionally, there are intermunicipal entities (Law No.75/2013). These can take the form of Intermunicipal Communities or of Metropolitan Regions and correspond to the NUT III territorial units. There are currently 21 intermunicipal communities and two metropolitan areas in Continental Portugal. Intermunicipal entities are free associations of municipalities, non-territorial, with their own budget and management, and clear objectives, to which the associated municipalities delegate part of the functions or competences conferred on them by law, with the aim of provide services to all its members. According to Law No. 50/2018, intermunicipal entities have, amongst other, power to appoint members representing municipalities on river basin district councils, manage projects financed with European funds and manage investment caption programmes.

On the scope of the Portuguese Climate Framework Law (Law no. 98/2021) the CCDRs need to develop Planos Regionais de Ação Climática – PRACs (Regional Climate Action Plans), which should include the dimensions of mitigation and adaptation to climate change. CCDRs are also, for example, responsible for the development of the Estratégias Regionais de Especialização Inteligente – RIS3 (Regional Innovation Smart Specialisation Strategies), an approach created by the European Union in 2010. The RIS3 are regional strategies that aim to address regional challenges and support regional development through the identification and promotion of areas of innovative specialization. These strategies usually include lines of action related with the increase of sustainability and of territorial cohesion, decarbonization, the transition to a more circular economy and/or the sustainable use of resources/assets. These strategies are also closely linked to European Union funding, especially in the context of cohesion policies and structural funds. Both the RIS3 and other plans and strategies developed by the CCDRs and by the intermunicipal entities are not, in general, directly binding on municipalities. They rather serve as strategic guides for regional and sub-regional development, and municipalities are encouraged to align their policies and actions with their guidelines. It is up to each municipality to integrate them in their local legal instruments and regulations, such as in the municipal-level Instrumentos de Gestão Territorial – IGT (Territorial Management Instruments). The IGTs are the legal and planning documents that regulate and guide land use and spatial planning that compose the Portuguese territorial management system. The Plano Diretor Municipal – PDM (Municipal Master Plan) is the primary urban planning instrument at municipal level. It is mandatory and defines the municipality's structure in terms of land use and regulates the urban conditions for new projects and developments.

In sum, there is no energy nor climate legislation at regional or sub-regional level in Portugal, nor regional or sub-regional incentives, supporting mechanisms or financial tools targeting energy transition or decarbonization targets. There are solely non-binding strategies and plans developed at regional and sub-regional level, that serve as guideline to the municipalities. Nevertheless, the active participation of the municipalities in these organizations condition the municipalities access to funding, including to national and European Union funding.

At regional level, Loulé is one of the municipalities that form part of the Comunidade Intermunicipal do Algarve - AMAL (Algarve Intermunicipal Community of Algarve), an organisation dedicated to fostering intermunicipal cooperation in the region. AMAL plays a key role in coordinating and promoting the sustainable and integrated development of the Algarve, addressing areas requiring a cohesive approach, such as mobility, the environment, social cohesion, territorial planning, and climate change adaptation strategies. AMAL also acts as a liaison between municipalities and the Central Government, supporting the decentralisation and implementation of regional public policies.

The municipalities that form AMAL are Albufeira, Alcoutim, Aljezur, Castro Marim, Faro (regional capital), Lagoa, Lagos, Loulé, Monchique, Olhão, Portimão, São Brás de Alportel, Silves, Tavira, Vila do Bispo and Vila Real de Santo António.

Loulé, one of the largest municipalities in terms of both area and population, plays a significant role within AMAL. It is known for its leadership in innovative and sustainable projects aligned with regional priorities, such as promoting environmentally friendly practices and valuing natural and cultural heritage.

Also concerning AMAL, the municipality of Loulé participated in the elaboration of Plano Intermunicipal de Adaptação às Alterações Climáticas do Algarve - PIAAC-AMAL (Algarve Intermunicipal Climate Change Adaptation Plan), in 2019. A strategic document developed by AMAL aimed at identifying vulnerabilities and implementing measures to adapt the region to climate change. PIAAC-AMAL seeks to evaluate the potential impacts of climate change, such as rising sea levels, increased frequency of extreme weather events like droughts, heatwaves, and floods, and the growing scarcity of water resources. By analysing these vulnerabilities, the plan identifies the sectors most at risk, including agriculture, tourism, biodiversity, and water management,

and proposes measures to mitigate these risks. The plan focuses on integrating climate resilience into various aspects of regional planning and governance, ensuring that all 16 municipalities of the Algarve collaborate on a unified approach. This collaborative model includes the active participation of local communities, non-governmental organisations, businesses, and academic institutions to develop adaptive strategies that are both practical and inclusive. The adaptation measures related to the H&C sector are described in Table 2.

Sector	Adaptation measure
Energy	Promoting bioclimatic architecture in local government buildings
	Strengthening Agência Regional de Energia e Ambiente do Algarve – AREAL (Algarve Regional Energy and Environment Agency) mission and resources
Security of People and Property	Implement emergency planning measures for very high temperatures and heatwaves

Table 2 - PIAAC-AMAL adaptation measures related to the H&C sector. (source: PIAAC-AMAL 2019)

In 2006, as part of the ENERSUR project, developed by Agência Regional de Energia e Ambiente do Algarve - AREAL (Algarve Regional Energy and Environment Agency) and Instituto Nacional de Engenharia - INETI (National Institute of Engineering, Technology and Innovation), mapping of the Algarve's solar energy resource was carried out. This project concluded that, of the 15 municipalities, Loulé is amongst the seven with the highest solar energy resource.

The local context

Regarding local context, the municipality of Loulé developed the Estratégia Municipal de Adaptação às Alterações Climáticas – EMAAC (Municipal Climate Change Adaptation Strategy) in 2016 and, more recently in 2021, the Loulé's Plano Municipal de Ação Climática – PMAC (Municipal Climate Action Plan) and Plano de Ação para a Sustentabilidade Energética e Climática – PASEC (Sustainable Energy and Climate Action Plan).

PMAC includes the following measures from the Strategic Adaptation Axis and Strategic Mitigation Axis, that are pertinent to the H&C sector:

Sector	Measure	Mitigation Measure
Public Spaces	M1	Promoting thermal softening in public spaces
Biodiversity	M2	Strengthening and safeguarding urban green structures
Buildings	M3	Promoting thermal softening in public and private buildings
Health	M6	Preventing a minimizing the impact of rising temperatures on human health
Buildings	M21	Increasing energy efficiency in buildings and NZEB buildings
Energy	M24	Increasing energy efficiency in equipment, boilers, air conditioning and ventilation systems
Buildings + Energy	M25	Implementing renewable energy projects in municipal buildings
Energy	M26	Promoting the renewable energy production

Table 3 - PMAC measures (source: PMAC, 2021)

The PASEC includes also relevant climatic and energetic sustainability measures:

Sector	Measure	Mitigation Measure
Buildings	M7	Energy efficiency in buildings and NZEB buildings (e.g. improving the infrastructure of municipal buildings, improving thermal comfort and reducing energy consumption; incentive program)
Energy	M10.1	Maintenance, optimization and renovation program for equipment, boilers, climatization and ventilation systems in municipal buildings
Energy	M12 and M13	Promotion of renewable energy production (Renewable energy communities; Promoting the collection, storage and availability of biomass at municipal or inter-municipal level; Promoting integrated renewable energy pilot projects)

Table 4 - PASEC measures (source: PASEC, 2021)

Loulé City Council has joined the Covenant of Mayors for Climate and Energy, a European initiative that brings together local authorities committed to reducing CO_2 emissions and adapting to climate change. Launched by the European Commission in 2008, it has grown into a global movement with over 10,000 signatories worldwide. The municipality of Loulé became a signatory of this pact on June 5, 2021, as reported by the Loulé City Council. By joining the Covenant of Mayors, Loulé committed to developing and implementing a Sustainable Energy and Climate Action Plan (SECAP) to achieve ambitious climate and energy objectives. This includes reducing greenhouse gas emissions by 40% by 2030, compared to 2020 levels. Through this commitment, Loulé aims to contribute to the European Union's climate goals and promote sustainable development within its community.

Apart from strategies and plans developed, the municipality of Loulé participated in city networks, such as adapt.local, ICLEI, ODSlocal – Municipal Platform for the Sustainable Development Goals, Circular Cities Networks, Healthy Cities and Green City Accord and in projects/initiatives in renewable energy, carbon neutral, and climate change areas, such as ClimAdapPT.Local, Urban heat island effect adaptation - Loulé Municipal Stadium (REACT-EU), CApt2 - Water Circularity: By everyone and for everyone, initial member of the ODSlocal Project and member of the EU Climate Change Adaptation Mission.

Additionally, some initiatives such as Loulé's Municipal Observatory for the Environment and Territory (https://omat.cm-loule.pt/), the website Loulé Adapta (louleadapta.pt), the SERES Platform – Efficient Solution for Sustainable Energy Resources (support tool for energy management in buildings, installations and public lighting), and Loulé Solar Program (program that previews the installation of 2 MWp production units for self-consumption in the municipality by 2025, which began in 2019 with the implementation of a School Energy Community pilot project at the Professor Sebastião Teixeira School in the village of Salir with the installation of a photovoltaic self-consumption production unit, combined with various training actions aimed at the entire school community. Subsequently, the Salir school project was replicated in around two dozen schools, broadening the concept of the energy community and raising awareness among the municipality's school population to accelerate behavioural changes and rationalize energy consumption), are also part of the Municipality of Loulé's history.

Regulation 884/2024 was published, in 2024, corresponding to the first material correction to the Municipal Urbanization and Building Regulation (RMUE). Annex 11, concerning the efficient use of natural resources, aims to concretize a set of guidelines related to adaptation to climate change, explained in Loulé's EMAAC. Table 5 shows some of these guidelines (with measures) related to H&C sector.

Sector	Measure
Energy Efficiency	Whenever feasible, urban development operations should be designed in such a way as to maximize the building's the location and orientation of the building in its urban and architectural aspects and promote thermal comfort, by means of solutions that allow passive heating and cooling, which maximize solar gains in winter and control them in summer
	The principles underlying the previous paragraph relate to the promotion of natural lighting and ventilation, as well as the use of renewable energies, helping to minimize energy consumption, reduce greenhouse gas emissions and increase energy efficiency
Solar gain control	New buildings should maximize the potential for heating, cooling, ventilation and natural ventilation and natural lighting, optimizing the sun exposure of the building and adjoining public or private spaces or private spaces, as well as neighbouring buildings
	Interventions in pre-existing buildings must not jeopardize or worsen the conditions of conditions of the building itself and neighbouring buildings
	Orientations that optimize the capture of sunlight and reduce energy consumption and greenhouse gas emissions should be favoured energy consumption and greenhouse gas emissions
Use of natural ventilation	When designing buildings, if it is technically and functionally possible, natural ventilation systems that utilize only wind or temperature variation should be considered as a way of preventing overheating and overcooling inside buildings and ensuring good indoor air quality
Use of renewable energies	When designing buildings, if it is technically and functionally possible, natural ventilation systems that utilize only wind or temperature variation should be considered as a way of preventing overheating and overcooling inside buildings and ensuring good indoor air quality.
	The use of renewable energy sources to generate electricity, for consumption by the of the buildings themselves or sale to the national grid, namely through photovoltaic panels or wind energy panels or wind energy harvesting systems, can be considered whenever it is technically feasible and aesthetically appropriate.
	When the need for water heating is foreseen in swimming pools with a capacity of more than 150m^3, a system of solar collectors or equivalent technology must be installed whenever it is considered economically viable, and thermal covers must be used on the water surface to avoid heat loss and water loss through evaporation.

Table 5 - Guidelines related to H&C sector in RMUE. (source: RMUE, 2024)

In 2025, the municipality of Loulé has planned two measures related to climate action:

- Launch the municipal program ''Loulé Energia'' to encourage the exchange of conventional light bulbs with incandescent, halogen and compact fluorescent technology for equivalent energy-efficient light bulbs with LED technology (energy classification A, in accordance with Commission Delegated Regulation (EU) 2019/2015 of 11 March 2019), making it possible to encourage a reduction in consumption and savings on the electricity bill of families living in the municipality.
- Launching Collective Self-Consumption in Alte. The aim of this project is to install Self-Consumption Production Units (hereinafter referred to as UPACs) in specific buildings belonging to entities previously identified by the municipality (IPSSs, schools and parish councils), making it possible to generate renewable energy for direct consumption by the participants and optimizing energy efficiency in the region. The UPACs provided for in the project include the installation of photovoltaic systems on the roofs of the buildings provided and the carrying out of all the works necessary for their operationalization and maintenance.

3. The local energy system

The local energy demand

Regarding energy consumption for the H&C sector, there is no specific data available at municipal level for Loulé. Given the lack of data that directly relates the consumption of each sector of activity by energy vector, is presented in PMAC 2021 a projection of electricity consumption in Loulé by sector of activity for 2020, 2030 and 2050 (Table 6).

Tipo	2020 (MWh)	%	2030 (MWh)	%	2050 (MWh)	%
Doméstico	216 677	43,3	222 206	44,3	232 509	45,0
Não-Doméstico	189 122	37,8	191 751	38,3	204 854	39,7
Edifícios do Estado	9 948	2	8 686	1,7	7 802	1,5
Indústria	58 788	11,8	52 988	10,6	48 746	9,4
Agricultura	6 832	1,4	6 927	1,4	7 400	1,4
Iluminação de Vias Públicas	18 553	3,7	18 544	3,7	15 074	2,9
Total	499 920	100	501 102	100	516 385	100

Table 6 - Projection of electricity consumption in Loulé by sector of activity, for 2020.2030 and2050. (source: PMAC, 2021)

A prospective energy mix (based on 2018 data) was made, in the scope of the PMAC 2021, for energy consumption by energy source for the 2050 horizon (Table 7)

Source	2016 (MWh)	%	2020 (MWh)	%	2030 (MWh)	%	2050 (MWh)	%
Electricity	474 143	49,1	499 921	51,5	501 102	52,1	516 385	**55,1**
Fossil fuels	491 144	50,9	470 447	48,5	460 052	47,9	420 903	**44,9**
Natural Gas	32	0,0	34	0,0	28	0,0	28	**0,0**
Butane	3 452	0,4	3 306	0,3	3 233	0,3	2 958	**0,3**
Propane	42 000	4,4	40 230	4,2	39 341	4,1	35 993	**3,8**
Gasoline e Auto Gas	108 195	11,2	103 635	10,7	101 346	10,5	92 721	**9,9**
Road Diesel	322 516	33,4	308 923	31,8	302 101	31,4	276 392	**29,5**

Colored diesel	14 949	1,6	14 319	1,5	14 003	1,5	12 811	**1,4**
Others	0	0,0	0	0,0	0	0,0	0	**0,0**
Total	**965 287**	**100**	**970 368**	**100**	**961 154**	**100**	**937 288**	**100**

Table 7 - Prospective Energy Mix 2018: Energy consumption by energy source for 2026, 2020, 2030, 2050 (source: PMAC, 2021)

It was also possible to obtain data on the type of H&C systems used in classic households (2021) in the following table:

	Number of classic households	% of total classic households
With air conditioned	11331	38%
Without air conditioned	18134	61%
With central heating	1888	6%
With non-central heating - open fireplace	4392	15%
With non-central heating – heat recovery unit	1113	4%
With non-central heating – mobile unit (electric heater, gas heater, etc)	9227	31%
With non-central heating – fixed units (salamander heater, wall heaters, etc)	3103	10%
No heating	9342	32%

Table 8 - Type of H&C systems present in classic households in the municipality of Loulé, according to the census of 2021 (INE 2024

The local energy supply

According to DGEG data, in 2023 the municipality of Loulé had 26.9 MW of photovoltaic energy production and 1.2 MW of renewable thermal energy (Table 9).

Municipality	Source	Installed power (MW)
Loulé	Photovoltaic	26,9
	Thermal	1,2
	from renewable source	1,2

Table 9 - Installed power in electricity generating plants in 2023 (source: DGEG, 2024)

According to E-Redes (https://e-redes.opendatasoft.com/), Loulé was, in the 3rd trimester of 2024, 2.189 self-consumption units and 15.879 kW of installed capacity for self-consumption. In Figures 5 and 6, one can see the cumulative number of self-consumption units and the cumulative installed power for self-consumption per quarter.

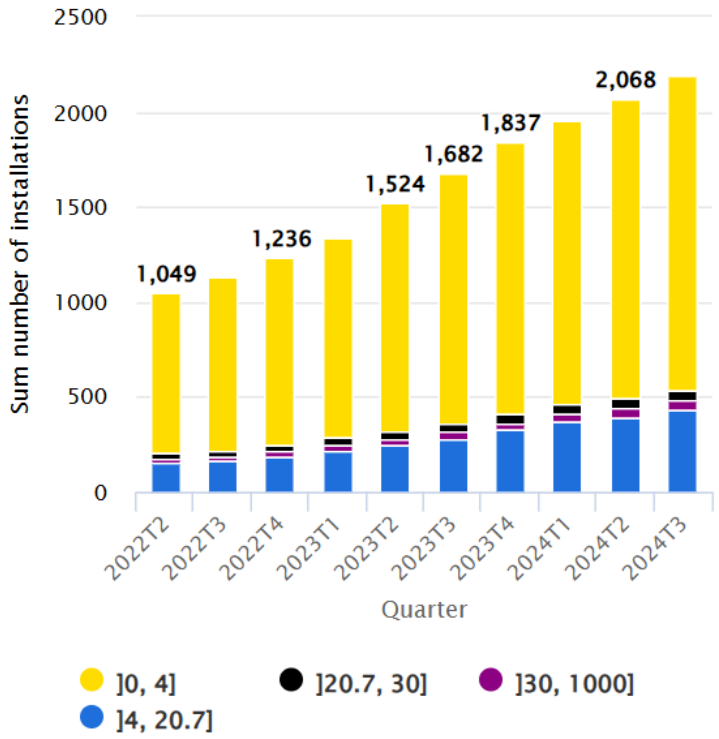


Figure 5 - Cumulative number of installations for self-consumption for the municipality of Loulé per quarter and per installed power range (E-Redes 2024)

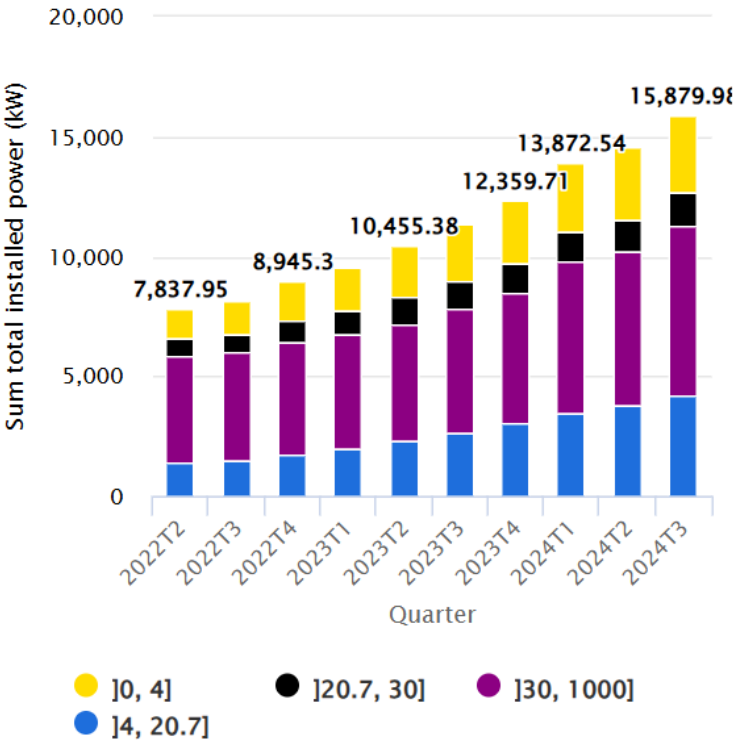


Figure 6 - Cumulative installed power for self-consumption for the municipality of Loulé per quarter and per installed power range (E-Redes 2024)

4. Mapping of H&C target groups

For the list of identified stakeholders, some progress needs to be completed. There are a considerable number of relevant companies/associations listed below, although it is necessary to identify new stakeholders, contact them to present the project, ask for feedback, to discuss needs and identify changes.

STAKEHOLDER	TYPOLOGY
Associação Empresarial da Região do Algarve	Business, service and industry associations
Associação do Comércio e Serviços da Região do Algarve	
Associação dos Hotéis e Empreendimentos Turísticos do Algarve	
Associação dos Industriais Hoteleiros e Similares do Algarve	
Região do Turismo do Algarve	
Comunidade intermunicipal do Algarve - AMAL	Inter-municipal association
University of Algarve, R&D centres and other local/regional research institutions	local/regional research institutions
To be determined	Financial/banking institutions
Associação de Defesa do Património Cultural e Ambiental do Algarve – Almargem	Civil society organisations, including associations of residents
Associação de Moradores das Romeirinhas	
Associação Moradores Quarteira	
Comissão de Coordenação e Desenvolvimento Regional do Algarve – CCDR Algarve	Regional development institutions
Cooperativa para o Desenvolvimento dos Territórios de Baixa Densidade - QRER	
Associação in Loco	
Associação Portuguesa para a Defesa do Consumidor - DECO	Other relevant public or private institutions
Recovery and Treatment of Solid Waste - ALGAR	
Agência Regional de Energia e Ambiente do Algarve – AREAL	Electricity companies and their associations
Renewable energy and heating/cooling companies	
To be determined	Municipal companies, Parish Councils, Local Council for Monitoring Climate Action

Table 10 - List of stakeholders in Loulé

5. Summary in national language

O município de Loulé, localizado na região do Algarve, é um dos principais centros económicos da região, destacando-se pelas atividades ligadas ao turismo e aos serviços. A sua diversidade territorial inclui zonas costeiras, barrocal e montanhas, oferecendo características ecológicas e climáticas singulares, que influenciam diretamente as demandas e oportunidades relacionadas ao aquecimento e arrefecimento.

No âmbito da transição energética e da adaptação às alterações climáticas, Loulé tem desenvolvido diversas estratégias e planos municipais. Em 2016, foi criada a Estratégia Municipal de Adaptação às Alterações Climáticas (EMAAC), seguida do Plano Municipal de Ação Climática (PMAC) e do Plano de Ação para a Sustentabilidade Energética e Climática (PASEC), ambos lançados em 2021. Estes documentos incluem medidas destinadas a promover o conforto térmico em espaços públicos e edifícios, aumentar a eficiência energética e implementar projetos de energia renovável em infraestruturas municipais.

Entre as iniciativas mais relevantes, destacam-se o Programa Solar de Loulé, que prevê a instalação de 2 MWp de unidades de produção para autoconsumo até 2025, e a participação do município em redes de cidades como ICLEI, Circular Cities e projetos como ClimAdapPT.Local e REACT-EU. Estas ações evidenciam o compromisso do município com a sustentabilidade e a eficiência energética.

O sistema energético local é caracterizado por um consumo predominante no setor doméstico (43%) e não doméstico (38%), além de uma transição gradual de combustíveis fósseis para eletricidade renovável. Em termos de capacidade instalada, o município conta com 26,9 MW de potência em plantas fotovoltaicas, complementadas por sistemas de autoconsumo com capacidade total de 15,8 MW.

Apesar dos avanços, existem desafios a serem enfrentados, como a variabilidade sazonal da população, que gera flutuações no consumo de energia, e a necessidade de intervenções em cerca de 26% dos edifícios existentes. Contudo, o elevado potencial para a expansão da energia solar, devido aos recursos naturais favoráveis, representa uma oportunidade significativa para o município continuar a liderar na transição energética e na adaptação às alterações climáticas.

MUNICIPALITY OF SETÚBAL, SESIMBRA AND PALMELA

1. The local territorial context

SETÚBAL

Setúbal is a municipality located in the Lisbon region, on the northern shore of the Sado Estuary in Portugal. Renowned for its natural richness, history, and economic significance, the area exhibits a blend of urban and rural landscapes.

Main geographic, territorial and urbanistic features

- **Location and Territory:**
  - Setúbal is situated in the Lisbon Metropolitan Area, on the Setúbal Peninsula, bordered by the Atlantic Ocean and the Sado Estuary. The municipality spans approximately 230 km², encompassing urban, rural, and natural areas.
  - It is surrounded by significant natural landmarks, such as the Arrábida Natural Park, known for its limestone cliffs and biodiversity (including the Marine Park Professor Luís Saldanha), and the Sado Estuary Natural Reserve, home to diverse wildlife, including a resident dolphin population.
  - The municipality develops on an area of very gentle relief, contrasting with the elevations of the Arrábida mountain range and the São Luís mountain range.
- **Urban Development:**
  - The city of Setúbal serves as the administrative and economic hub of the municipality. It combines historic districts with modern infrastructure, reflecting its evolution from a fishing and industrial centre to a tourism-oriented destination.
  - Residential areas are a mix of traditional housing and newer developments, with increasing urban expansion towards the peripheries.
  - The city is experiencing urban growth while balancing their industrial, maritime, and tourism sectors.

Climate framework

- **Characteristics:**
  - Setúbal has a Mediterranean climate, characterised by hot, dry summers and mild, wet winters. Average summer temperatures range between 25°C and 30°C, while winter temperatures typically vary from 10°C to 15°C.
  - The region occasionally experiences heatwaves, with temperatures exceeding 40°C during extreme events.

- **Trends and Issues:**

By the end of the 21st century, Setúbal's territory will face significant climate-related risk:

- Temperatures will rise in average (specially in summer and autumn), contributing to very severe droughts and an increased risk of wildfires, particularly in the surrounding Arrábida hills.
- Bioclimatic comfort projections indicate an increase in the frequency and duration of heatwaves and a decrease in cold spells. Across the Metropolitan Area of Lisbon, cold-related discomfort will drop significantly, while heat-related discomfort will intensify. By the century's end, cold discomfort is expected on fewer than half of winter days (compared to over 75% currently), while heat stress will affect more than half of August days and extend from April to October. Setúbal: Reduction of 83–108 cold discomfort days annually; heat stress projected for 78 days annually. Urban areas will experience heightened heat stress due to the urban heat island effect.
- Rainfall will be more irregular, with a tendency to decrease and a greater frequency of extreme events, increasing the risk of flash floods, mainly in the city centre, as well as soil erosion and slope instability.
- Rising sea levels will greatly increase exposure to coastal erosion and estuarine flooding, particularly along the Setúbal waterfront and the inner Sado estuary. Low-lying areas near the estuary and beaches across the municipality will be highly susceptible to flooding, coastal overtopping, erosion, and cliff retreat.

Socio-economic framework

- **Population:**
  - Setúbal municipality has a population of 123 496 residents. The demographic profile reflects an ageing population, with a growing percentage of elderly residents and a declining birth rate.
  - Immigration has partially offset population decline, with communities from Cape Verde, Brazil, and Eastern Europe contributing to cultural diversity.
- **Economic Activities:**
  - Historically an industrial and fishing hub, Setúbal's economy has diversified, with significant contributions from tourism, services, and port activities. The port of Setúbal is a key player in regional and international trade.
  - The surrounding areas support agriculture (notably vineyards producing Moscatel wine) and small-scale industries.
- **Trends and Challenges:**
  - Economic disparities persist, with pockets of socio-economic vulnerability in some urban neighbourhoods.
  - The ageing population and youth migration to larger cities pose challenges for workforce sustainability and long-term economic growth.

Setúbal's strategic location and rich natural and cultural assets make it a complex region, balancing development with environmental and socio-economic challenges.

SESIMBRA

Sesimbra, is a picturesque municipality in the Lisbon region, in the Setúbal District, celebrated for its natural richness, historic significance, and coastal culture. It spans diverse landscapes, from rugged coastline to protected natural parks.

Main geographic, territorial and urbanistic features

- **Location and Territory:**
  - Sesimbra is situated in the Lisbon Metropolitan Area (approximately 40 km south of Lisbon), on the Setúbal Peninsula, along the Atlantic coast. The municipality covers about 196 km² and features a mix of urban areas, coastal settlements, and vast natural landscapes.
  - It is bordered by the Arrábida Natural Park to the east and the Cabo Espichel cliffs to the west, creating a striking blend of limestone formations, sandy beaches, and forested hills.
  - Its calm waters have made the city for more than 50 years an area of technological relevance, as a landing point for submarine communication cables (Google was the last one).
- **Urban Features:**
  - The town of Sesimbra, the municipal centre, is a charming fishing village turned tourist destination. Its urban fabric is characterised by narrow streets, whitewashed houses, and a lively harbour area.
  - Other notable areas include the inland village of Cotovia and the tourist-oriented settlements along the coastline, such as Lagoa de Albufeira and Aldeia do Meco.
  - Urban development is relatively limited, preserving the region's natural and cultural heritage, though seasonal tourism drives the expansion of services and infrastructure.

Climate framework

- **Characteristics:**
  - Sesimbra has a Mediterranean climate, with warm, dry summers and mild, wet winters. Average summer temperatures range from 21°C to 27°C, while winter temperatures generally hover between 10°C and 14°C. Coastal breezes moderate extreme heat.
  - Rainfall occurs predominantly between October and March, with extended dry periods during summer.
  - Prevailing winds in Sesimbra are influenced by its proximity to the Atlantic, with moderate speeds that occasionally intensify during specific seasons.
- **Trends and Issues:**

By the end of the 21st century, Sesimbra's territory will face significant climate-related risks:

- Temperatures will rise in average (specially in summer and autumn), contributing to very severe droughts and an increased risk of wildfires, particularly in the surrounding Arrábida hills.
- Bioclimatic comfort projections indicate an increase in the frequency and duration of heatwaves and a decrease in cold spells. Across the Metropolitan Area of Lisbon, cold-related discomfort will drop significantly, while heat-related discomfort will intensify. By the century's end, cold discomfort is expected on fewer than half of winter days (compared to over 75% currently), while heat stress will affect more than half of August days and extend from April to October. Sesimbra: Reduction of 83–108 cold discomfort days annually; heat stress projected for 72 days annually. Urban areas will experience heightened heat stress due to the urban heat island effect.
- Rainfall will be more irregular, with a tendency to decrease and a greater frequency of extreme events, increasing the risk of flash floods, soil erosion and slope instability.
- The frequency of tropical nights and very hot days will increase significantly, while frosty days will practically disappear. Elderly people are highly vulnerable to climate change, especially during heatwaves. While the estuarine influence in Setúbal helps reduce heat effects, the city's size and density intensify urban heatwaves.
- Coastal erosion and rising sea levels will threat all the municipality's beaches and cliffs, posing challenges for tourism and local ecosystems.

Socio-economic framework

- **Population:**
  - Sesimbra has a population of 52 394 residents, with a significant influx of visitors during the summer months.
  - The population is ageing, mirroring national trends, although the area attracts younger families and remote workers seeking a better quality of life. Seasonal workers also contribute to the local demographic shifts.
- **Economic Activities:**
  - Fishing remains a cornerstone of Sesimbra's identity and economy, with its harbour serving as a centre for commercial and artisanal fishing.
  - Tourism is a dominant economic driver, supported by attractions like its beaches, the medieval Sesimbra Castle, and nature-based activities in the surrounding parklands.
  - Small-scale agriculture, including vineyards and organic farming, plays a notable secondary role.
- **Trends and Challenges:**
  - The seasonal nature of tourism creates economic variability and dependence on summer visitors, impacting local businesses and employment.
  - Urban sprawl linked to tourism and second-home developments poses challenges to sustainable land use and environmental conservation.

- Efforts to diversify the economy, such as promoting cultural and eco-tourism, aim to reduce dependency on traditional sectors.

Sesimbra balances its historical roots and natural charm with the pressures of modernisation and tourism, striving to preserve its heritage while addressing environmental and socio-economic challenges.

PALMELA

Palmela is a municipality located in the Lisbon region, in the Setúbal District, with a combination of historical heritage, strategic geographical location and diverse natural landscapes.

Main geographic, territorial and urbanistic features

- **Location and Territory:**
  - Palmela lies at the crossroads of the Setúbal Peninsula, situated between the Arrábida Natural Park and the Tagus Estuary. With 462 km², Palmela is the largest municipality of the Metropolitan Area of Lisbon, encompassing urban, rural, and semi-natural areas.
  - The municipality has two protected areas: the Arrábida Natural Park to the south and the Sado Estuary Nature Reserve to the south-east. To the north-east is the Montado ecosystem of Rio Frio, considered to be the largest in Europe
  - The territory includes rolling hills, fertile plains, and vineyards, which are part of the renowned Setúbal wine region, especially famous for Moscatel wine.
- **Urban Features:**
  - The town of Palmela is known for its historic centre, dominated by the medieval Palmela Castle, which offers panoramic views of the region.
  - Urban development is concentrated around the town and surrounding villages such as Quinta do Anjo and Pinhal Novo, the latter being a significant residential and logistical hub due to its proximity to Lisbon and railway connections.
  - Urban sprawl is limited by zoning laws and the protection of agricultural and natural areas.
  - Despite improvements in building conservation, Palmela still has many deteriorated structures, emphasizing the need for historic centre rehabilitation and urban regeneration to address climate change impacts like heatwaves.

Climate Framework

- **Characteristics:**
  - Palmela has a Mediterranean climate, with warm, dry summers and mild, wet winters. Average maximum temperatures range from 15°C in January to 31°C in August, with an annual average of 23°C. Minimum vary between 6°C in February and 16°C in August, with an annual average of 11°C
  - The region benefits from cooling Atlantic breezes but is susceptible to heatwaves during summer.

- Most rainfall occurs between October and April, while May to September is drier.

- **Trends and Issues:**

By the end of the 21st century, Palmela's territory will face significant climate-related risks:

- Temperatures will rise in average (specially in summer and autumn), contributing to very severe droughts and an increased risk of wildfires, particularly in the surrounding Arrábida hills.
- Bioclimatic comfort projections indicate an increase in the frequency and duration of heatwaves and a decrease in cold spells. Across the Metropolitan Area of Lisbon, cold-related discomfort will drop significantly, while heat-related discomfort will intensify. By the century's end, cold discomfort is expected on fewer than half of winter days (compared to over 75% currently), while heat stress will affect more than half of August days and extend from April to October. Palmela: Reduction of 83–108 cold discomfort days annually; heat stress projected for 91 days annually. Urban areas will experience heightened heat stress due to the urban heat island effect.
- Rainfall will be more irregular, with a tendency to decrease and a greater frequency of extreme events, increasing the risk of flash floods, mainly around the Sado Estuary, affecting agriculture and water resources, as well as soil erosion and slope instability.

Socio-Economic Framework

- **Population:**
- Palmela has 71 410 residents, distributed across urban centres and rural communities with an ageing population but also younger families attracted by its affordability and proximity to Lisbon.
- Immigration contributes to demographic diversity, with workers from Eastern Europe, Africa, and Brazil forming part of the community.
- **Economic Activities:**
- Palmela is a prominent agricultural hub, particularly known for its vineyards and wine production, olive groves, and fruit orchards.
- Palmela hosts industrial zones (logistics and manufacturing facilities), including the car factory Volkswagen Autoeuropa, the largest foreign investment in Portugal, key in the region's economy as a centre of industrial excellence that drives economic growth and innovation in the territory.
- Tourism: Historical landmarks, wine tourism, and natural attractions draw visitors, contributing to the local economy.
- Services and Retail: Local businesses cater to the needs of residents and tourists, while larger retail developments are concentrated in Pinhal Novo.
- **Trends and Challenges:**
- The agricultural sector faces challenges due to water scarcity and changing climatic conditions, prompting the need for more sustainable practices.

- While industrial and logistical activities provide employment, they also bring environmental concerns, including air and noise pollution.
- The ageing population and the migration of younger residents to urban centres like Lisbon pose socio-economic sustainability challenges.

Palmela stands out for its rich cultural heritage, agricultural identity, and strategic economic position. However, the municipality must navigate the complexities of climate change, demographic shifts, and economic diversification to sustain its development.

2. The reference policy and strategic context

The regional context

There is not energy and climate legislation at regional level, nor regional incentives, supporting mechanisms and financial tools targeting energy transition. What there is in the Arrábida Territory (composed of the municipalities of Setúbal, Palmela and Sesimbra) is a common Climate Change Mitigation and Adaptation Strategy, concretised, for each one of these municipalities, in a Climate Change Adaptation Local Plan (PLAAC Arrábida project, funded by EEA Grants) and a Climate Neutrality Transition Roadmap (EuCityCalc project, funded by Horizon Europe). This transition roadmap considers around 30 measures to achieve the goal of decarbonizing the territory and is monitored by the Arrábida Ø Emissions initiative, which brings together all decarbonisation efforts in the region.

These documents, resulting from stakeholders' co-creation processes led by ENA, prepare the Arrábida Territory to face the challenge of climate change by identifying vulnerabilities, reducing risks and impacts and promoting adaptation and resilience, as well as outlining mitigation strategies for these municipalities (see the Arrábida's mitigation measures' table below), helping to plan the region's transition towards climate neutrality.

The local context

Palmela, Setúbal, and Sesimbra joined the Covenant of Mayors (in 2009, 2016, and 2021, respectively), but with varying levels of implementation. However, in 2024, all three municipalities committed with an adaptation and decarbonisation roadmap for the entire region (Arrábida Territory) by 2050. The referred plans provide essential tools to create the Local Climate Action Plans, which aim to address both mitigation and adaptation strategies at the local level, crucial for enhancing the region's resilience to climate change and promoting sustainable development.

	Action	Energy Savings (MWh/y)	RES Production (MWh/y)	CO2 reduction (t CO2/y)
Services	Promotion of renewable energy communities (CER)		2 240	591
	Promotion of sustainability criteria in the construction process	3 976		1 050
	Renovation of service buildings (public)	25 496	10 927	9 470
Residential buildings	Enhancing water efficiency in buildings	234		61
	Promoting efficient use of resources	1 074		279
	Creation of a fund to combat energy poverty	460		120

	Promotion of buildings with high energy efficiency	29 861		7 764
	Renovation of residential buildings	155 018	66 436	57 578
	Promotion of local consumption	5 462		1 420
	Eco Neighborhoods	8 000		2 080
	Heat pumps in private buildings	93 917		24 418
	Reduction of water losses in the distribution network	2 992		778
	Promotion of energy efficiency and renewables in industry	28 336	18 891	12 279
Industry	Innovation clusters	12 751		3 315
	Promotion of industrial symbiosis and circular economy	55 071		14 319
Energy production	Increase in the share of renewable energy produced		2 569 857	668 163
Residues	Waste Prevention and Separation	5 462		1 420
	Quality Public Transport	47 729		12 409
	Flexibility in Work Hours	9 589		2 493
	Intelligent Mobility Management	13 069		3 398
	Low Emission Zones	51 885		13 490
Transportation	Promotion of Soft Mobility Modes	227 000		59 020
	Compact Urban Planning	59 661		15 512
	Bike-Sharing System	2 360		614
	Charging Stations for Electric Vehicles	599 400		155 844
	Low Emission Vehicles	30 956		8 049
	Electrification of the Nautical Sector	7 705		2 003
	Increase in Carbon Sequestration in Forests and Other Land Uses	86		22
Primary sector	Promotion of Sustainability in Animal, Plant Production, and Pasture Soils	87 939		22 864
	Efficient Use of Resources in Agricultural Production	21 985		5 716

Arrábida's mitigation measures

The collaboration between the municipalities of Palmela, Sesimbra, and Setúbal, E-Redes, and MOBIE, coordinated by ENA, led to the creation of a regional electromobility plan. This plan includes a public network of EV charging stations, shared e-bike systems, electric public transport, and low-emission zones. By 2030, the aim is to install 209 normal and 76 high-power charging points, alongside other sustainability-focused initiatives.

Regarding heating and cooling, there are no specific plans or data characterising the sector, only isolated initiatives focused on combating heat islands. These initiatives aim to address local temperature imbalances but do not involve comprehensive strategies or large-scale projects for district heating or cooling systems. More detailed plans and actions in this area are yet to be developed.

The urban and territorial planning regulations in Palmela, Setúbal, and Sesimbra are part of broader national and regional frameworks, designed to align with Portugal's carbon neutrality goals and promote sustainable urban and regional development.

The territorial development of these municipalities is influenced by the National Spatial Planning Policy Programme (PNPOT), which is the overarching instrument for spatial planning in Portugal. The plan emphasizes sustainable land use, the prevention of environmental degradation, and the integration of

various policy sectors to foster resilient, low-carbon urban spaces. For instance, the Landscape Transition Programme includes measures for sustainable landscape management, fire prevention, and resilience, aligning with climate adaptation strategies.

Building regulations in these municipalities also follow national standards, which emphasize energy efficiency and the decarbonisation of the built environment (from EPBD directive). The building code incorporates requirements for energy performance, mandating improvements in insulation, the integration of renewable energy sources (such as solar panels), and the promotion of low-carbon technologies by reducing the energy use in buildings. Renovation plans also focus on improving energy efficiency in older buildings, which is a significant part of the commitment to the European Green Deal's 2050 carbon neutrality goals.

Overall, the region is taking significant steps toward integrating energy transition goals and carbon neutrality into its urban and territorial plans. However, specific details regarding H&C scenarios are less clear, suggesting an area for further development in upcoming plans.

Palmela, Setúbal, and Sesimbra are actively addressing climate change through localized adaptation strategies. Under the PLAAC Arrábida project, the three municipalities have developed specific climate adaptation plans. These plans focus on reducing vulnerabilities to climate change impacts, such as coastal flooding and heatwaves, which are expected to become more frequent in the coming decades. The region is particularly vulnerable to heatwaves, with a projected increase in hot days from 10 to 44 annually by the end of the century.

In terms of energy and carbon neutrality, these adaptation strategies intersect with local mitigation actions, especially regarding the heating and cooling (H&C) sector. The local strategies focus on reducing the urban heat island effect and adapting to changing weather patterns. These measures indirectly support energy transitions by promoting energy-efficient buildings and green infrastructure, which helps to reduce the need for cooling in the summer and heating in the winter. The role of the H&C sector in these plans is integrated into broader efforts to reduce emissions, manage energy demand, and enhance local resilience to extreme temperatures.

3. The local energy system

The local energy demand

The following energy consumption inventory is for the year 2022. This information is provided by the Directorate-General for Energy and Geology for all municipalities in Portugal.

SETÚBAL

Sector	FINAL ENERGY CONSUMPTION [kWh]							
	Electricity	Natural Gas	LPG	Heating Oil	Diesel	Gasoline	Other fossil fuels	Total
Municipal buildings, equipment/facilities	16 360 051	1 794 879	582 853					18 737 783
Tertiary	105 814 270	14 396 515	4 742 952	1 424 016			9 300 590	135 678 343
Residential buildings	150 299 814	46 875 687	43 884 092	2 912 190				243 971 783
Public lighting	9 890 623							9 890 623
Industry	103 741 739	175 087 455	9 694 458		10 737 533	0	43 878 652	343 139 837
Municipal fleet					5 285 292	321 562		5 606 854
Public transport	585 366				19 404 715			19 990 081
Private and commercial transport	7 115 438	14 993	85 109	2 511 146	631 520 013	167 215 171	7 993 620	816 455 490
Agriculture, Forestry, Fisheries	6 203 398	47 121	1 924 400	3 832 652	69 824 502	642 821	2 566	82 477 460
Water for human consumption	4 546 979							4 546 979
Waste	4 377 281							4 377 281
Waste Water	4 366 726							4 366 726

SESIMBRA

Sector	FINAL ENERGY CONSUMPTION [kWh]							
	Electricity	Natural Gas	LPG	Heating Oil	Diesel	Gasoline	Other fossil fuels	Total
Municipal buildings, equipment/facilities	9 678 657	187 413	190 408					10 056 478
Tertiary	37 739 052	1 668 509	2 891 392					42 298 953
Residential buildings	80 601 257	13 837 490	23 036 701					117 475 448
Public lighting	4 789 982							4 789 982
Industry	9 223 495	35 341	54 311		17 736 874	0	326 600	27 376 621
Municipal fleet					4 675 413	106 501		4 781 914
Public transport								0
Private and commercial transport	2 122 916	2 142	0		164 266 659	59 432 526	223 416	226 047 659
Agriculture, Forestry, Fisheries	1 118 440	3 213	38 593	3 942 738	20 362 841		6 531	25 472 356
Water for human consumption								0
Waste	30 029							30 029
Waste Water	3 695 764	4 284						3 700 048

PALMELA

Sector	FINAL ENERGY CONSUMPTION [kWh]							
	Electricity	Natural Gas	LPG	Heating Oil	Diesel	Gasoline	Other fossil fuels	Total
Municipal buildings, equipment/facilities	3 595 636	1 008 816	219 289					4 823 741
Tertiary	56 154 540	4 081 315	2 309 050	1 076 121				63 621 026
Residential buildings	104 235 599	19 547 690	16 938 913	2 200 892				142 923 094
Public lighting	4 082 634							4 082 634
Industry	258 320 381	34 922 703	5 657 305	194 959	17 810 857	18 494 056	69 543 839	404 944 100
Municipal fleet					2 534 659	132 061		2 666 720
Public transport	2 750 058				4 814 144			7 564 202
Private and commercial transport	2 969 150	2 626 992	193 475		317 116 539	78 325 181	3 728 830	404 960 167
Agriculture, Forestry, Fisheries	11 066 007	3 654 014	201 526	558	32 306 230		65 195	47 293 530
Water for human consumption	1 217 383							1 217 383
Waste	2 199 497							2 199 497
Waste Water	2 790 551							2 790 551

In the urban areas of the Setúbal, Palmela and Sesimbra municipalities, around 60% of buildings are residential, 30% commercial and services and 10% industrial/workshops/warehouses.

Regarding the use of renewable energy sources in heating and cooling consumption, there is no available information indicating the percentage of RES (renewable energy sources) used. However, in the residential sector, a small number of buildings utilize air conditioning systems to regulate ambient air temperature. These systems often rely on aerothermal technology, which operates through heat pumps that extract heat from the outside air—even at very low temperatures—and transfer it indoors. This process can also be reversed to provide cooling.

Aerothermal systems offer several advantages, including high energy efficiency, as they significantly reduce energy consumption and achieve very high coefficients of performance (COP). Additionally, they are sustainable and environmentally friendly, as they utilize a renewable energy source—air—thereby reducing CO_2 emissions.

Apart from air conditioning units (Split or Multi-Split), the predominant solution is electric radiators for heating in winter. In this sector, there is a small percentage of gas central heating systems and solid biomass fireplaces.

In the services sector, the predominant solutions are direct expansion split, multi-split and VRV/VRF systems.

In the industrial sector, buildings are typically not air-conditioned, and heat requirements originate from industrial processes.

Regarding heat requirements for the production of domestic hot water, in the residential sector the predominant solutions are electric water heaters and gas water heaters, and in the services sector gas boilers and electric water heaters.

According to the Directorate-General for Energy and Geology (DGEG), in the municipalities of Setúbal, Sesimbra, and Palmela approximately 60% of energy consumption is allocated to heating and hot water. Moreover, none of the municipalities has specific data available on energy consumption related to the cooling of buildings. Since 2019, a general trend towards reduced consumption of butane, propane, and heating oil in the H&C sectors has been observed, largely driven by the electrification of buildings. However, natural gas consumption has shown slight increases in specific sectors in all three municipalities.

The municipality of Setúbal has experienced a decline in the use of butane, propane, and heating oil for H&C since 2019, while natural gas consumption has slightly increased in the residential and tertiary sectors.

Unlike Setúbal and Palmela, Sesimbra reports no consumption of heating oil. In the tertiary sector, natural gas and butane consumption have slightly increased since 2019, whereas propane consumption decreased between 2019 and 2022. In the residential sector, overall energy consumption for H&C has declined, except for natural gas, which has seen a modest rise.

In the residential sector of Palmela, the consumption of butane and propane increased slightly between 2019 and 2022, while heating oil usage saw a slight decrease. Natural gas consumption has remained relatively stable, averaging around 19,500,000 kWh annually. In the tertiary sector, natural gas and propane usage have shown minimal changes, but butane consumption has risen slightly, while heating oil consumption has continued to decline.

The local energy supply

These municipalities host various photovoltaic, biomass-based cogeneration, and biogas cogeneration plants. Biomass cogeneration accounts for the largest share of electricity produced (62%). In these cogeneration plants, all thermal energy is used locally within the adjacent industrial units.

RES plants	Instaled power MW_e	Anual production MWh_e
Parque Solar Quinta do Anjo (Palmela)	1,8	2 507
Parque Fotovoltaico da Salgueirinha (Palmela)	4,6	7 200
Central Solar Quinta do Anjo (Palmela)	32,87	74 000
CSF Algeruz (Setúbal)	7,41	17 744
Central Solar Quinta da Seixa - 2ª fase (Palmela)	8,1	11 000
Central do Conde - Herdade do Pinhal das Formas (Palmela)	13,64	24 902
Central Solar Fotovoltaico do Sadino (Setúbal)	14,95	29 689
Central Solar Fotovoltaico do Sadino (Setúbal)	22,22	40 529

Montinhoso (Palmela)	9	16 431
Central biomassa Portucel (Setúbal)	54	250 000
Central PV Portucel (Setúbal)	2,2	4 013
Central Cogeração FIT (Palmela)	30	6 718
Central Cogeração Enerpulp (Setúbal)	12,5	70 000
Cogeração Amarsul (Setúbal)	2	798

This area, due to its proximity to major consumption centers, the topography of the land, and its population density, has great potential for the installation of photovoltaic parks. It is expected that, in the short term, the current 198 GWh of PV production will increase to 688 GWh.

4. Mapping of H&C target groups

STAKEHOLDER	TARGET GROUP	Contact person(s)
Municipality of Setúbal – Sustainable Development and Environmental Emergency Department	Local authority	Cristina Coelho
Municipality of Palmela – Departments of Works, Logistics and manteinance / Environment and Energy Efficiency	Local authority	Teresa Palaio / Rui Farinha
Municipality of Sesimbra - Sustainability and Climate Action Division	Local authority	Marta Franco
ADENE	National energy agency	Joana Fernandes
AML – Metropolitan Area of Lisbon	Regional authority	Carlos Carvalho
ENA – Energy and Environment Agency of Arrábida	Sectoral (public) agency	Orlando Paraíba
E-REDES (Electricity Distributor)	Infrastructure and (public) service provider	Victor Tavares Morais
Setúbal Politechnic Institute (IPS)	Academia	Prof. João Francisco Fernandes
APESE – ESCO's Portuguese Association	ESCOs	Jorge Borges de Araújo
ZERO	Environmental NGO	Francisco Ferreira
AISET - Setúbal Peninsula Industry Association	Business support and trade association	Nuno Maia
Lisbon Tourism Regional Entity	Tourism public entity	Ricardo Mesquita / Jorge Humberto
Aicep Global Parques	Industrial and logistics parks' manager (public entity)	Manuel Gaeiras
APSS – Setúbal and Sesimbra Port Authority	Port Authority	Nuno Almeida
CCDR – LVT Lisbon and Tagus Valley Regional Coordination and Development Commission	Public entity for development and territorial cohesion	Carlos Pina
Docapesca	Public company responsible for managing fishery-related port infrastructures	Sérgio Faias
Arrábida's Health Local Unit	Health entity	Célia Maia / João Diegues
The Navigator Company	Business company	António Redondo
Coca- Cola EuroPacific Partners	Business company	Carlos Branco
ACISTDS Setúbal District Trade and Services Association	Business support and trade association	Isaú Alves Fialho da Maia
SAPEC Industrial Park	Industrial Park	Vânia Marques
Arwatt	SMEs	Tbc
AICCOPN Association of Civil Construction and Public Works Industrialists	Business support and trade association	Manuel Joaquim Reis Campos

5. Summary in national language

Contexto territorial local

O município de Setúbal combina áreas urbanas, rurais e naturais, destacando-se pelo Parque Natural da Arrábida e a Reserva Natural do Estuário do Sado. A cidade, centro económico e administrativo, equilibra setores industriais, marítimos e turísticos, mas enfrenta riscos climáticos como ondas de calor, redução de precipitação e inundações. Com 123.496 habitantes, a economia diversificou-se do setor industrial para o turismo e atividades portuárias.

Com 196 km², Sesimbra integra paisagens costeiras e o Parque Natural da Arrábida. A vila piscatória evoluiu para um destino turístico, mantendo características tradicionais. O clima mediterrânico e a proximidade do Atlântico moderam temperaturas, mas a região enfrenta riscos de incêndios, erosão costeira e ondas de calor. A economia baseia-se na pesca, turismo e agricultura em pequena escala, mas depende do turismo sazonal.

Palmela, o maior município da Área Metropolitana de Lisboa (462 km²), combina vinhedos, áreas naturais e o Castelo de Palmela. A economia é diversificada, com destaque para a agricultura, a Autoeuropa (o maior investimento estrangeiro em Portugal) e o turismo. Enfrenta desafios climáticos como ondas de calor, secas e inundações, além de pressões demográficas.

Os três municípios destacam-se pela riqueza natural e cultural, mas enfrentam desafios comuns relacionados com alterações climáticas, envelhecimento demográfico, desigualdades económicas e equilíbrio entre desenvolvimento e conservação.

Contexto político e estratégico de referência

Contexto nacional

O setor de aquecimento e arrefecimento (H&C) representou 36% do consumo final de energia (FEC) em Portugal em 2018, totalizando 6,2 Mtep. O consumo de energia neste setor deverá diminuir 7,4% entre 2020 e 2030, segundo o Plano Nacional de Energia e Clima (PNEC) 2024. Em 2018, 41,2% do FEC no setor era de fontes renováveis, com a bioenergia como principal recurso. Espera-se que as bombas de calor, a energia solar térmica e os gases renováveis desempenhem um papel crescente até 2030.

O PNEC 2024 estabelece metas de 46% (2025) e 63% (2030) de fontes renováveis no setor H&C, promovendo sistemas de RES-H&C e tecnologias eficientes. Além disso, medidas como o apoio a planos municipais e regionais de ação climática, a modernização de edifícios e o combate à pobreza energética foram introduzidas.

Portugal enfrenta desafios significativos relacionados com o desconforto térmico, com 20,8% da população incapaz de aquecer as suas casas no inverno e 38,3% reportando desconforto no verão (dados de 2023). Para mitigar estes problemas, o PNEC propõe estratégias de longo prazo para a eficiência energética e incentivos, como o programa “Vale Eficiência”.

No setor industrial, os fundos do programa “Recuperar Portugal” promoveram inovação em tecnologias de baixo carbono e renováveis, embora estas linhas de financiamento estejam encerradas.

Para garantir a transição energética, são promovidos programas de formação e sensibilização para a adoção de energias renováveis e tecnologias eficientes.

Contexto regional

No Território Arrábida (Setúbal, Palmela e Sesimbra), não há legislações regionais nem incentivos específicos direcionados à transição energética. Contudo, a região tem estratégias comuns de mitigação e adaptação às alterações climáticas, como os Planos Locais de Adaptação às Alterações Climáticas (PLAAC, financiados por EEA Grants) e os Roteiros de Transição para a Neutralidade Climática (EuCityCalc, financiado pelo Horizon Europe). Ambos os documentos, elaborados em processos de cocriação liderados pela ENA, identificam vulnerabilidades e promovem a adaptação, resiliência e mitigação, preparando o território para os desafios climáticos e apoiando a transição para a neutralidade climática. Os roteiros incluem cerca de 30 medidas monitorizadas pela iniciativa Arrábida Ø Emissões, que coordena os esforços regionais de descarbonização.

Contexto local

Os municípios de Palmela, Setúbal e Sesimbra aderiram ao Pacto de Autarcas (2009, 2016 e 2021, respetivamente) e comprometeram-se a implementar uma estratégia de adaptação (2021) e um roteiro de descarbonização (2024) do Território da Arrábida até 2050. Estes documentos, que servem de base para os Planos Locais de Ação Climática, combinam estratégias de mitigação e adaptação para fortalecer a resiliência às alterações climáticas e promover o desenvolvimento sustentável.

As medidas incluem, entre outras, a instalação de bombas de calor em edifícios privados, a renovação de edifícios públicos e residenciais para melhorar a eficiência energética, e a promoção de edifícios altamente eficientes e bairros ecológicos. Na indústria, incentiva-se a eficiência energética e a integração de energias renováveis nos processos produtivos. O planeamento urbano compacto e o aumento da produção de energia renovável contribuem para a redução do efeito de ilhas de calor e para a eletrificação de sistemas de climatização. Além disso, a criação de comunidades de energia renovável (CER) promove o consumo local de energia limpa, reforçando a transição energética, a sustentabilidade e a resiliência climática.

Embora avanços estejam em curso, o setor de aquecimento e arrefecimento carece de estratégias abrangentes, evidenciando uma oportunidade para maior desenvolvimento futuro.

O sistema energético local

A procura local de energia

Em 2022, os três municípios apresentaram um consumo energético variado. Com cerca de 60% dos edifícios residenciais, 30% comerciais e de serviços, e 10% industriais, a utilização de fontes renováveis para aquecimento e arrefecimento (H&C) não está detalhada, mas destaca-se o uso de sistemas aerotérmicos, como bombas de calor, que oferecem alta eficiência energética e reduzida emissão de CO_2. No setor residencial, predominam radiadores elétricos e sistemas de ar condicionado para climatização, com um uso limitado de aquecimento central a gás e lareiras a biomassa. Para AQS utilizam-se principalmente esquentadores elétricos e a gás. No setor de serviços, prevalecem sistemas Split, Multi-Split e VRV/VRF, enquanto na indústria o arrefecimento e aquecimento centra-se nos processos industriais.

Cerca de 60% do consumo energético nos três municípios é destinado ao aquecimento e à produção de ACS. Desde 2019, o uso de butano, propano e gasóleo de aquecimento diminuiu devido à eletrificação dos edifícios, enquanto o gás natural teve ligeiro aumento em alguns setores. Em Setúbal, os combustíveis fósseis para H&C diminuíram, mas o gás natural cresceu nos setores residencial e terciário. Sesimbra não utiliza gasóleo de aquecimento e registou pequenas alterações no consumo de gás natural e butano. Em Palmela, o gás natural mantém-se estável, com leve aumento de butano e propano no setor residencial e redução no uso de gasóleo de aquecimento.

O fornecimento local de energia

Setúbal, Palmela e Sesimbra possuem centrais de energia renovável, como parques fotovoltaicos e centrais de cogeração a biomassa e biogás. A biomassa representa 62% da eletricidade produzida, com a energia térmica utilizada nas unidades industriais adjacentes. A produção fotovoltaica atual é de 198 GWh, com previsão de aumento para 688 GWh, devido ao grande potencial para novos parques solares, impulsionado pela proximidade a centros de consumo, topografia e densidade populacional.

Entre os principais empreendimentos destacam-se o Parque Solar Quinta do Anjo (74 GWh), o Parque Fotovoltaico da Salgueirinha (7,2 GWh) e a Central Biomassa Portucel (250 GWh), entre outros, que contribuem significativamente para a transição energética local e para o abastecimento sustentável de energia.

Mapeamento de atores relevantes

Os atores identificados como relevantes para participar no desenvolvimento dos planos locais de aquecimento e arrefecimento incluem autoridades locais (municípios de Setúbal, Palmela e Sesimbra), agências de energia (ADENE, ENA), autoridades regionais (AML, CCDR-LVT), fornecedores de infraestrutura (E-REDES, Docapesca, APSS), academia (IPS), ONGs ambientais (ZERO), associações empresariais e comerciais (AISET, ACISTDS, AICCOPN), parques industriais (SAPEC, Aicep Global Parques), empresas (The Navigator Company, Coca-Cola, Arwatt), entidades de saúde (ULS Arrábida) e de turismo (ERT Lisboa), além da APESE (Associação de ESCOs).

MUNICIPALITY OF ÉVORA

1. The local territorial context

The municipality of Évora, with an area of 1.307 km^2, occupies around 4,8% of the Alentejo Region and 1,4% of the territory of mainland Portugal. It is the 5th largest Portuguese municipality. Located in the South-Central of Continental Portugal, Évora is the capital of the district with the same name. Évora is distributed across 12 parishes: Bacelo e Senhora da Saúde, Canaviais, Évora (São Mamede, Sé, São Pedro e Santo Antão), Malagueira e Horta das Figueiras, Nossa Senhora da Graça do Divor, Nossa Senhora da Tourega e Nossa Senhora de Guadalupe, Nossa Senhora de Machede, São Bento do Mato, São Manços e São Vicente do Pigeiro, São Miguel de Machede, São Sebastião da Giesteira e Nossa Senhora da Boa Fé, e Torre de Coelheiros. The urban area of the municipality (the city of Évora), occupies 16,4 km^2.

According to census information, in 2021, the municipality of Évora had an overall population of 53.577 inhabitants (52% of which were between 25 and 64 years old), meaning a low average population density of around 41 inhabitants/km^2. The average annual growth rate of population (2011/2023) is negative -3% (GEE 2023).

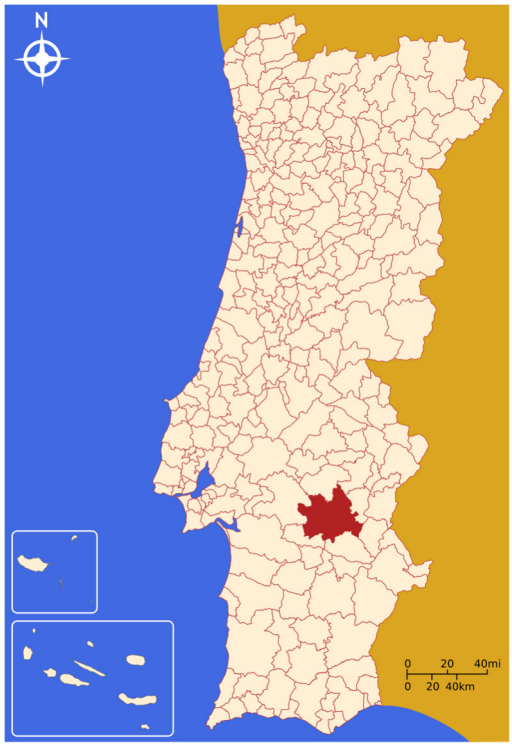


Figure 3 - Location of Évora' municipality (Wikipedia 2024)

The territory of the municipality has a slightly hilly landscape, with an average altitude of 265 metres, but with a clear hypsometric division, marked by the influence of two main elevations, the Serra de Monfurado in the northern quadrant and the Serra de Portel in the southern quadrant and is cut by three hydrographic basins (Tejo, Sado and Guadiana Rivers).

The climate, influenced by the latitude and remoteness, is characterized by high thermal amplitude between the winter and summer months, with very high temperatures in July, August and September and low temperatures in December, January and February. The highest maximum temperature recorded was 42°C in July and the lowest minimum temperature recorded -2.9°C in January. As presented in the Plano Intermunicipal de Adaptação às Alterações Climáticas do Alentejo Central – PIAAC-AC (Central Alentejo Intermunicipal Climate

Change Adaptation Plan), according to the Köppen-Geiger Climate Classification the climate in Alentejo Central is temperate mediterranean (mesothermic) with rainy winters and dry and hot summers – classification Csa (PIAAC-AC 2020:53-78). According to the climatic projections for Évora for the end of the century (2071-2100), an increase in the average annual temperature of between 1,5°C and 4,7°C is projected, with an increase of the monthly averages of the maximum temperature in all months (for example, for the month of August – the hottest –, the increases could vary between 1,9°C and 5,4°C by the end of the century). It is also projected an increase in the average number of summer days (between 22 and 60 days) and on the average number of very hot days (between 14 and 62 days), in contrast to the number of frost days, which is projected to decrease. Regarding the total number of heatwaves (for 30-year periods), the projection points to an increase in their frequency as early as 2041-2070 (EMAAC-Évora 2017:31-35). In 2023 were registered 2 heatwaves, a 6-day heatwave in June and a 7-day heatwave in August (https://rea.apambiente.pt/content/ondas-de-calor-e-de-frio).

The Municipality of Évora is one of the main administrative and economic centers of the Alentejo region. The city of Évora is a touristic and historical city, known as the museum-city, with an occupation that dates more than twenty centuries, going as far back as Celtic times. In 2021 the tertiary sector employed 64,6% of Évora's working population, while 30,8% and 4,6% of the municipality's employees worked in the secondary sector and in agriculture, respectively (GEE 2023).

The historic centre of the city of Évora, due to the integrity of its historically authentic building stock, is recognized as an UNESCO's World Heritage site since 1986 (https://whc.unesco.org/en/list/361). Some buildings date from the medieval period, others from the 16th, 17th and 18th centuries, when Évora became a royal residence and was elevated to an ecclesiastical city. The population growth during the last centuries led to the construction of new quarters to the west, south and east of the city center, outside of the city walls. Figure 2 shows the different construction periods for existing buildings in the Évora municipality in 2021.

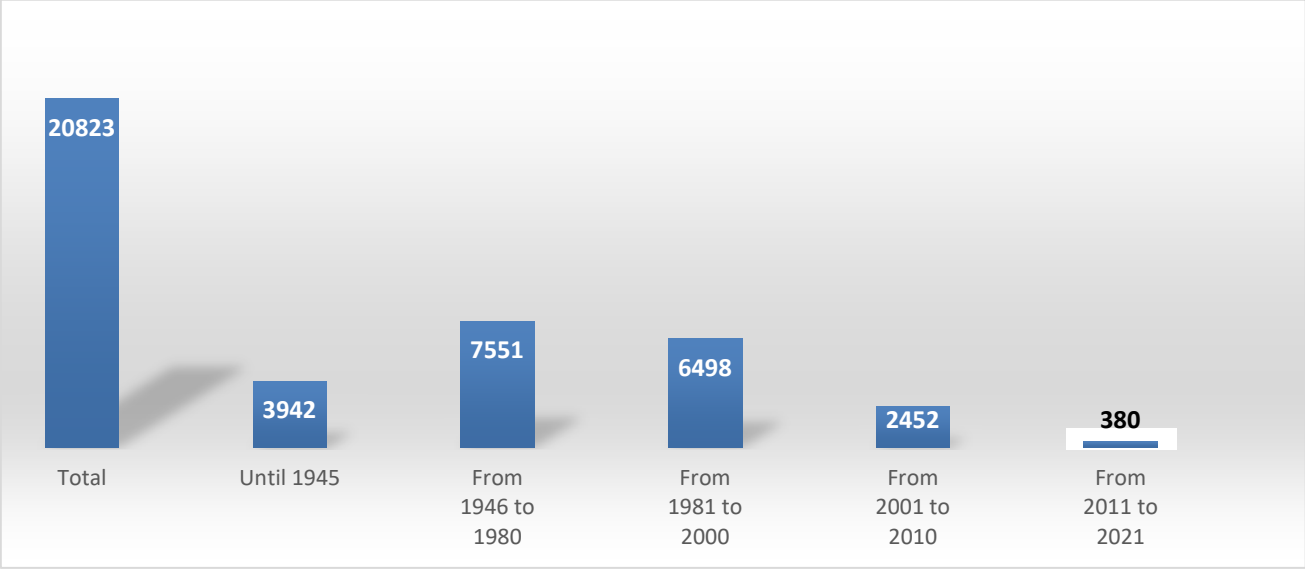


Figure 2 - Construction periods for existing buildings in Évora in 2021 (INE 2021)

Regarding the state of its buildings in the last available year (2021), as can be seen in Figure 3, the Municipality of Évora has a total of 20.823 buildings built, of which 2,2% need deep interventions, 5,3% need medium interventions, 19,9% only small interventions and 73% need no interventions.

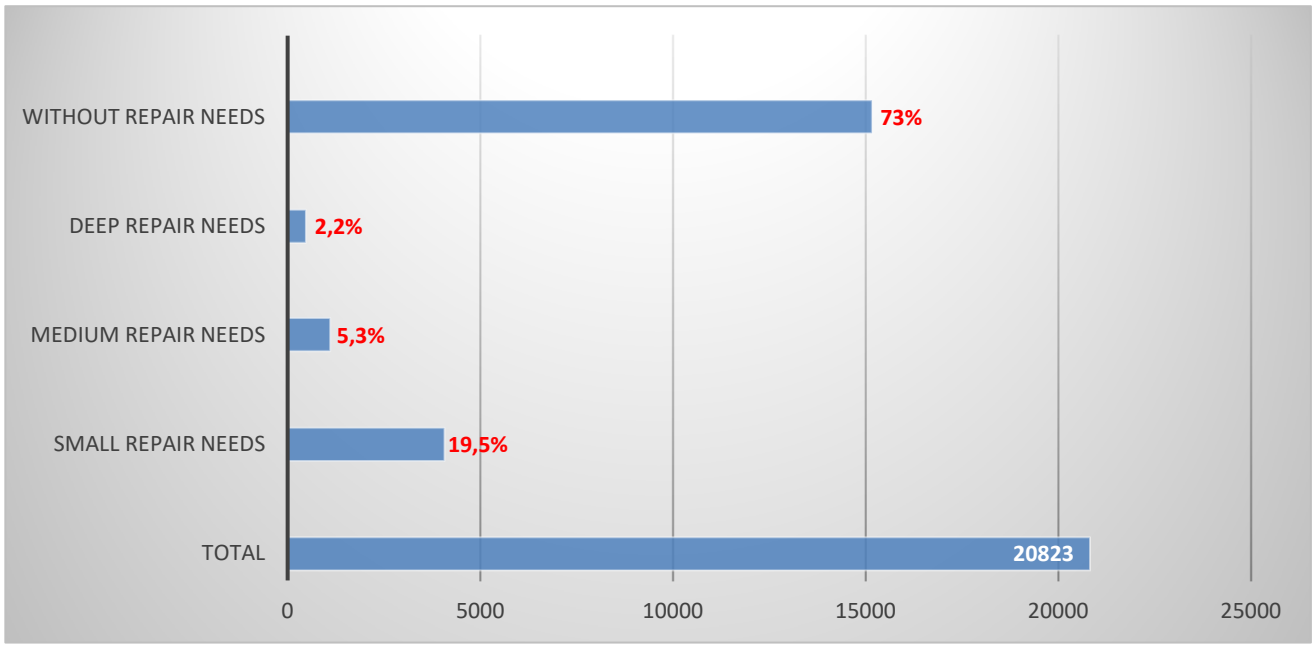


Figure 3 - Total number of buildings built and repair needs (INE 2021)

It is also relevant to analyse the total number of energy certificates issued in the municipality of Évora, by energy class, for all types of buildings (Figure 4). The predominant classes are C, D and E with 24,4%, 26,3% and 18,6% respectively. The total number of certificates in Évora is 9.471. The energy certificate is a mandatory document in many countries that assesses the energy efficiency of a property, classifying it on a performance scale (for example, from A+ to G). It identifies the expected energy consumption and suggests improvements to reduce costs and emissions. It comes from the EPBD (Energy Performance of Buildings Directive), a European directive aimed at improving the energy efficiency of buildings. In Portugal, it has been mandatory since 2009 for new and existing properties in cases of sale, rental or major renovation. Implementation follows the rules of the Energy Certification System for Buildings (SCE), managed by ADENE (Energy Agency).

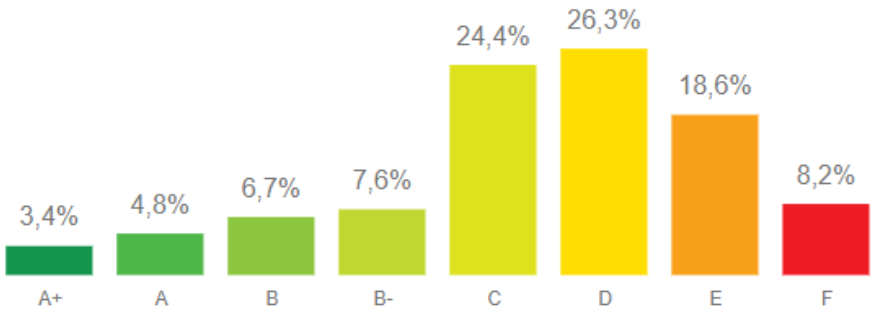


Figure 4 - Total energy certificates issued in the municipality of Évora, by energy class (SCE 2024)

2. The reference policy and strategic context [max 3 pages]

The regional context

Regionally there are, in Continental Portugal, Comissões de Coordenação e Desenvolvimento Regional – CCDR (Regional Coordination and Development Commissions). These are peripheral services of the direct administration of the State, endowed with administrative and financial autonomy (but devoid of legal personality), which have powers in the fields of coordination and articulation of the various sectoral policies at regional level, implementation of environmental policies and spatial and urban planning, technical support for local authorities and their associations and management of European funding programmes (https://diariodarepublica.pt/dr/lexionario/termo/ccdr-comissao-coordenacao-desenvolvimento-regional).
There are currently 5 CCDRs in Portugal (Decree-Law No. 228/2012) that correspond to the 5 regions of Continental Portugal (North, Centre, Lisbon and Tagus Valley, Alentejo, Algarve). Furthermore, sub-regionally, there are intermunicipal entities (Law No.75/2013). These can take the form of Intermunicipal Communities or of Metropolitan Regions and correspond to the NUT III territorial units. There are currently 21 intermunicipal communities and two metropolitan areas in Continental Portugal. Intermunicipal entities are free associations of municipalities, non-territorial, with their own budget and management, and clear objectives, to which the associated municipalities delegate part of the functions or competences conferred on them by law, with the aim of providing services to all its members. According to Law No. 50/2018, intermunicipal entities have, amongst other, power to appoint members representing municipalities on river basin district councils, manage projects financed with European funds and manage investment caption programmes.

On the scope of the Portuguese Climate Framework Law (Law no. 98/2021) the CCDRs need to develop Planos Regionais de Ação Climática – PRACs (Regional Climate Action Plans), which should include the dimensions of mitigation and adaptation to climate change. CCDRs are also, for example, responsible for the development of the Estratégias Regionais de Especialização Inteligente – RIS3 (Regional Innovation Smart Specialisation Strategies), an approach created by the European Union in 2010. The RIS3 are regional strategies that aim to address regional challenges and support regional development through the identification and promotion of areas of innovative specialization. These strategies usually include lines of action related with the increase of sustainability and of territorial cohesion, decarbonization, the transition to a more circular economy and/or the sustainable use of resources/assets. These strategies are also closely linked to European Union funding, especially in the context of cohesion policies and structural funds. Both the RIS3 and other plans and strategies developed by the CCDRs and by the intermunicipal entities are not, in general, directly binding on municipalities. They rather serve as strategic guides for regional and sub-regional development, and municipalities are encouraged to align their policies and actions with their guidelines. It is up to each municipality to integrate them in their local legal instruments and regulations, such as in the municipal-level Instrumentos de Gestão Territorial – IGT (Territorial Management Instruments). The IGTs are the legal and planning documents that regulate and guide land use and spatial planning that compose the Portuguese territorial management system. The Plano Diretor Municipal – PDM (Municipal Master Plan) is the primary urban planning instrument at municipal level. It is mandatory and defines the municipality's structure in terms of land use and regulates the urban conditions for new projects and developments.

In sum, there is no energy nor climate legislation at regional or sub-regional level in Portugal, nor regional or sub-regional incentives, supporting mechanisms or financial tools targeting energy transition or decarbonization targets. There are solely non-binding strategies and plans developed at regional and sub-regional level, that

serve as guideline to the municipalities. Nevertheless, the active participation of the municipalities in these organizations condition the municipalities access to funding, including to national and European Union funding. In the regional context, the municipality of Évora plays a key role in Central Alentejo, as it is the regional capital and concentrates a significant number of resources and services that are essential for implementing regional policies.

Évora has elaborated the Plano Intermunicipal de Adaptação às Alterações Climáticas do Alentejo Central - PIAAC-AC (Central Alentejo Intermunicipal Climate Change Adaptation Plan) in 2020, along with the 14 municipalities that belong to the Central Alentejo Intermunicipal Community (CIMAC) and is part of the assessment and updating of the Estratégia Integrada de Desenvolvimento Territorial (EIDT) do Alentejo Central 2021-2027 (Integrated Territorial Development Strategy for Central Alentejo 2021-2027), based in the Integrated Territorial Development Strategy 2014-2020. The EIDT are instruments of sub-regional territorial integration that are promoted by intermunicipal communities and metropolitan areas (https://www.forumdascidades.pt/content/estrategias-integradas-de-desenvolvimento-territorial). They constitute sub-regional strategies to territories composed of NUT III regions or groupings of NUT III regions and are the base for the contracting of Pactos para o Desenvolvimento e Coesão Territorial (Pacts for Territorial Development and Cohesion) and Pactos para o Desenvolvimento Local de Base Comunitária (Pacts for Community-Based Local Development). Its recognition constitutes a precondition for the implementation of Abordagens Integradas de Desenvolvimento Territorial (Integrated Approaches to Territorial Development) and Planos Estratégicos de Desenvolvimento Urbano Sustentável (Strategic Plans for Sustainable Urban Development). The aim of the EIDT is to take advantage of the territory's strategic resources, promote social inclusion, efficiency and rationalization of inter-municipal collective services, energy sustainability and sustainable mobility.

PIAAC-AC is an initiative aimed at tackling the challenges posed by climate change in the Central Alentejo region. This plan was developed based on climate diagnoses and projections for the region, which indicate significant vulnerabilities due to the semi-arid characteristics of the territory, the strong dependence on activities such as agriculture and the increased frequency of extreme phenomena such as heat waves, prolonged droughts and forest fires (PIAAC-AC 2020). The plan's objectives include identifying climate risks and the vulnerabilities of natural and human systems, proposing concrete adaptation measures and promoting sustainable and integrated management between municipalities. The adaptation measures related with the H&C sector are summarized in Table 2.

Sector	Measure	Adaptation Measure
Human Health	M1	Reduce exposure to heat in outdoor environments
Energy and energy security	M4	Sensitise the population to implement strategies to reduce energy consumption and improve energy comfort
	M5	Assess and prevent the impact of heatwaves on energy consumption
	M6	Improving energy performance, air conditioning and thermal comfort in public buildings
	M7	Promote cooling of the urban environment surrounding buildings

Table 9 - PIAAC-AC adaptation measures (2020).

The 14 municipalities that belong to the CIMAC are Alandroal, Arraiolos, Borba, Estremoz, Évora, Montemor-o-Novo, Mora, Mourão, Portel, Redondo, Reguengos de Monsaraz, Vendas Novas, Viana do Alentejo and Vila Viçosa.

Between the Estratégia Integrada de Desenvolvimento Territorial (EIDT) do Alentejo Central 2014-2020 (Integrated Territorial Development Strategy for Central Alentejo 2014-2020) and the Assessment and updating of the EIDT for 2021-2027 period, there has been a significant evolution in priorities, approach and the integration of new global and regional dynamics. While the 2014-2020 EIDT was designed to respond to the challenges of the initial period of implementation of Portugal 2020, the updated version adjusts to the demands of Portugal 2030, the European Green Deal and the structural changes brought about by the COVID-19 pandemic. Both EIDTs reflect an integrated vision for the sustainable development of the region, addressing challenges and opportunities in priority areas such as social cohesion, economic competitiveness, environmental sustainability and the enhancement of cultural heritage (EIDT 2014-2020; EIDT 2021-2027).

In the 2021-2027 period, the Alentejo Central EIDT is now centred on five main strategic objectives: Anticipating the effects of climate change and promoting the decarbonisation of Central Alentejo; Promoting the digital transition and technological innovation in all economic sectors; Strengthening the competitiveness of the regional economy, promoting intelligent specialisation and innovation; Fostering social and territorial cohesion, with a special focus on digital inclusion and improving access to essential services (EIDT 2021-2027).

The local context

The municipality of Évora is signatory of the Covenant of Mayors for Climate and Energy since 2011 (https://eu-mayors.ec.europa.eu/en/signatory/13822). On that scope, since Évora didn't renew the 2nd cycle, it solely designed the municipal Plano de Ação para a Energia Sustentável – PAES (Sustainable Energy Action Plan) in 2012.

The PAES establishes a comprehensive strategy for reducing greenhouse gas emissions and increasing energy efficiency in the municipality, in line with the objectives of the Covenant of Mayors. This plan outlines specific measures to achieve a 20 per cent reduction in CO_2 emissions by 2020, promoting increased efficiency in the use of energy. This plan establishes a range of actions aimed at increasing efficiency and maintaining the well-being of the population. The actions related to the H&C sector are:

Measures	Actions	Expected energy savings (MWh/year)	Expected production of renewable energy (MWh/year)	Expected reduction in CO2 emissions (t/year)
Urban planning and regulation	1.Promote energy-efficient buildings by ensuring "right to sunlight" and creating conditions for bioclimatic solutions, such as south-facing façades, large, glazed surfaces, green roofs, and tree-lined streets	14150	0	5220
	2. Facilitate building retrofits and installation of energy-efficient equipment by removing regulatory and authorization barriers			

	3. Adopt minimum energy efficiency standards for new constructions			
	4. Establish a minimum percentage of use of renewable energies in relation to that consumed by the building	3158	3158	1165
Financial incentives	5. Create financial incentives for buildings with higher energy performance through mechanisms like property tax (IMI) reductions	1722	0	96
Information / Sensibilization	6. Raise awareness among the population on energy-efficient buildings, the use of sustainable materials, and adopting efficient heating/cooling systems. This includes the promotion of thermal insulation, airtightness, and efficient heating/cooling technologies	260	0	96
	7. Informing the population about the importance and benefits of behavior and replacement of equipment to reduce energy consumption	25000	0	9225
	8. Informing about available resources: where the information is, what measures are prioritized, who can advise, how much it costs, what tools are needed, what financial aid is available, etc			
	9. Promote and stimulate the school community to the importance of energy efficiency, including in the school community habits of monitoring and controlling energy consumption			
	10. Inform about energy production possibilities and promote local energy production	1,9	1,9	0,7

Table 10 - PAES related to the H&C sector for the Buildings' Sector (PAES 2012).

Also locally, the municipality of Evora has developed the Estratégia Municipal de Adaptação às Alterações Climáticas – EMAAC (Municipal Climate Change Adaptation Strategy) in 2016. The main objective of the EMAAC is to promote effective and resilient adaptation to climate change, with a focus on protecting the municipality's population, infrastructure and natural resources, to guarantee environmental sustainability and quality of life for future generations. Based on this analysis, the strategy defines concrete actions and adaptation measures to mitigate the impacts of climate change. The adaptation measures related to the H&C sector are:

Area of Expertise	Adaptation Option	Objectives/Opportunities
Strengthening the municipality's resilience to climate change through the Municipal Spatial Planning Plans (PMOT)	Improving climate comfort and sustainability	% of wooded area in zones of maximum infiltration
	Adoption of mechanisms to encourage the use of sustainable construction measures	Increasing the energy efficiency of new sustainability of associated green spaces
Building a city more resilient to climate change	Improving the climate comfort and sustainability of public and private spaces through greater energy efficiency and water efficiency	The Power usage effectiveness (PUE) Regulation contains a normative reference that encourages the adoption of environmental sustainability solutions and measures in projects

		to be developed in the municipality's urban space.
		Incentives for the application of good sustainable construction practice measures defined by the local authority and transposed into the Urbanisation Plan regulations
		Guide to good sustainable construction practices drawn up (finalised by the date of publication of the next revision of the Évora Urbanisation Plan)
		% of projects licensed by the Evora Municipal Council by the end of the period of validity of the next revision of the Évora Urbanisation Plan must incorporate a % of the measures contained in the Guide to good sustainable construction practices.
Building a residential area that is more resilient to climate change	Building a climatically comfortable residential area with sustainable public and private spaces at the cost of greater efficiency in the use of energy and water	The Detailed Plan Regulation refers to a normative reference contained in the Evora Urbanisation Plan that encourages the adoption of environmental sustainability solutions and measures in projects to be developed in the municipality's urban space

Table 11 - EMAAC adaptation measures related to the H&C sector (EMAAC 2016).

The EMAAC carried out a study of the potential impact of the thermal vulnerability of Évora's housing stock, considering not only the current and future climatic characteristics for the municipality, but also the type of construction and air conditioning of the building stock and, finally, the ability of residents to adapt to reduce their thermal discomfort. The parishes were classified on a scale of 1 (not very vulnerable) to 20 (very vulnerable). Currently, vulnerability ranges from 9 (Évora - Santo Antão) to 12 (São Manços and São Vicente do Pigeiro). In the future, it is expected to increase to between 10 and 13, with São Manços and São Vicente do Pigeiro remaining the most vulnerable. In terms of future heatwaves, it is estimated that around 11.167 residents will be very vulnerable to thermal discomfort in their homes in the summer. These are people over the age of 65 living in Évora parishes with vulnerability equal to or greater than 10 in heatwave scenarios.

Evora has also prepared the Plano Municipal de Adaptação às Alterações Climáticac – PMAAC (Municipal Plan for the Adaptation to Climate Change), which was approved by the Municipal Assembly in December of 2024. This plan includes the operationalisation of the adaptation measures of the above strategy from the perspective of thermal comfort. The PMAAC studied the risk of excessive heat and heatwaves, based on the risk mapping of the municipality's territorial management instruments, the Intermunicipal Geographic Information Systems, the

mapping of certain climatic risks produced by the National Emergency and Civil Protection Authority (ANEPC) and by CIMAC under the PIAAC-AC. The risk of excessive heat and heat waves in Evora is currently considered to be very significant. The parishes with the greatest susceptibility are the União de Freguesias de S. Manços e S. Vicente do Pigeiro. The study suggests that, in the future, the general trend of this risk in the municipality will worsen. In the União de Freguesias de S. Manços e S. Vicente do Pigeiro, susceptibility to the risk of excessive heat and heat waves will remain very high. In the remaining parishes in the municipality, susceptibility is expected to increase from high to very high, reinforcing the need for attention to this risk and possible mitigation measures.

About vulnerability to excessive heat and heatwaves, also studied in the PMAAC, susceptibility varies between high and very high, and current vulnerability is already considered very high in all parishes. There are notable discrepancies in the proportion of the resident population without air conditioning, with more favourable situations in the peri-urban parishes around the city of Évora (Canaviais, União de Freguesias de Bacelo e Sra da Saúde, União de Freguesias de Malagueira e Horta das Figueiras), possibly explained by the fact that they are more recently built areas and therefore better equipped in terms of air conditioning. In the future, the projected worsening of climatic parameters associated with high temperatures and the greater frequency, intensity and duration of extreme heat events should mean that the municipality's vulnerability to this risk will remain at the highest level.

In this context, the need to adapt the municipality more quickly to the worsening of extreme heat events and other climatic phenomena studied in the PMAAC stands out. Table 5 lists the adaptation measures and actions somehow related to the H&C sector, although the H&C sector is not directly mentioned. Each adaptation action has information on its form(s) of implementation, promoter(s), effectiveness and implementation timeframe. Guidelines for the integration of the defined adaptation measures on the municipality's Territorial Management Instruments, which will allow for their legal implementation on the municipality, are also presented on the PMAAC. The mitigation part of the plan is due to be drawn up in 2025.

Adaptation Measure	Adaptation Action	Execution schedule
M6 - Promote thermal comfort in urban areas	A6.1 - Expansion of urban green and blue infrastructure as the main climate amenity tool	2022-2025 / 2025-2030
	A6.2 - Other public space interventions capable of reducing vulnerability to high temperatures	2022-2025
	A6.3 - Improving the thermal comfort of municipal buildings	2022-2025 / 2025-2030
	A6.4 - Facilitating and promoting access to energy self-production for the population	2022-2025 / 2025-2030
M8 - Responding to the challenges of climate change through municipal regulations and plans	A8.1 - Review the Municipal Master Plan and the Urbanisation Plan in force in the municipality, taking climate challenges into account	2022-2025 / 2025-2030
	A8.2 - Update the Regulations for the Presentation and Design of Outdoor Space Projects in the Municipality of Évora	2022-2025
	A8.3 - Draw up the Municipal Regulations for the Management of Trees in the Urban Environment	2022-2025 / 2025-2030

	A8.7 - Draw up Évora's Municipal Climate Action Plan	2022-2025
M9 - Promote the reduction of exposure of people and property to extreme weather events	A9.1 - Develop the Local Preventive Civil Protection Strategy	2022-2025
	A9.2 - Develop and publicise the Guide for Civil Protection Agents	2022-2025
	A9.3 - Develop the Local Preventive Civil Protection Programme: From Everyone to Everyone	2022-2025
	A9.4 - Carry out awareness-raising, information and training actions for citizens of all age groups on minimising impacts and resilience to extreme weather events.	2022-2025
	A9.5 - Carry out awareness-raising, information and training activities on minimising impacts and resilience within local institutions and entities in all sectors, with a particular focus on education and support for the elderly.	2022-2025
	A9.6 - Maintain the Municipal Civil Protection Service's social networks as a vehicle for raising awareness and providing information on resilience and impact minimisation, both preventative and operational.	2022-2025
	A9.7 - Continued involvement in the International Network of Resilient Cities as a way of reinforcing knowledge of international best practices, exchanging experiences and training in a shared active context.	2022-2025
	A9.8 - Issuing warnings to the population when extreme weather events occur.	2022-2025 / 2025-2030
M13 - Increase the resilience of economic, cultural and sporting activities to climate change	A13.1 - Promote the installation of photovoltaic panels on infrastructures and buildings associated with economic activities	2022-2025
M14 - Improve the level of knowledge about natural heritage and climate change	A14.2 - Raise awareness of the importance of the services provided by natural ecosystems in adapting to climate change.	2022-2025 / 2025-2030
	A14.4 - Encourage residents to enhance their gardens and patios by planting native trees and shrubs.	2022-2025
M16 – Produce and make available information relevant to the adaptation	A16.1 - Develop a “Guide to Good Practices for the Construction of Sustainable Buildings” to support and consultation on thr municipal services and the municipality’s website.	2022-2025

Table 12 - Adaptation measures and actions related to the H&C sector (PMAAC 2024).

The municipality referred that the Local H&C Plan should be aligned with two other existing municipal instruments, namely the Urbanisation Plan (a binding plan, currently under revision) and the Estratégia de Reabilitação Urbana (Urban Rehabilitation Strategy), which encompasses privately-owned buildings. Furthermore, due to the fact that the Historic Centre of Évora is a UNESCO's World Heritage site, interventions on the building stock and the placement of solar photovoltaic systems are limited due to legal provisions regarding the protection of historic buildings, including Law No. 107/2001 of 8 September and Decree-Law No. 309/09 of 23 October (https://whc.unesco.org/en/list/361).

The municipality of Évora is also involved in city networks such as ClimAdaPT.local and the EU Climate Change Adaptation Mission. It is also important to highlight that in 2021 the municipality joined the Green City Accord, an initiative of the European Commission launched in 2020 to encourage European cities to make ambitious commitments to environmental sustainability. Its aim is to promote cleaner, healthier and more sustainable urban environments, in line with the European Green Deal. The agreement sets targets to be achieved by 2030 in five priority areas: improving air quality, protecting and providing access to clean water, preserving nature and biodiversity, waste management and the transition to a circular economy, as well as reducing noise pollution. Cities in European Union member states can join the agreement, committing themselves to setting ambitious environmental targets, reporting progress periodically and collaborating with other signatories to share good practices. By participating, cities receive recognition as environmental leaders and can access technical and financial support to implement their actions. The initiative also works in partnership with networks such as the Covenant of Mayors, promoting the integration of local, national and European efforts in favour of sustainability.

Évora has also participated in relevant initiatives/projects in the areas of climate change, carbon neutrality and renewable energies throughout the years such as InSMART, Lighthouse City - Positive Energy CITY Transformation Framework - POCITYF and Laboratório Vivo para a Descarbonização de Évora - LVpDÉ. To highlight Évora's participation on the project InSMART – Integrative Smart City Planning, co-funded by the European Commission within the Seventh Framework Programme – that was developed between 2013 and 2016 and that aimed to address urban challenges of energy and climate. Its objective was to implement comprehensive models addressing the participating city's current and future energy needs through an integrative and multidisciplinary planning approach. This approach identified the optimum mix of short, medium and long term measures for a sustainable energy future, and addressed the efficiency of energy flows across the various city sectors, namely buildings, transport and mobility, urban spaces, water/sewage system, waste chain and decentralized energy supply (https://smart-cities-marketplace.ec.europa.eu/projects-and-sites/projects/insmart).

3. The local energy system

The local energy demand

There is no specific data available at municipal level for Évora regarding energy consumption nor energy needs for the H&C sector. As part of its participation in the Covenant of Mayors, in response to the obligations assumed by the municipality of Évora, a balance sheet of final energy consumption by sector and by energy vector was elaborated in the Energy and Emissions Inventory in 2019 (Table 6).

Sector	FINAL ENERGY CONSUMPTION [MWh]															
			Fossil fuels								Renewable energy					
	Electricity	Heat / cooling	Natural gas	Liquefied gas	Heating oil	Diesel	Petrol	Linhite	Coal	Other fossil fuels	Vegetable oils	Biofuels	Other forms of biomass	Solar thermal energy	Geothermal energy	Total
BUILDINGS AND EQUIPMENT / FACILITIES:																
Tertiary buildings and equipment	84611	0	18926	3001	0	0	0	0	0	0	0	0	0	0	0	106538
Residential buildings	85488	0	18394	47097	0	0	0	0	0	0	0	0	0	0	0	150979
Municipal street lighting	6977	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6977
Subtotal of buildings and equipment / facilities	177077	0	37320	50098	0	0	0	0	0	0	0	0	0	0	0	264494
TRANSPORT:																
Public transport	0	0	0	0	0	2642	0	0	0	0	0	0	0	0	0	2642
Private and commercial transport	0	0	27	2738	0	280495	71377	0	0	0	0	0	0	0	0	354636
Transport subtotal	0	0	27	2738	0	283137	71377	0	0	0	0	0	0	0	0	357278
Total	**177077**	**0**	**37346**	**52836**	**0**	**283137**	**71377**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**621773**

Table 13 - Final energy consumption by sector and by energy vector in the municipality of Évora for 2019 (Energy and Emissions Inventory 2019).

A previous balance sheet of final energy consumption by sector and by energy vector was made in 2012 on the scope of the PAES for the year 2009 (Table 7). According to the Energy Emissions Inventory and the PAES, the locally produced electricity in the municipality in 2009 and 2019 (excluding installations/units > 20 MWh) was of 0,26 MWh, correspondent solely to photovoltaic energy, and there was no local combined production of heat/cold and electricity.

Sector	FINAL ENERGY CONSUMPTION [MWh]															
			Fossil fuels								Renewable energy					
	Electricity	Heat / cooling	Natural gas	Liquefied gas	Heating oil	Diesel	Petrol	Linhite	Coal	Other fossil fuels	Vegetable oils	Biofuels	Other forms of biomass	Solar thermal energy	Geothermal energy	Total
BUILDINGS AND EQUIPMENT / FACILITIES:																
Tertiary buildings and equipment	81546	0	10670	3911	0	0	0	0	0	0	0	0	0	0	0	96128
Residential buildings	97987	0	8340	92041	0	0	0	0	0	0	0	0	0	0	0	198368
Municipal street lighting	8016	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8016
Subtotal of buildings and equipment / facilities	187550	0	19010	95952	0	0	0	0	0	0	0	0	0	0	0	302512
TRANSPORT:																
Public transport	0	0	0	0	0	3253	0	0	0	0	0	0	0	0	0	3253
Private and commercial transport	0,8	0	0	2122	0	245826	80319	0	0	0	0	0	0	0	0	318268
Transport subtotal	0,8	0	0	2122	0	249079	80319	0	0	0	0	0	0	0	0	331521
Total	**187550**	**0**	**19010**	**98075**	**0**	**249079**	**80319**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**634033**

Table 14 - Final energy consumption by sector and by energy vector in the municipality of Évora in 2009 (PAES 2012).

More recent data, namely the consumption of electricity by sector of activity in Évora for the year 2023, is available consulting the website of the Direção-Geral de Energia e Geologia General - DGEG (Directorate of Energy and Geology) (Table 8).

Setor	Consumo (kWh)
Agriculture and fisheries	16 185 639
Industry	103 039 075
Non-domestic	87 010 782
State buildings	8 966 462
Street lighting	2 247 815
Domestic	86 553 362
Total	**304 003 136**

Table 15 - Energy consumption by sector in Évora in 2023 (DGEG 2023)

It was also possible to obtain data on the type of H&C systems used in classic households (2021) in the following table:

	Number of classic households	% of total classic households
With air conditioned	10287	46%
Without air conditioned	12038	54%
With central heating	1165	5%
With non-central heating - open fireplace	3232	14%
With non-central heating – heat recovery unit	2199	10%
With non-central heating – mobile unit (electric heater, gas heater, etc)	10336	46%
With non-central heating – fixed units (salamander heater, wall heaters, etc)	2354	10%
No heating	3039	14%

Table 16 - Type of H&C systems present in classic households in the municipality of Évora, according to the census of 2021 (INE 2024)

The local energy supply

Regarding energy production in the municipality of Évora, according to DGEG data, in 2023 there was 65,2 MW of photovoltaic energy production and 0,5 MW of thermal (0,26 MW from renewable source) (Table 10).

Municipality	Source	Installed power (MW)
Évora	Photovoltaic	65,2
	Thermal	0,5
	from renewable source	0,2

Table 17 - Installed power in electricity generating plants in 2023 (DGEG 2024)

According to E-Redes (https://e-redes.opendatasoft.com/), Évora was, in the 3rd trimester of 2024, 215 726 self-consumption units and 1 712 555 kW of installed capacity for self-consumption. In Figures 5 and 6, one can see the cumulative number of self-consumption units and the cumulative installed power for self-consumption per quarter.

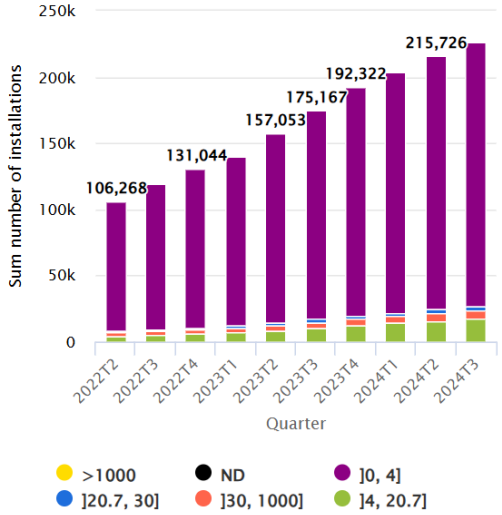


Figure 5 - Cumulative number of installations for self-consumption for the municipality of Évora per quarter and per installed power range (E-Redes 2024)

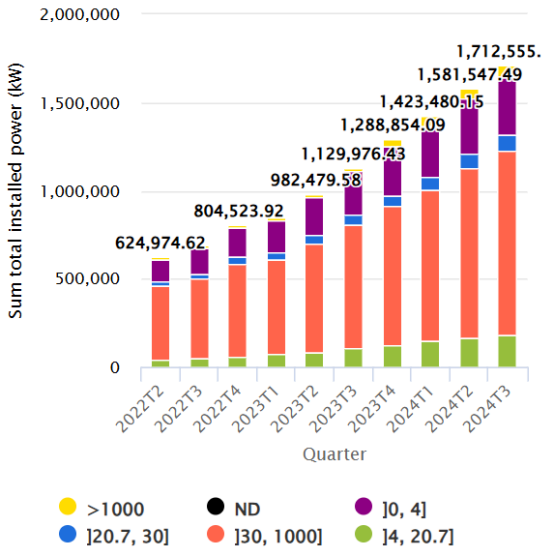


Figure 6 - Cumulative installed power for self-consumption for the municipality of Évora per quarter and per installed power range (E-Redes 2024)

4. Mapping of H&C target groups

For the list of identified stakeholders, some progress needs to be completed. There are a considerable number of relevant companies/associations listed below, although it is necessary to identify new stakeholders, contact them to present the project, ask for feedback, to discuss needs and identify changes.

STAKEHOLDER	TYPOLOGY
Associação Comercial do Distrito de Évora	Service and industry associations
ACOS – Agricultores do Sul	
Intermunicipal community of the CIM do Alentejo Central and its member municipalities	Intermunicipal community
To be defined	Financial/banking institutions
University of Évora and other local/regional research institutions	Local/regional research institutions
Associação de Moradores e Amigos do Centro Histórico de Évora – AMACHE	Civil society organisations, including residents' associations
Associação De Moradores do Bairro do Bacelo	
Associação de Moradores e Cidadãos - Malagueira Viva e Vivida	
Monte-ACE – Desenvolvimento Alentejo Central	Regional development institutions
Agência de Desenvolvimento Regional do Alentejo – ADRAL	
To be defined	Other relevant public or private institutions
Lobosolar - Energias Renováveis	Electricity companies and their associations, as well as RES companies
EMBRAER	Relevant industries/companies

Table 18 - List of stakeholders in Évora

5. Summary in national language

O município de Évora, localizado no Alentejo Central, destaca-se pela sua importância regional, sendo a capital do distrito de Évora. Com uma área de 1.307 km², o território apresenta um clima semiárido caracterizado por temperaturas elevadas no verão, temperaturas baixas no inverno e fenómenos meteorológicos extremos, como ondas de calor e secas prolongadas. Évora é um polo económico regional, com atividades predominantes no sector terciário e indústria. É um município com características particulares. Destas, destacamos a grande amplitude térmica entre o verão e o inverno, a existência de um parque edificado antigo (o centro histórico da cidade de Évora) classificado como Património Mundial da UNESCO, uma baixa densidade populacional dispersa por uma extensa área e um sector industrial relevante.

Em relação ao setor do aquecimento e arrefecimento e transição energética, o município aderiu ao Pacto de Autarcas para o Clima e Energia em 2011 e desenvolveu o Plano de Ação para a Energia Sustentável (PAES) em 2012. Este plano teve como objetivo reduzir as emissões de CO_2 em 20% até 2020, promovendo a eficiência energética nos edifícios e a utilização de energias renováveis. As ações incluem incentivos fiscais, reabilitação de edifícios e sensibilização do público para práticas sustentáveis e tecnologias eficientes de aquecimento/arrefecimento. Além disso, a Estratégia Municipal de Adaptação às Alterações Climáticas (EMAAC) de 2016 define medidas para mitigar os impactes das alterações climáticas, como o aumento da eficiência energética e o incentivo à construção sustentável. O recém-aprovado Plano Municipal de Adaptação às Alterações Climáticas de Évora (PMAAC), por sua vez, define as medidas e as ações de adaptação às alterações climáticas, assim como as diretrizes para as integrar nos Instrumentos de Gestão Territorial municipais, operacionalizando-as ao nível municipal. A nível regional, é de destacar o Plano Intermunicipal de Adaptação às Alterações Climáticas do Alentejo Central (PIAAC-AC) e a Avaliação e atualização da Estratégia Integrada de Desenvolvimento Territorial (EIDT) do Alentejo Central 2021-2027, baseada na EIDT 2014-2020.

Relativamente ao sistema energético, Évora tem uma capacidade instalada de 65,2 MW em energia fotovoltaica, com um crescimento significativo de unidades de autoconsumo, atingindo mais de 215.000 unidades até 2024, representando uma produção fotovoltaica considerável. No entanto, subsistem desafios, nomeadamente a falta de dados detalhados para o setor do aquecimento e arrefecimento, a falta de metas, ações e *guidelines* nos planos/políticas existentes e poucos incentivos e esquemas/instrumentos de financiamento.

MUNICIPALITY OF VILA REAL

1. The local territorial context

The municipality of Vila Real is located in the Douro region. It is the capital of the district of Vila Real and is distributed across 9 parishes: Abaças, União das Freguesias de Adoufe/Vilarinho de Samardã, Andrães, Arroios, União das Freguesias de Borbela/Lamas de Ôlo, Campeã, União das Freguesias de Constantim/Vale de Nogueiras, União das Freguesias de Nogueira/Ermida, Folhadela, Guiães, União das Freguesias de São Tomé do Castelo/Justes, União das Freguesias de Mouçós/Lamares, Lordelo, Mateus, Mondrões, União das Freguesias de Vila Real, Parada de Cunhos, União das Freguesias de São Miguel da Pena/Quintã/Vila Cova, Torgueda e Vila Marim. Vila Real is situated at an altitude of 450 metres near the Marão and Alvão mountains.

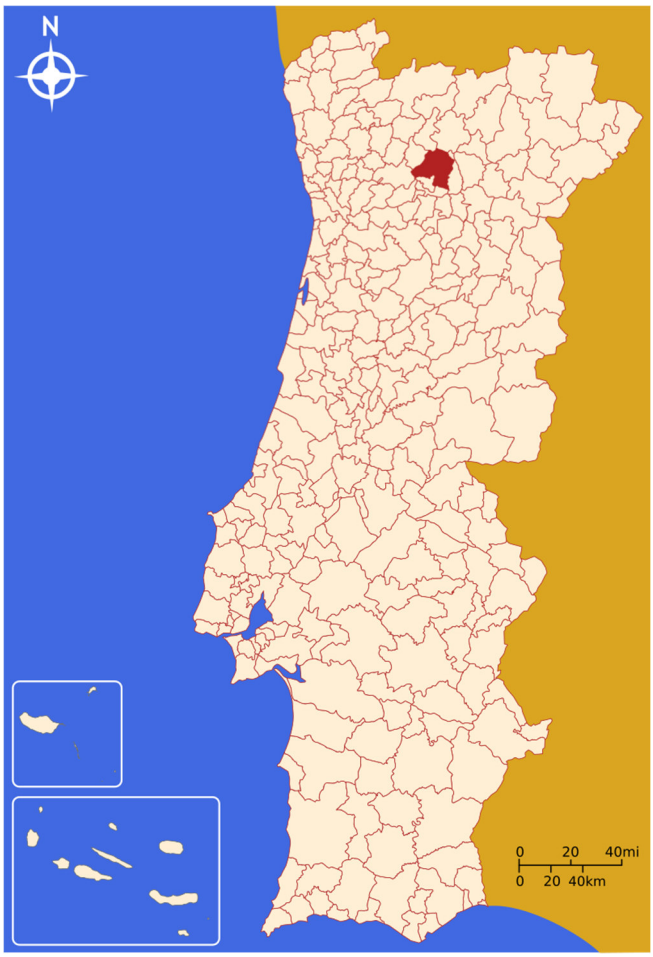


Figure 4 - Location of Vila Real's municipality (Wikipedia 2024)

According to INE, in 2023, the municipality of Vila Real had an overall population of 49.571 inhabitants (54% of which were between 25 and 64 years old), meaning an average population density of around 130 inhabitants/km^2, higher than the Portuguese average of 115,4 inhab/km^2 for the same year (PORDATA 2024). The average annual growth rate of population (2011/2023) is -0,3%, so slightly negative (GEE 2023). The municipality has two types of landscapes: a more mountainous area and another characterised by its proximity to the Douro River.

Vila Real's climate is classified as oceanic or Mediterranean influenced by its elevation, the proximity to the Douro River valley, and the surrounding Marão and Alvão mountain ranges. Summers tend to be warm and dry, while winters are cool and wet, often with frost and occasional snowfall in higher areas. This creates a climate

that blends Mediterranean and Atlantic influences. According to the Plano de Ação Intermunicipal para as Alterações Climáticas do Douro – PAIAC-Douro (Intermunicipal Action Plan for Climate Change in the Douro), climatic projections for the Douro Region predict the reduction of the average annual precipitation with the increase of the extreme events of intense precipitation, the increase of the average annual temperature, specially of the maximum temperatures, more frequent and intense heat waves and the reduction of the number of days of frost (PAIAC-Douro 2018). In 2023 no heat waves were registered in the Vila Real municipality (https://rea.apambiente.pt/content/ondas-de-calor-e-de-frio).

The most dominant sectors of activity in Vila Real, in terms of the number of establishments, are information and communication activities, real estate activities, human health and social support activities, water collection, treatment and distribution. On the other hand, the sectors in which Vila Real stands out the least, in terms of number of establishments are agriculture, animal production, hunting, forestry and fishing, manufacturing, accommodation, catering and similar, and extractive industries. In 2022 there were in the municipality a total of 7.212 enterprises that employed 15.630 workers (Diagnóstico Social de Vila Real 2024). The tertiary sector employed 75,1% of Vila Real's working population in 2021, while 23,4% and 1,4% of the employees worked, respectively, in the secondary and in the primary sector (GEE 2023).

The Universidade de Trás-os-Montes e Alto Douro – UTAD (University of Trás-os-Montes and Alto Douro) plays a central role in the municipality of Vila Real, combining the development of education with research and business development in various areas. The Regia Douro Park, promoted by the Municipality of Vila Real, UTAD and Rede de Parques Tecnológicos e Incubadoras (Portuspark - Network of Technology Parks and Incubators), represents a pillar of integrated economic development, combining UTAD's strong expertise and knowledge with the endogenous resources of the Douro region. The areas of activity that are part of this park are agri-food, agri-industrial, oenology, viticulture, green economy, environmental valorisation and agri-environmental technologies. Through the combination of a Business Incubator-Accelerator, a Business Centre (Douro Business Centre), a Technological Pole of Excellence and 26 industrial plots, Regia supports entrepreneurs and companies, business projects, national and international investors, research and international investors, promoting research, as well as the development and transfer of technology and knowledge (Diagnóstico Social de Vila Real 2024)

To characterize the building stock, Figure 2 shows the different construction periods for existing buildings in Vila Real in 2021.

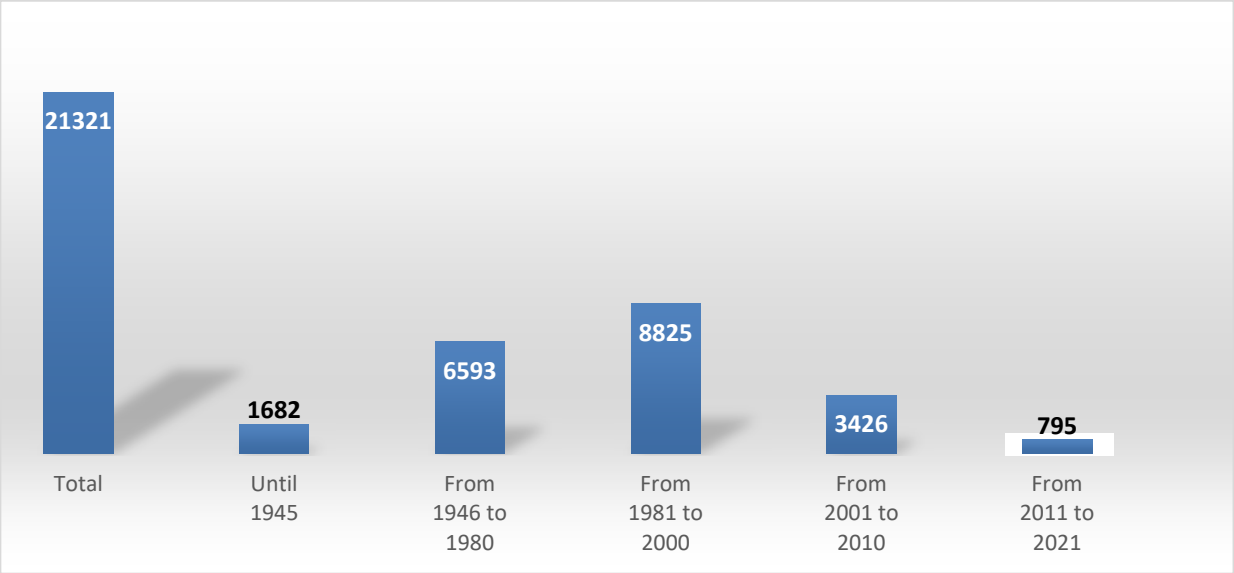


Figure 2 - Construction periods for existing buildings in Vila Real in 2021. (INE 2021)

Regarding the state of its buildings in the last available year (2021), as can be seen in Figure 3, the Municipality of Vila Real had a total of 21.321 buildings built, of which 5,9% need deep interventions, 9,3% need medium interventions, 14,9% only small interventions and 69,8% need no interventions.

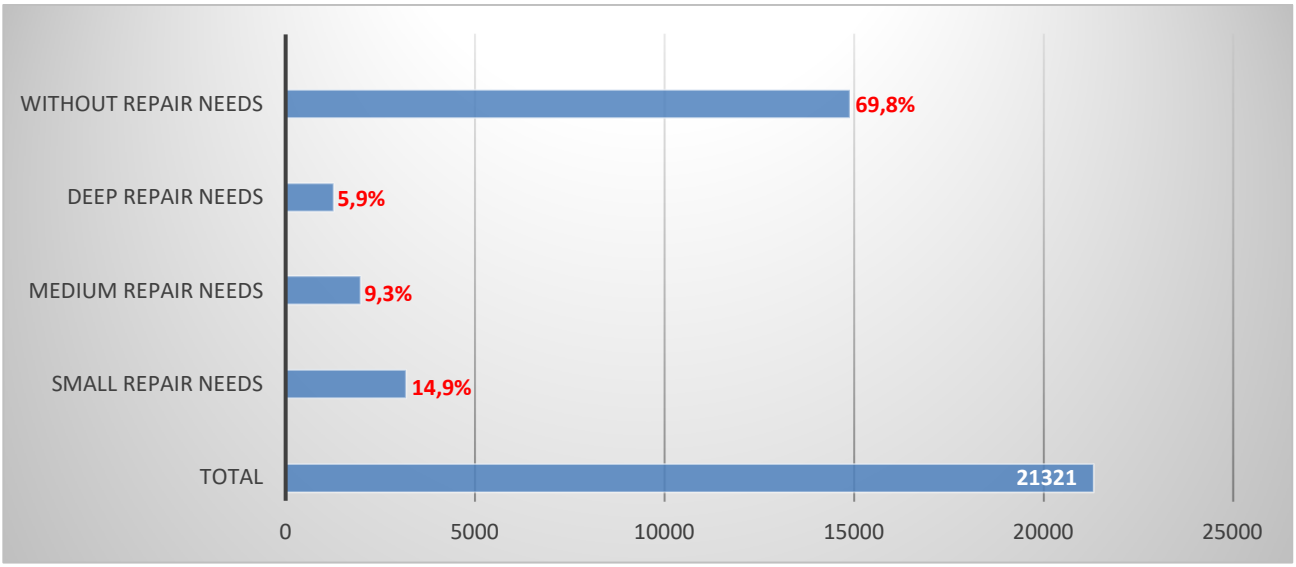


Figure 3 - Total number of buildings built and repair needs (INE 2021)

It is also relevant to analyse the total number of energy certificates issued in the municipality of Vila Real between 2014 and 2024, by energy class, for all types of buildings (Figure 4). The predominant classes are C, A and D with 19,2%, 15,9% and 14,6% respectively. The total number of certificates in Vila Real is 8.219. The energy certificate is a mandatory document in many countries that assesses the energy efficiency of a property, classifying it on a performance scale (for example, from A+ to G). It identifies the expected energy consumption and suggests improvements to reduce costs and emissions. It comes from the EPBD (Energy Performance of Buildings Directive), a European directive aimed at improving the energy efficiency of buildings. In Portugal, it has been mandatory since 2009 for new and existing properties in cases of sale, rental or major renovation. Implementation follows the rules of the Energy Certification System for Buildings (SCE), managed by ADENE (Energy Agency).

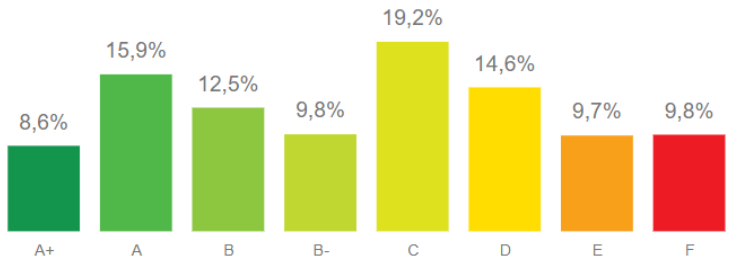


Figure 4 - Total energy certificates issued in the municipality of Vila Real, by energy class (SCE 2024).

2. The reference policy and strategic context

The regional context

Regionally there are, in Continental Portugal, Comissões de Coordenação e Desenvolvimento Regional – CCDR (Regional Coordination and Development Commissions). These are peripheral services of the direct administration of the State, endowed with administrative and financial autonomy (but devoid of legal personality), which have powers in the fields of coordination and articulation of the various sectoral policies at regional level, implementation of environmental policies and spatial and urban planning, technical support for local authorities and their associations and management of European funding programmes (https://diariodarepublica.pt/dr/lexionario/termo/ccdr-comissao-coordenacao-desenvolvimento-regional).
There are currently 5 CCDRs in Portugal (Decree-Law No. 228/2012) that correspond to the 5 regions of Continental Portugal (North, Centre, Lisbon and Tagus Valley, Alentejo, Algarve). Furthermore, sub-regionally, there are intermunicipal entities (Law No.75/2013). These can take the form of Intermunicipal Communities or of Metropolitan Regions and correspond to the NUT III territorial units. There are currently 21 intermunicipal communities and two metropolitan areas in Continental Portugal. Intermunicipal entities are free associations of municipalities, non-territorial, with their own budget and management, and clear objectives, to which the associated municipalities delegate part of the functions or competences conferred on them by law, with the aim of provide services to all its members. According to Law No. 50/2018, intermunicipal entities have, amongst other, power to appoint members representing municipalities on river basin district councils, manage projects financed with European funds and manage investment caption programmes.

On the scope of the Portuguese Climate Framework Law (Law no. 98/2021) the CCDRs need to develop Planos Regionais de Ação Climática – PRACs (Regional Climate Action Plans), which should include the dimensions of mitigation and adaptation to climate change. CCDRs are also, for example, responsible for the development of the Estratégias Regionais de Especialização Inteligente – RIS3 (Regional Innovation Smart Specialisation Strategies), an approach created by the European Union in 2010. The RIS3 are regional strategies that aim to address regional challenges and support regional development through the identification and promotion of areas of innovative specialization. These strategies usually include lines of action related with the increase of sustainability and of territorial cohesion, decarbonization, the transition to a more circular economy and/or the sustainable use of resources/assets. These strategies are also closely linked to European Union funding, especially in the context of cohesion policies and structural funds. Both the RIS3 and other plans and strategies developed by the CCDRs and by the intermunicipal entities are not, in general, directly binding on municipalities. They rather serve as strategic guides for regional and sub-regional development, and municipalities are encouraged to align their policies and actions with their guidelines. It is up to each municipality to integrate them in their local legal instruments and regulations, such as in the municipal-level Instrumentos de Gestão Territorial – IGT (Territorial Management Instruments). The IGTs are the legal and planning documents that regulate and guide land use and spatial planning that compose the Portuguese territorial management system. The Plano Diretor Municipal – PDM (Municipal Master Plan) is the primary urban planning instrument at municipal level. It is mandatory and defines the municipality's structure in terms of land use and regulates the urban conditions for new projects and developments.

In sum, there is no energy nor climate legislation at regional or sub-regional level in Portugal, nor regional or sub-regional incentives, supporting mechanisms or financial tools targeting energy transition or decarbonization targets. There are solely non-binding strategies and plans developed at regional and sub-regional level, that serve as guideline to the municipalities. Nevertheless, the active participation of the municipalities in these organizations condition the municipalities access to funding, including to national and European Union funding.

Vila Real is in the North of Continental Portugal and is therefore under the jurisdiction of the Comissão de Coordenação e Desenvolvimento Regional do Norte – CCDR-NORTE (Norte Portugal Regional Coordination and Development Commission), which is responsible for the execution of regional environmental and land-use planning, as well as the regional development of the NUT II – North Region. This entity also oversees the management of European programs and other regional development financial instruments within the North Region. In the context of Vila Real, the CCDR-NORTE supports local development projects, promotes sustainability, and ensures the effective implementation of policies related to the environment, infrastructure, and economic growth, with a focus on aligning local objectives with the broader regional strategies, such as the Norte 2030 Program. The Norte 2030 Program (Norte Regional Program 2021-2027) aims to make the Norte region greener and more low carbon by providing financial mechanisms related to Energy Efficiency, with the main mission of reducing primary energy consumption in the public and social sectors and the corresponding Greenhouse Gas (GHG) emissions.

Under the current Norte 2030 Program, through the NORTE2030-2024-14 call for proposals of 31/05/2024 - Energy efficiency in local administration and private social solidarity institutions, Vila Real has already submitted two applications: 'Energy efficiency in the Vila Real Municipal Library building' and 'Energy efficiency in the Vila Real Municipal Theatre', and a third is being prepared - 'Energy efficiency in the Town Hall building', all of which include, among others, intervention measures in terms of heating and cooling.

At regional level, two plans/strategies in which the municipality of Vila Real was involved are highlighted: Estratégia Integrada de Desenvolvimento Territorial da Região do Douro 2015 (Integrated Territorial Development Strategy for the Douro Region) and the Plano de Ação Intermunicipal para as Alterações Climáticas 2018 – PIAAC-Douro (Douro Intermunicipal Climate Change Adaptation Plan).

The Integrated Territorial Development Strategy for the Douro Region 2015 was prepared by the Douro Intermunicipal Community and outlines the vision, strategy, and action plan for the region's development during the 2014-2020 structural programming period. The strategy proposes an integrated vision for the region, centred on four main axes:

1. **Competitiveness, knowledge, and innovation**
   1.1. Development of the agri-food sector and other endogenous production sectors
   1.2. Affirmation of tourism and visitation
2. **Territorial sustainability**
   2.1. Protection of the environment and landscape and valorisation of heritage
   2.2. Urban development and revitalisation
   2.3. Promoting the efficiency of energy resources
3. **Inclusion and social cohesion**
4. **Territorial networks and innovation**

Related to the H&C sector, axis 2.3 mentions two measures: Rehabilitation of public buildings and rationalisation of their energy performance and Intervening in the rehabilitation of social housing buildings.

The Intermunicipal Action Plan for Climate Change in the Douro (PAIAC-Douro), developed in 2018, is an initiative of the Douro Intermunicipal Community (CIM-Douro) aimed at enhancing the region's resilience to climate change. The PAIAC-Douro was developed through a participatory approach involving the 19 municipalities within CIM-Douro, alongside experts and the local community. Climate analyses were conducted, vulnerabilities were identified, and mitigation and adaptation measures were defined, resulting in an action

plan with prioritised measures. The measures correspond to concrete actions that can be taken normally used to achieve objectives that are defined in the strategies and operationalising the options that were selected. Tables 2 and 3 summarise some of the proposed climate change mitigation and adaptation measures related to the H&C sector.

Sector	Mitigation Measure
Construction and Urban Planning	Encouraging the integration of renewable energies in buildings, such as solar thermal panels (for hot water production), photovoltaic panels (for electricity generation), among others
	Encouraging the use of A^{+++} rated appliances and equipment, which are more energy efficient
	Encouraging the use of more efficient lighting devices, such as LED lamp
	Encouraging the use of consumption meters, smart meters, among others, to control consumption.
Production and Energy	Encouraging increased energy production from renewable sources, such as wind energy (produced by the wind), solar energy (produced by the sun), hydroelectric energy (produced by water currents), bioenergy (produced by biomass) and geothermal energy (produced by the Earth's internal heat)
	Encouraging the replacement of high-carbon energies with low-carbon energies, such as replacing the use of coal with the use of natural gas

Table 19 – PAIAC-Douro climate change mitigation measures (source: PAIAC Douro 2018)

Nº	Measure	Objective	Description
14	Develop and Implement a Heat Wave Contingency Plan	• To support the population, particularly the most vulnerable, in situations of increasingly frequent extreme temperatures and heatwaves, acting in prevention and supporting professionals in the sector • To create decision support tools for better response to Extreme Adverse Temperature Contingency Plans • To encourage awareness-raising and informing citizens about the impacts of heatwaves • To create communication and study tools to support key players in the health sector	The aim of the Heat Wave Contingency Plan is to create conditions to reinforce the impact and response capacity of the Extreme Adverse Temperature Contingency Plans, reinforcing the importance of all the services and establishments of the National Health Service (SNS), with a focus on heat waves. At the same time, the aim is to train citizens in personal protection (literacy) and the readiness of health services to respond to an increase in demand or a different demand than expected.

27	Develop a Guide to Good Practices in Sustainable Construction and/or Rehabilitation	• Identify construction and rehabilitation measures in buildings, aiming for energy efficiency • Identify a set of solutions that guarantee the fulfilment of quality requirements about the thermal comfort of the building stock • Evaluate intervention proposals and their impact on building energy consumption • Evaluate the potential impact of climate change on the thermal comfort of the building stock • Estimate the energy savings provided by each intervention, to assess whether it is justifiable to conduct the intervention, considering the return on investment period	The buildings sector is responsible for the consumption of around 40 per cent of final energy in Europe and 30 per cent in the case of Portugal, so improving the energy performance of buildings is a key factor for energy and environmental sustainability. Numerous studies show that it is possible to reduce energy consumption in the buildings sector by around 50% through energy efficiency measures. The aim is therefore to develop a Good Practice Guide for construction and refurbishment that can result in improvements in the thermal and energy behaviour of buildings to help reduce energy consumption in this sector.

Table 20 - PAIAC-Douro climate change adaptation measures (PAIAC Douro 2018).

CIM-Douro is currently working on an application to Norte 2030 financing scheme to support the development of a new Intermunicipal Plan for Adaptation to Climate Change for CIM-Douro.

The local context

The municipality of Vila Real is signatory of the Covenant of Mayors for Climate and Energy since 2013 (https://eu-mayors.ec.europa.eu/en/signatory/17881). On that scope, it designed the municipal Plano de Ação para a Energia Sustentável – PAES (Sustainable Energy Action Plan) in 2015, that was updated in 2017.

The PAES of Vila Real, drawn up under the Covenant of Mayors for Climate and Energy, establishes a strategy to reduce CO_2 emissions and promote energy efficiency in the municipality. As part of the implementation of the PAES, several energy sustainability measures were defined, the implementation of which will enable the fulfilment of the commitment made when the Covenant of Mayors was signed. The sustainable energy measures related with the H&C sector are summarized in Table 4. Each of these measures include several actions that are detailed in the plan.

Measure	Action
Energy audits, efficient construction and building certification	Promoting efficient construction and carrying out audits in buildings, public services and industries to identify and assess the degree of energy efficiency, resulting in energy certification
Open energy management systems	Using information and communication technologies as tools to improve energy efficiency and reduce consumption in public and private buildings, public lighting and transport

Efficient household equipment	Promote the gradual renovation of inefficient consumer household equipment, especially electrical appliances
Efficient industrial equipment and processes	Promote a gradual renewal of industrial equipment with more efficient ones and promote the optimization of industrial processes aiming to improve sustainability (inc. heat and cold production methods such as cogeneration, combustion systems, industrial heat and cold recovery)
Solar thermal energy	Install solar thermal collectors in tourist accommodation buildings, domestic buildings, buildings for human health activities, sports activities, among others
Efficient climate and ventilation systems	Improving the energy efficiency of climate and ventilation systems in buildings used for tourist accommodation, services, domestic purposes, human health activities and sports and recreational activities, among others
Efficient boilers	Renovate boilers, using more technologically efficient feed systems or replace boilers with more efficient ones
Biomass and forest residues	Promoting the use of forest biomass and forest residues as fuel for the sustainable production of various forms of final energy: electricity, heat and combined heat and power
Optimising the energy and climate aspects of urban planning	Rehabilitating the building stock, promoting energy-efficient rehabilitation, by drawing up a bioclimatic urban design manual and a plan for improving and optimising the urban network. Adaptation of the Plano Diretor Municipal – PDM (Municipal Master Plan), keeping energy sustainability as a determining element
Integrated renewable generation	Promote and incentivise investment in mini-generation projects and other energy production projects for self-consumption or the sale of energy using renewable energy sources.

Table 21 - PAES measures related to the H&C sector (PAES, 2015).

The municipality of Vila Real drew up in 2018 its Estratégia Municipal de Adaptação às Alterações Climáticas – EMAAC (Municipal Strategy for Adaptation to Climate Change) through a joint initiative with the Douro Intermunicipal Community, in line with the Estratégia Nacional de Adaptação às Alterações Climáticas – ENAAC (National Strategy for Adaptation to Climate Change). The aim of this initiative is to develop actions to anticipate and prepare the Vila Real municipality for possible climatic events that may occur during this process of change. Table 5 shows the adaptation actions identified for the Municipality of Vila Real on the EMAAC, related to the H&C sector.

Adaptation Action	**Key Sectors**
Periodically promote actions to educate, raise awareness and inform residents about the problem of climate change, its impacts and consequences for the region / municipality (current and future) and the adaptation, mitigation and self-protection measures that should be adopted	Agriculture, Forestry and Fisheries; Biodiversity; Spatial Planning and Cities; Water Resources; Human Health; Security of Persons and Goods; Tourism

Implementation of a monitoring, forecasting, information and warning system on a local scale for the most frequently occurring adverse weather events (e.g.: implementation of a network of shared meteorological stations)	Agriculture, Forestry and Fisheries; Biodiversity; Spatial Planning and Cities; Water Resources; Human Health; Security of Persons and Goods; Tourism
Drawing up a Guide to Good Practices in the construction and/or refurbishment of buildings (e.g. bioclimatic design solutions, more energy-efficient materials and construction practices and presenting the costs and benefits of adopting these solutions)	Energy and Industry; Spatial Planning and Cities
Creation / reinforcement of green spaces, particularly in urban areas, using native vegetation adapted to the characteristics of the climate (current and future)	Biodiversity; Spatial Planning and Cities; Water Resources;
Promotion of risk analysis studies to identify the road infrastructures most exposed to the formation of ice, fog and mist to implement prevention measures	Security of Persons and Goods
Promote the adoption of more snow- and ice-resistant materials/floors in the construction and rehabilitation of road infrastructures	Security of Persons and Goods
Drawing up a Municipal Contingency Plan for periods of extreme temperatures - heat waves and cold snaps	Agriculture, Forestry and Fisheries; Water Resources; Human Health; Security of Persons and Goods; Tourism
Promoting increased energy efficiency in buildings (building materials / heating systems)	Energy and Industry; Spatial Planning and Cities; Human Health; Security of Persons and Goods; Tourism

Table 22 – EMAAC's adaptation actions related to the H&C sector (EMAAC 2018).

The municipality has not yet developed a Municipal Climate Action Plan, on the scope of the Portuguese Climate Framework Law - Law no. 98/2021.

Concerning the municipal-level Territorial Management Instruments, the existent Municipal Master Plan, updated in 2018, does not include themes nor targets of energy transition nor decarbonization. There is also no Municipal Regulation related to these matters. Cases are handled punctually and according to the requirements of each project regarding energy efficiency and decarbonization issues. One example is the installation of PCVE - Electric Vehicle Charging Stations where, within the scope of decarbonization, MOBI.E recently advanced with a national project to install the so-called "Electric Streets" in the municipalities. Vila Real analyzed the proposed terms and agreed with the installation of 3 PCVE, which are currently in the installation phase. This is one of the cases in which, although there is no "Municipal Electric Mobility Regulation", the municipality created the necessary conditions aimed at the emergence of good practices and the adoption of measures/approvals that facilitated the PCVE implementation.

Furthermore, Vila Real has participated in city networks such as Eixo Atlântico do Noroeste Peninsular – Agência Ecológica Urbana (Atlantic Axis of the Northwest Peninsula - Urban Ecological Agency), which is a cross-border

association for the promotion of environmental and urban planning policies that encompasses the 34 most representative urban and population centers in the north of Portugal and Galicia, of which Vila Real has been a member since it was founded in 1992. The municipality of Vila Real has also developed a project financed by Fundo Ambiental (Environmental Fund)''Floresta Urbana'', with the aim of combating heat islands and collective self-consumption projects, centered in a first phase on municipal buildings.

Vila Real also expressed interest in the Espaços Cidadão Energia (Citizen Energy Spaces), which consist of one-stop-shops that support citizens in matters of energy efficiency, renewable energies and sustainable behavior.

3. The local energy system

The local energy demand

There is no specific data available at municipal level for Vila Real regarding energy consumption nor energy needs for the H&C sector. Given the lack of data that directly relates the consumption of each sector of activity by energy vector, is presented below the diagnosis of the municipal energy situation that was made on the scope of the Sustainable Energy Action Plan. Having 2015 as the reference year, energy consumption by sector was estimated for 2020, 2030 and 2050 in the PAES Monitoring Report of 2017 (Figure 5, 6, 7 and 8).

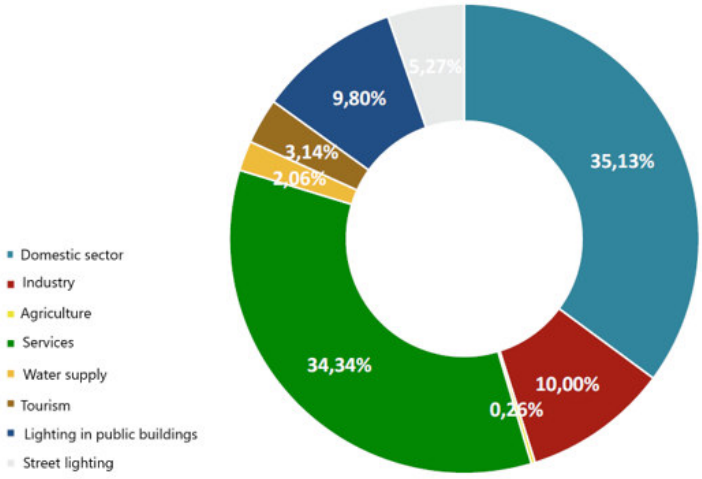


Figure 5 - Energy consumption by activity sector (%) in Vila Real in 2015. (source: PAES monitoring report, 2017)

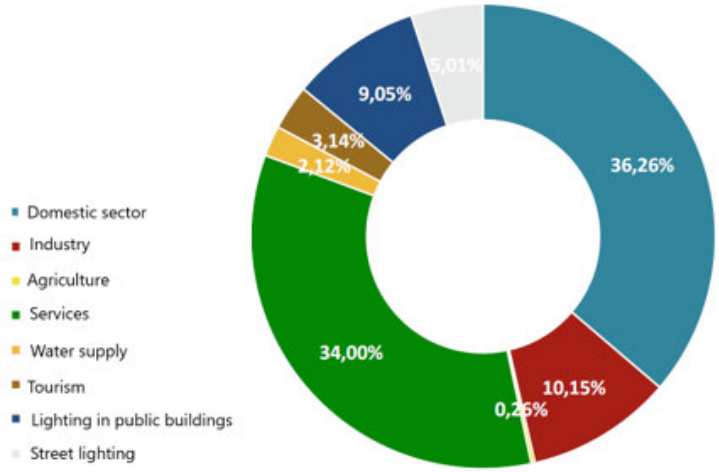


Figure 6 - Energy consumption by activity sector (%) in Vila Real in 2020. (source: PAES monitoring report, 2017)

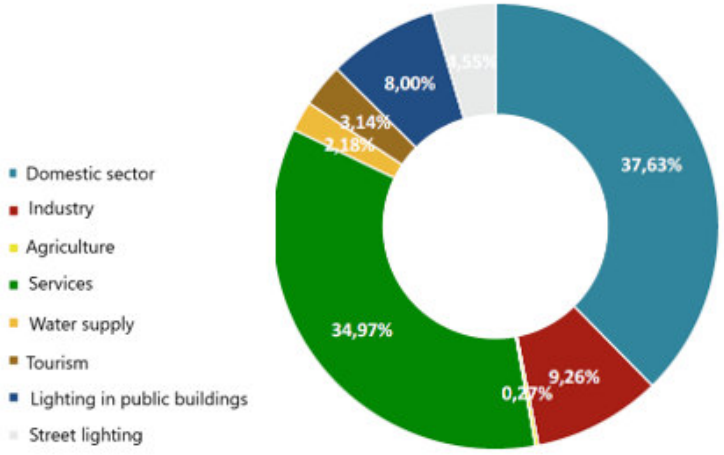


Figure 7 - Energy consumption by activity sector (%) in Vila Real in 2030. (source: PAES monitoring report, 2017)

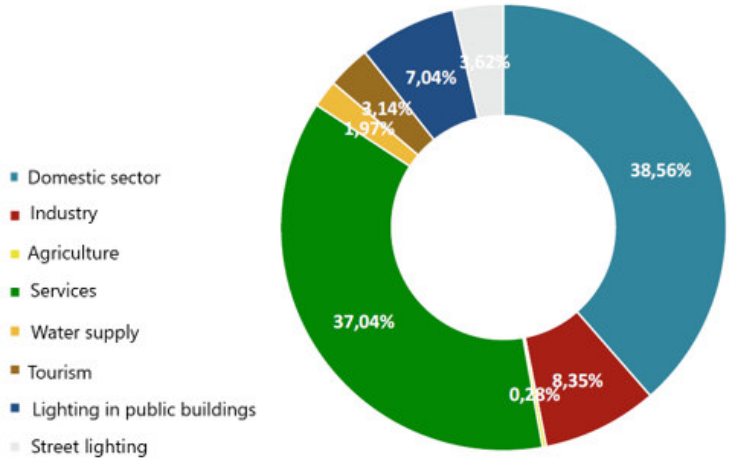


Figure 8 - Energy consumption by activity sector (%) in Vila Real in 2050. (source: PAES monitoring report, 2017)

The graphical representation of the final energy consumption, in Vila Real for the same years per energy vector, is presented in Figure 9, 10, 11 and 12.

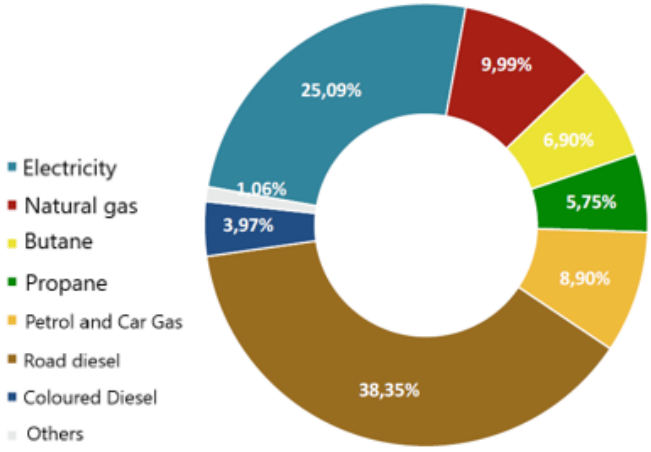


Figure 9 - Energy consumption by energy vector (%) in Vila Real in 2015. (source: PAES monitoring report, 2017)

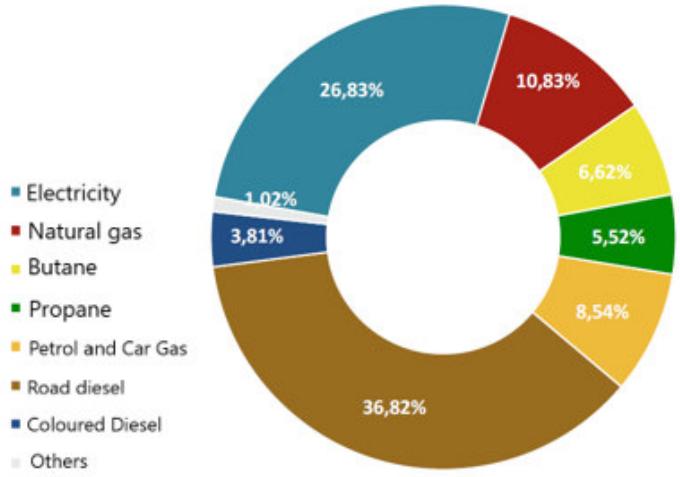


Figure 10 - Energy consumption by energy vector (%) in Vila Real in 2020. (source: PAES monitoring report, 2017)

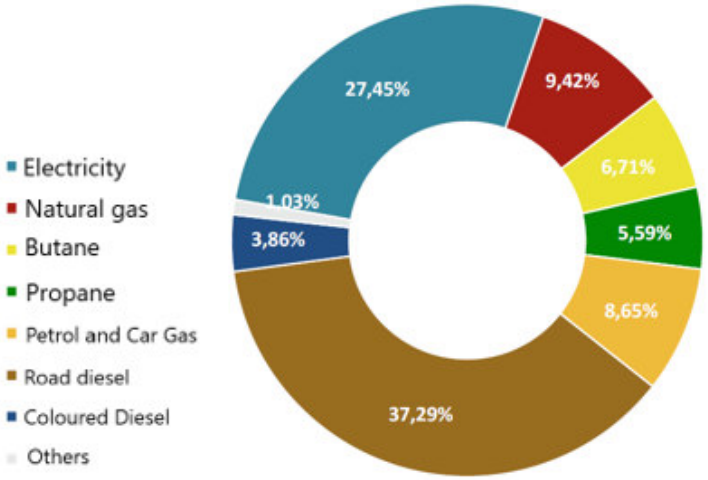


Figure 11 - Energy consumption by energy vector (%) in Vila Real in 2030. (source: PAES monitoring report, 2017)

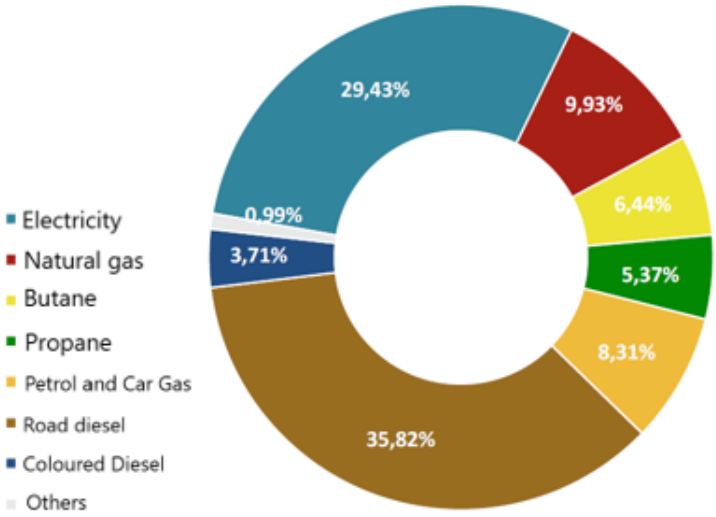


Figure 12 - Energy consumption by energy vector (%) in Vila Real in 2050. (source: PAES monitoring report, 2017)

It was also possible to obtain data on the type of H&C systems used in classic households (census of 2021) in the following table:

	Number of classic households	% of total classic households
With air conditioned	1233	8%
Without air conditioned	18120	92%
With central heating	6739	34%
With non-central heating - open fireplace	3635	18%
With non-central heating – heat recovery unit	2686	13%
With non-central heating – mobile unit (electric heater, gas heater, etc)	3348	17%
With non-central heating – fixed units (salamander heater, wall heaters, etc)	1070	5%
No heating	2275	11%

Table 23 - Type of H&C systems present in classic households in the municipality of Vila Real, according to the census of 2021 (INE 2024).

The local energy supply

Regarding energy production, according to DGEG data, the municipality of Vila Real had in 2023 5,3 MW of photovoltaic energy production, 20,3 MW from hydropower, 55,2 MW from wind power and 1,5 MW of thermal (0,6 MW from renewable source) (Table 6).

Municipality	Source	Installed power (MW)
Vila Real	Photovoltaic	5,3
	Hydropower	20,3
	Wind power	55,2
	Thermal	1,5
	from renewable source	0,6

Table 24 - Installed power in electricity generating plants in 2023 (DGEG 2024).

According to E-Redes (https://e-redes.opendatasoft.com/), Vila Real was, in the 3rd trimester of 2024, 1.481 self-consumption units and 5888 kW of installed capacity for self-consumption. In Figures 13 and 14, one can see the cumulative number of self-consumption units and the cumulative installed power for self-consumption per quarter.

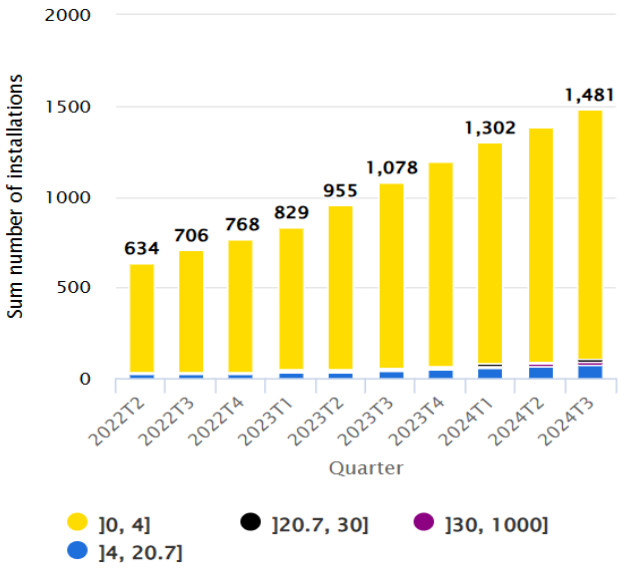


Figure 13 - Cumulative number of installations for self-consumption for the municipality of Vila Real per quarter and per installed power range (E-Redes 2024).

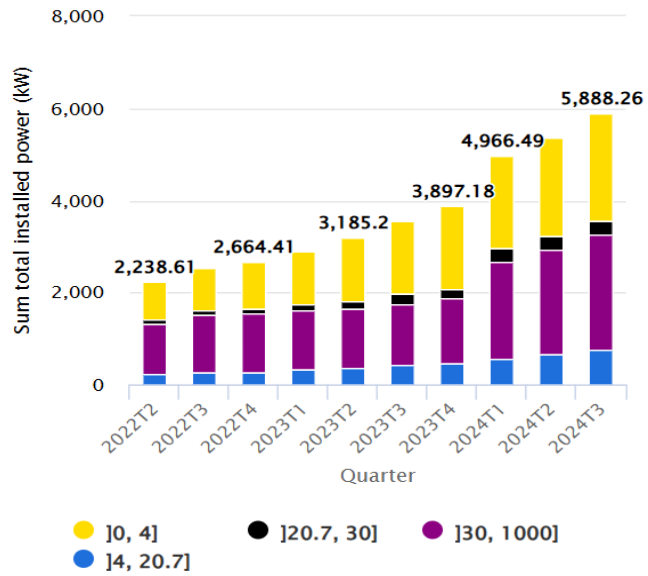


Figure 14 - Cumulative installed power for self-consumption for the municipality of Vila Real per quarter and per installed power range (E-Redes 2024).

4. Mapping of H&C target groups

For the list of identified stakeholders, some progress needs to be completed. There are a considerable number of relevant companies/associations listed below, although it is necessary to identify new stakeholders, contact them to present the project, ask for feedback, to discuss needs and identify changes.

STAKEHOLDER	TYPOLOGY
Associação Comercial e Industrial de Vila Real - ACIVR	Service and industry associations
Associação Empresarial – NERVIR	
Delegação de Vila real da Associação dos industriais da Construção Civil e Obras Públicas –AICCOPN	
Conselho Agrícola do Distrito de Vila Real – CADVR	
Associação Florestal de Trás-os-Montes	
Associação de Agricultores do Concelho de Vila Real	
CIM-Douro intermunicipal community and its member municipalities	Intermunicipal community
To be defined	Financial/banking institutions
University of Trás-os-Montes and Alto Douro and other local/regional research institutions	Local/regional research institutions
Regia-Douro Park – Parque de Ciência e Tecnologia	
To be defined	Civil society organisations, including residents' associations
Douro Mission Technical Office of the Northern Regional Coordination and Development Commission – CCDR-NORTE	Regional development institutions
Advid - Associação Desenvolvimento da Viticultura Duriense	
Eixo Atlântico do Noroeste Peninsular	
To be defined	Other relevant public or private institutions
To be defined	Electricity companies and their associations, renewable energy, and heating/cooling companies

Table 25 - List of stakeholders in Vila Real.

5. Summary in national language

O município de Vila Real, situado na região do Douro, é um dos centros urbanos mais relevantes do norte de Portugal, com características territoriais diversificadas que incluem áreas montanhosas e paisagens próximas ao rio Douro. O clima, com influências mediterrânicas e atlânticas, impacta diretamente as necessidades de aquecimento e arrefecimento, enquanto a economia local é impulsionada por setores como a saúde, os serviços imobiliários e a comunicação.

No contexto da transição energética e da adaptação às alterações climáticas, Vila Real tem implementado estratégias como o Plano de Ação para a Energia Sustentável (PAES), desenvolvido em 2015 e atualizado em 2017 e a Estratégia Municipal de Adaptação às Alterações Climáticas (EMAAC). Estas iniciativas incluem medidas para melhorar a eficiência energética, reabilitar edifícios, promover energias renováveis e fomentar o autoconsumo, que já conta com 1.481 unidades e uma capacidade instalada de 5,9 MW.

O sistema energético local caracteriza-se pela produção diversificada, com 55,2 MW de energia eólica, 20,3 MW de energia hídrica e 5,3 MW de fotovoltaica. A maior parte do consumo energético está associada ao setor doméstico e a sistemas de aquecimento e arrefecimento não centralizados.

Apesar dos progressos, persistem desafios como a escassez de dados energéticos detalhados e a necessidade de maior articulação com *stakeholders*. No entanto, o município dispõe de oportunidades significativas para expandir o uso de energias renováveis, reforçar a eficiência energética e liderar a adaptação climática, alinhando-se com as metas regionais e nacionais para a sustentabilidade e a descarbonização.

MUNICIPALITY OF FUNCHAL

1. The local territorial context

Location and characterisation

The Madeira Archipelago consists of two inhabited islands, Madeira and Porto Santo, which are about 42 kilometres apart. They are the two inhabited islands of the Madeira Archipelago, one of the seven outermost regions of the European Union, located in the North Atlantic.

Figure 5: Illustration of Autonomous Region of Madeira (ARM) and aerial view of the municipality of Funchal

Source: https://d-maps.com/carte.php?num_car=261235&lang=en and Visit Madeira

The Madeira Archipelago is about 900 kilometres from the Azores and mainland Portugal. The nearest territories are the Canary Islands, about 500 kilometres from the island of Tenerife, and the African coast, about 800 kilometres from Casablanca, Morocco. The island of Madeira has a surface area of 736.75 km^2, with the municipality of Funchal accounting for approximately 10% of the island's total surface area (76 square kilometres). The municipality of Funchal is divided into 10 parishes and is characterised by steep slopes from sea level to an altitude of 1 800 metres, with a very dispersed population. According to sample data from the Energy Certification System (ECS), around 75 % of residential buildings in Funchal are located at altitudes below 300m, with an average altitude of around 205m.

Demography

According to the preliminary results of the 2021 census, the resident population of the ARM at that time was 251 060, of which 245 902 lived on the island of Madeira (98% of the archipelago's population) and 5 158 on the island of Porto Santo (2% of the archipelago's population). The municipality of Funchal concentrates about 43% of the population of Madeira Island, with 105 782 inhabitants, and has a population density of 1 449 inhabitants/km^2, which highlights the high population concentration in Funchal, the capital of the island and the archipelago.

Table 26: Population trends in Funchal and the ARM

	1981	1991	2001	2011	2021	2023 est.
Funchal	112 746	115 403	103 961	111 892	105 782	107 562
RAM	252 844	253 426	245 011	267 785	250 744	256 622

Source: Regional Directorate of Statistics (DREM)

In 2021, 76% and 78% of the population of RAM and Funchal respectively will be over 25 years old. The average age is 44.4 years in RAM and 45.6 years in Funchal. Approximately 12% of the population in RAM is over 65, compared to 15% in Funchal.

Economy

Using the official figures from the published regional accounts, the following table shows the evolution of Gross Domestic Product (GDP) and Gross Value Added (GVA) over the last 20 years in the RAM, with no specific data for Funchal.

Table 27: Evolution of GDP and GVA in ARM at market prices

	2001	2005	2009	2011	2019	2020	2021	2022Po
GDP [Meuro]	2826	3893	4346	4440	5126	4450	5026	6021
GVA [Meuro]	2497	3402	3886	3921	4475	3914	4398	5271

Source: INE, Regional Accounts, base 2016, 1995 - 2022Po

In 2022, the largest contribution to GVA in the RAM comes from tertiary sector activities (82% of GVA), with a strong presence of activities related to tourism and trade. Although no data are available for the municipality of Funchal, the weight of the tertiary sector is even greater, as a large proportion of service activities are concentrated there.

Climate

The region is characterised by a subtropical climate (mild in both winter and summer), which means that more energy is required for cooling than for heating. With respect to sea level, there is a thermal gradient of about 1ºC/100m with increasing altitude.

Between 1976 and 2019, the annual mean temperature at the Funchal/Observatório station ranged from 18.1°C (the temperature recorded in 1976 and 1984) to 20.6°C (the value recorded in 2004 and 2019). Comparing the 1976-1980 period with the 2015-2019 period, the average annual temperature in the first period was 18.5°C, while in the second it was 20.3°C, an increase of 1.8°C. In fact, between 1976 and 1980, the average air temperature was always below 19.0°C, while between 2015 and 2019 it was equal to or above 20.0°C. Between 2000 and 2019, the Funchal Observatory recorded 137 tropical nights, i.e. nights with a minimum daily temperature above 20.0 °C. (Source: Acliemac Project-Study 3 History of Gradual Climate Change and Extreme Weather Events).

RAM has a Climate Change Adaptation Strategy (CLIMA-Madeira Strategy) which is currently being revised. Of particular note are the SSP2 and SSP5 climate scenarios, in which three time horizons were characterised, the first between 2021 and 2050 with daily simulations, the second between 2051 and 2080 with monthly simulations and finally between 2081 and 2100 with 20 years of monthly simulations. For all the time horizons, two scenarios were characterised, SSP2-4.5 and SSP5-8.5 to assess the uncertainty associated with future social paths. For the comparative analysis between the scenarios and the historical data, the anomalies between the climatological normal of the scenarios and the reference period between 1981 and 2010 were calculated.

Table 28: Temperature anomalies based on the monthly climatological normal between 1981 and 2010

	SSP2			SSP5		
	2021-2050	2050-2080	2080-2100	2021-2050	2050-2080	2080-2100
Winter	0.9 °C	2.7 °C	3.2 °C	0.8 °C	3.5 °C	4.9 °C
Spring	0.4 °C	2.4 °C	2.7 °C	0.4 °C	3.0 °C	4.4 °C
Summer	2.8 °C	2.8 °C	3.2 °C	3.2 °C	3.7 °C	5.3 °C
Autumn	1.3 °C	2.9 °C	3.3 °C	1.3 °C	3.6 °C	5.1 °C

Source: https://observatorioclima.madeira.gov.pt/ssp2-ssp4/

According to the Ensemble RT3 project forecast, the RAM is expected to experience an increase in cooling degree days (CDD) in the different climate scenarios, assuming an increase in cooling energy demand; on the other hand, a decrease in heating degree days (HDD) is expected in two of the three climate scenarios, assuming a decrease in heating energy demand, as a result of the expected temperature increase due to climate change.

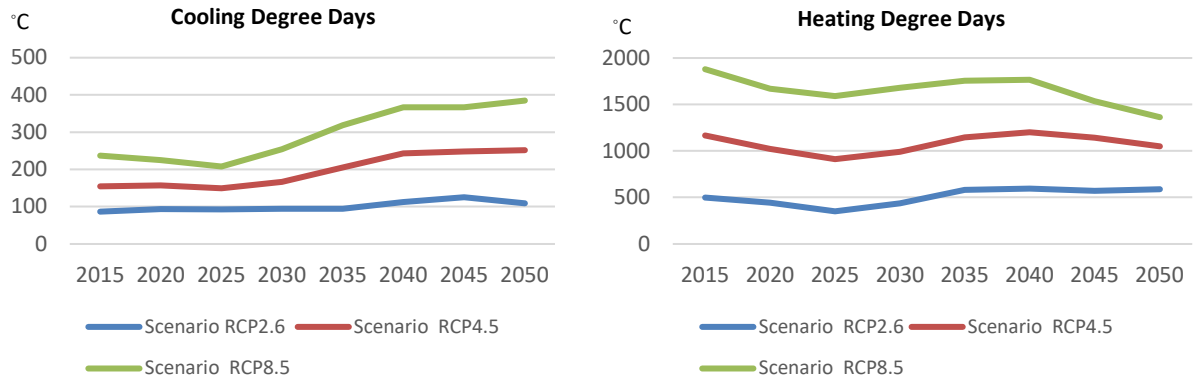


Figure 6: Scenario of CDD and HDD in RAM between 2015-2050

Source: https://ensemblesrt3.dmi.dk/, Madeira Region: https://maps.invert.at/hdd#map=10/-1878815.12/3910457.41/0/0

In the Acliemac project, a dynamic simulation was carried out for a residential building considering two different climates: one corresponding to the reference climate for the ARM, corresponding to an altitude of 205m, and the other with an average annual temperature 1.5°C higher than this reference climate. The analysis of the energy demand considered in the simulation corresponds to the calculation of the energy required for H&C in order to maintain the comfort temperature of the living spaces between 18°C and 25°C. The following figure shows the results obtained for these two climates.

Table 29: Annual energy needs for the simulated climates in residential buildings

	Annual energy needs [kWh]		
	Reference climate	Climate +1,5°C	Variation
Heating	1 792	760	-58%
Cooling	3 752	4 485	+20%
Total	5 544	5 245	-5%

Source: Acliemac project

2. The reference policy and strategic context

Regional context

At regional level, the regional government approved the first energy plan in 1989, with subsequent updates in 1992, 2002, 2012 and 2022. The successive plans have been the guiding instruments of the regional strategy for security of supply, reducing dependence on foreign sources, energy efficiency, making the best use of endogenous energy resources and minimising the negative environmental impacts associated with the use of fossil fuels.

In 2022, AREAM developed the latest energy and climate policy instrument, the Sustainable Energy and Climate Action Plan for the Autonomous Region of Madeira (SECAP-ARM), within the framework of C-Track 50. The SECAP-ARM is in line with national and European policies and defines the objectives and targets for the 2030 and 2050 time horizons in the fields of energy and climate, in accordance with Regulation (EU) 2018/1999 of the European Parliament and of the Council and the National Energy and Climate Plan (NECP), which will allow the region to effectively monitor and report on its contributions to the national plan. The strategy sets out the following targets to be achieved by 2030 and 2050.

Table 30: Targets for 2030 and 2050-SECAP RAM

Indicators	Target	
	2030	2050
Share of renewable energy resources in primary energy demand	18%	60%
Share of renewable energy resources in electricity production	55%	95%
Reduction in fossil fuel consumption compared to 2005	45%	85%
Reduction in GHG emissions compared to 2005	55%	85%

Source: SECAP RAM

In order to structure the regional energy and climate policy, five strategic dimensions have been identified, in line with the five dimensions of the Energy Union: Energy Security, Internal Energy Market, Energy Efficiency, Decarbonisation and Research, Innovation and Competitiveness. Within each strategic dimension, lines of action have been defined, reflecting priorities for intervention in areas with high potential for improvement in relation to the desired objectives, as summarised in the table below, which are then translated into a set of actions.

The energy policy of this instrument does not consider actions that focus directly on energy needs for heating and cooling, but rather on the different sectors and fields of intervention, covering energy supply and demand, adaptation to climate change, spatial planning and other relevant areas, with the participation of the different actors, including regional and local public administration, public and private companies and organisations, and citizens. The selection of actions took into account their coherence and technical and economic feasibility in the light of the latest technological and contextual knowledge and expectations for the future, favouring those with the greatest potential in relation to the objectives set. Scenarios were developed to model multiple variants and simulate the interactions between the different actions in order to identify and optimise the results for achieving the 2030 and 2050 objectives.

In SECAP-ARM, the main actions with an impact on energy demand for H&C and the fight against energy poverty are presented below. At the local SECAPs of Funchal, Machico, Câmara de Lobos, Ribeira Brava, São Vicente and Porto Santo, the types of actions are very similar in scope.

M-4.1. Develop and implement a long-term regional strategy to combat energy poverty M-4.2. Strengthen mechanisms to protect vulnerable consumers M-4.3. Renovate the social housing stock and housing for vulnerable families M-4.4. Promote energy efficiency and renewable energies to mitigate energy poverty E-1.1. Promote high-efficiency solutions and energy management systems in buildings E-1.2. Encourage renewable energies for heat production in buildings E-1.3. Encourage the electrification of energy consumption in buildings E-1.4. Improve thermal comfort in buildings E-1.5. Promote building renovation	E-1.6. Promote NZEB buildings E-2.2. Promote high-efficiency solutions and energy management systems in industry and construction E-3.1. Promote energy efficiency and renewable energies in the primary sector E-3.3. Promote the recovery of waste and effluents for energy purposes E-4.1. Improve energy efficiency in public services E-4.4. Promote green public procurement E-6.2. Create incentives for energy efficiency E-6.3. Promote energy performance contracts D-5.3. Mitigate the heat island effect I-5.3. Promote the training of technicians and specialists I-5.6. Promote information and awareness campaigns

In order to implement the actions presented in the SECAP-RAM and the local SECAPs, the following table shows the incentives, support mechanisms and financial instruments that are available or planned at regional level, which are aimed at the energy transition and the climate, and which have a direct or indirect impact on the decarbonisation of the H&C sector.

Table 31: Instruments and funding sources available for implementing decarbonisation actions in ARM

EU Programs		EIB - European Investment Bank; ELENA - European Local ENergy Assistance; EUCF - European City Facility; Cohesion Fund; Innovation Fund; Just Transition Fund; Horizon Europe; InnovFin Energy Demo Projects; Interreg Atlantic Area; Interreg Europe; Interreg MAC; InvestEU; CEF - Connecting Europe Facility; NESOI - European Islands Facility; CAP - Common Agricultural Policy; LIFE Programme - Environment and Climate Action Programme.
Regional incentives	Operational Programme	Types of action:

	Madeira 2030 (Priority: 2A. Madeira + Green: Climate Action and Energy Transition)	**-Decarbonisation of the industrial and business sector**, through subsidies, specifically aimed at energy efficiency in buildings and infrastructures and in all economic activity, namely in industry, services and commerce, as well as in the social sector; **-Energy Efficiency in Regional and Local Public Administration**, namely through the adoption of efficient technologies and the promotion of energy efficiency and the integration of renewable energies in Regional and Local Public Administration, namely in the areas of thermal insulation of buildings and installations, with the conversion of equipment to more efficient technologies, passive solar systems in buildings, production of DHW with renewable energies, energy monitoring and management systems.
	Resilience and Recovery Plan (RRP)	**Strengthening the Supply of Supported Housing in Madeira** - Construction of new social housing and rehabilitation of old buildings, with the aim of providing affordable housing for families on average incomes, also seeks to improve the energy efficiency of existing housing, contributing to environmental sustainability and reducing costs for residents. **Energy Efficiency in Madeira's Public Buildings** - Promoting the energy renovation of buildings and equipment used by the public sector in the ARM. The energy rehabilitation interventions to be developed involve the implementation of integrated solutions, namely the promotion of high-efficiency solutions and energy management systems in buildings, the promotion of renewable energies for heat production in buildings, encouraging the electrification of energy consumption in buildings by promoting the technological transition from fossil fuel equipment to more efficient electrical equipment and improving technical comfort in buildings.
	Casa +eficiente programme	The **Casa +Eficiente Programme** is a programme promoted by the Regional Government, which consists of granting non-refundable financial support for rehabilitation and improvement work on permanent homes owned by economically and financially disadvantaged households, with the aim of improving the energy performance of homes and consequently reducing energy bills.
	+ENERGIA Program	The **+ENERGIA Programme** establishes a system of incentives for the production and storage of energy from renewable sources in the ARM, offering non-refundable financial support to families, micro, small and medium-sized enterprises, cooperatives, private social solidarity institutions, non-profit associations and condominiums, helping to reduce energy dependence on the outside world and encourage sustainable consumption practices. This programme is funded by the Recovery and Resilience Plan (PRR) under investment 'RP-C21-i11.01-RAM'. The programme promotes the installation of: self-consumption electricity production systems; electricity storage systems; solar thermal systems; heat pumps; biomass systems; heat recuperators and stoves, biomass system components for DHW and space heating.

In 2023, the ARM, through the Regional Directorate for the Environment and the Sea (DRAM), initiated the revision of the CLIMA-Madeira Strategy. The Strategy, published in 2015, plays a fundamental role in supporting government policies that require a framework for a concerted and rapid response to the impacts of climate change. Given that adaptation to these changes is an open-ended and dynamic process, it is imperative that the Strategy is closely followed and monitored. The Strategy presents a range of future climate scenarios and sectoral actions to mitigate and adapt to the impacts of climate change in the region.

Of particular note are the C-TRACK 50 and Isle-Pact projects at regional and local level, which have contributed to the regional and local decarbonisation strategy.

The local context of Funchal

The municipality of Funchal joined the Covenant of Mayors in 2011 and drew up a SEAP in which it committed itself to reducing carbon dioxide (CO_2) emissions from energy consumption in its territory by 20%, increasing renewable energy resources by 30% and reducing fossil energy consumption by 20% by 2020. In 2018, the municipality renewed its commitment by joining the Covenant of Mayors on Energy and Climate, developing a SECAP with more ambitious goals and targets in response to the climate emergency, and committing to reduce CO2 emissions by at least 40% by 2030.

The municipality of Funchal has set the following objectives and targets to be achieved by 2030 and 2050.

Table 32: Monitoring 2023 and objectives and targets for 2030 and 2050-SECAP-Funchal

Objectives		Targets monitoring 2023	Targets	
			2030	2050
1.	Reduce final energy consumption compared to 2010	**10%**	39%	77%
2.	Increase the use of renewable energies compared to 2010	**8%**	170%	244%
3.	Reduce fossil fuel consumption compared to 2010	**14%**	51%	92%
4.	Reduce of GHG emissions compared to 2010	**8%**	45%	86%

Source: 1st Monitoring report of SECAP-Funchal

The Funchal Sustainable Energy and Climate Action Plan 2030-2050 (SECAP-Funchal 2030-2050), which materialises the strategy adopted to achieve the objectives and targets set by the municipality. This instrument considers the structure defined in Regulation (EU) 2018/1999.

The municipality of Funchal does not have a H&C network and does not have any information on the energy demand for H&C, although it is possible to access some information from ECS, which has a database on the H&C demand of the housing stock and service buildings with an energy certificate. To assess the demand, results are available for the housing sector based on surveys carried out in the 2021 Censuses and the 2020 Household Energy Consumption Survey, while the demand in other sectors will have to be assessed by carrying out surveys of service buildings belonging to public and private organisations.

The SECAP-Funchal actions are not directly aimed at reducing H&C demand, but the actions to be taken in residential buildings, public and private services and urban spaces will help to meet the higher cooling energy demand expected in the future.

In SECAP-Funchal, solar thermal and photovoltaic energy for self-consumption in buildings was considered energy efficient because it is not purchased by the user but leads to a reduction of electricity from the public grid and gas.

The main measures with an impact on H&C energy demand are partly like those included in the SECAP-ARM, but with an impact at local level.

Table 33: Expected impacts with the implementation of actions in 2030 in relation to 2010

Sector/fiel of intervention	Energy savings (MWh)	RES production (MWh)	GHG emissions (t CO2 eq)
Municipal buildings, equipment/facilities	1369	0	1591
Tertiary (non municipal) buildings,equipment/facilities	91 628	14 221	83 674
Residential buildings	77 717	0	41752
Public lighting	9839	0	8 067
Industry	-1 312	9591	6055
Municipal fleet	3982	826	1330
Public transport	36391	6825	11862
Private and commercial transport	297822		75224
Others (Agriculture, Forestry, Fisheries)	5 877	0	1526
Local Electricity Production	0	55 979	0
Local Heat/Cold Production	-	-	-

Source: SECAP-Funchal
To consult SECAP-Funchal: https://eu-mayors.ec.europa.eu/en/signatory/14003#actionPlansAndProgress

In 2024, the municipality of Funchal carried out the first SECAP-Funchal monitoring report, using 2023 as the reference year for the energy balance and emissions inventory.

Mitigation and adaptation actions have been implemented and during this period many actions have been financed or co-financed by available funding programmes (RRP, Operational Programme, etc.).

Below is a summary of the main measures to be implemented between 2021 and 2023 with an impact on energy demand for H&C and the fight against energy poverty.

Table 34: Summary of actions implemented between 2021 and 2023 in Funchal

- Implementation of the Local and Regional Housing Strategy. ◦ Funchal's Local Housing Strategy (2019-2024) includes the demographic and housing characterization of Funchal, a diagnosis of the municipality's housing shortages and an action plan that includes the following measures: management and maintenance of the municipal housing stock; community development and social inclusion; promotion of new housing and rehabilitation of existing municipal housing; support for renting, urban rehabilitation and municipal policies to encourage housing. (https://sociohabita.funchal.pt/empreendimentos) The Regional Housing Strategy (2020-2030) was developed by the Regional Secretariat for Social Inclusion and Citizenship and includes a framework for the housing sector in the Autonomous Region of Madeira, a characterization of housing shortages, contributions to the definition of the strategy (identification of the housing stock, priorities and measures of the municipalities and the Autonomous Region of Madeira, existing housing policy programs in the Autonomous Region of Madeira and investments made by the IHM (public entity responsible for implementing the housing policy of the Regional Government of Madeira). In this strategy, we highlight the following areas of intervention and measures to be implemented: - Social Housing (Strengthening the supply of social housing in Madeira); - Conservation and rehabilitation of the housing stock (rehabilitating and conserving the housing stock managed by the IHM; -Support for owner-occupied housing and renting (regenerating dilapidated housing estates, creating complementary support for national programs, reviewing and extending the financial support of Program for the rehabilitation of substandard housing)) (https://www.ihm.pt/uploads/divulgacoes/ERH.pdf)
- Implementation of the Solidarity Gas Programme and the Social Electricity Tariff. - Energy rehabilitation of social housing managed by the municipality and the GRM. - Design and construction of new social housing managed by the Municipality and the GRM, housing with energy needs at least 20% more demanding than the NZEB requirements. - Creation of the Casa +Eficiente programme, which provides support for rehabilitation and improvement work to minimise energy shortages and dependency and enable a reduction in energy bills and CO2 emissions. - Promoting high-efficiency solutions, solutions to improve comfort, energy management systems and the use of renewable energies for air conditioning, DHW and electricity production in private and public housing buildings. - Promoting the electrification of energy consumption in residential, private and public buildings. - Promoting the renovation of buildings. - Promotion of new NZEB buildings. - Creating incentives to improve energy efficiency - Creation of a tax strategy to promote urban regeneration. - Integrating sustainable energy criteria into spatial planning and management instruments. - Promoting the training of technicians and specialists. - Promotion of information and awareness campaigns.

Source: 1st Monitoring report of SECAP-Funchal

The municipality of Funchal is a member of the Adapt.local Association - Network of Municipalities for Local Adaptation to Climate Change, a national network that encourages Portuguese municipalities to implement measures to adapt to climate change. The municipality has a Municipal Strategy for Adaptation to Climate Change (EMAAC) and its integration into municipal planning tools to face the future challenges that the climate will pose to us as a society and territory and has developed and monitored actions to identify current and future climate vulnerabilities.

In accordance with Article 14 of the Framework climate law (Law no. 98/2021, of December 31, https://climate-laws.org/document/framework-climate-law-no-98-2021_2801), approved by Parliament, which provides for the development of Municipal Climate Action Plans (PMAC), the municipality of Funchal is currently developing the Funchal 2030 Climate Action Plan (PAC Funchal 2030) and training technicians from the municipality and other organisations involved. Under the umbrella of the Madeira Climate Strategy, the plan is being developed in close coordination with partners and the municipality, focusing on Funchal's energy inventory, bioclimatic specificities, territorial sensitivity, vulnerabilities, risks, strategy and the governance and management model for the municipal territory, with the aim of being a guiding tool for the operationalisation of Funchal's climate action policy. In the context of the Funchal 2030 CAP, each climate action measure will be characterised by its potential convergence with the Sustainable Development Goals (SDGs), and mitigation and adaptation measures will be integrated.

3. The local energy system

Local energy demand

As ARM is an island and has an isolated electricity system, we thought it would be interesting to look at the energy demand of RAM and the municipality of Funchal.

The energy balances presented only include electricity and fuels that are actually purchased. Solar thermal energy, solar photovoltaic energy for own use in final consumption, the renewable fraction of heat pumps and biomass consumption in the residential sector are not included because they are difficult to estimate, but biomass consumed in industrial boilers, bakery equipment and biomass boilers in hotels is included because this information is relatively easy to collect.

Locally produced energy includes the surplus electricity generated by photovoltaic systems, which is fed into the grid, as the producer is paid for this energy. The ARM does not have a district heating system for residential and commercial buildings. However, the private thermal power station in Caniçal produces around 12 GWh of heat per year in the form of steam, using the exhaust gases from the engines, and this heat is supplied to seven factories in the Madeira Industrial Free Trade Zone.

Regional energy demand

The following table shows the evolution of final energy consumption and greenhouse gas emissions in Madeira in 2009, 2019 and 2023:

Table 35: Final energy consumption per setor and GHG emissions in RAM

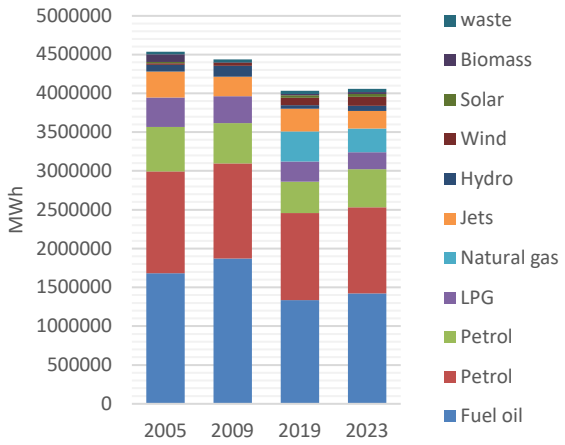
Year	Residential	Primary Sector	Secondary Sector	Tertiary Sector	Transport	Energy		GHG emissions
	[MWh]					[MWh]	[Toe]	[t CO2 eq]
2009	473 583	32 274	146 007	667 014	1 964 318	**3 283 196**	**282 304**	**1 239 972**
2019	452 775	29 244	174 818	560 900	1 759 344	**2 977 081**	**255 983**	**1 048 095**
2023*	469 394	26 524	156 517	588 488	1 702 503	**2 943 425**	**253 089**	**1 037 484**
Variation 2009-2023	-0,9%	-17,8%	7,2%	-11,8%	-13,3%	-10,3%	-10,3%	-16,3%

Source: Energy Plans, DREN and EEM
*Provisional

Between 2009 and 2023, final energy consumption will be reduced by 10.3% and greenhouse gas emissions by 16.3%.

The following table shows the evolution of consumption by energy form and indicators in 2005, 2009, 2019 and 2023:

Table 36: Primary energy per source of energy and evolution of indicators



	2005	2009	2019	2023*
Resident population in ARM (inhab)	253 878	263 067	253 956	256 622
Primary Energy Consumption per capita (toe/inhabitant)	5,12	4,71	4,13	4,04
Final Energy Consumption per capita (toe/inhab)	N.A	1,1	1,0	1,0
Electricity consumption (GWh)	803,9	876,9	808,5	856,3
Electricity consumption per capita (MWh/inhab)	3,17	3,33	3,18	3,34
Energy intensity in Primary Energy (toe/M€'2016)	100	88	68	53
Energy intensity in Final Energy (toe/M€'2016)	N.A	65	50	38
Electricity energy intensity (MWh/M€'2016)	206	202	158	130
% RES in primary energy demand	5,6%	5,0%	5,7%	7,1%

Source: Based on data from the ARM Plans (SEAP 2011, SECAP 2022) and a survey carried out by AREAM for the year 2023

Funchal energy demand

The following table shows the final energy consumption and greenhouse gas emissions for the municipality of Funchal in 2023:

Table 37: Final energy consumption and GHG emissions in Funchal in 2023

Sector	Final energy consumption [MWh]								GHG emissions [tCO2eq]
	Electricity	Fossil fuels				Renewable energies		Total	
		Liquid gas	Heating oil	Diesel	Gasoline	Biofuel	Other biomass		
Buoldings, equipment/ facilities and industries									
Municipal buildings, equipment/facilities	6 133	710		469	110	31		7 453	4 277
Public lighting	14 962							14 962	9 659
Tertiary (non municipal) buildings,equi/fac	255420	40 123	8 825	13 426	2 768	885	1838	323 285	180 653
Residential buildings	122 248	74 964						197 212	95 936
Industry Industry Non-ETS	13 206	852	31 091	10 390		685	915	57139	20 070
Subtotal	**411 969**	**116 649**	**39 916**	**24 285**	**2 878**	**1 601**	**2 753**	600 051	310 595
Transport									
Municipal fleet	6			7 110	193	469		7 778	2 017
Public transport	15			66 683		4 397		71 095	18 421
Private and commercial transport	600			309 411	194 953	20 339		525 303	136 018
Subtotal	**621**	**0**	**0**	**383 204**	**195 146**	**25 205**	**2753**	604 176	156 456
Other									
Agriculture, Forestry, Fisheries	517	1323		2 400		158		3 398	1 297
TOTAL	**413 107**	**117 972**	**39 916**	**409 889**	**198 024**	**26 964**	**2 753**	1 208 625	468 348

Source: 1st Monitoring report of SECAP-Funchal

In 2023, transport will account for about 50% of final energy consumption, corresponding to 33% of greenhouse gas emissions. Residential buildings account for about 16% of final energy demand.

The following table shows consumption by type of user, by energy form, local energy production and GHG emissions in 2010, 2017, 2020 and 2023.

Table 38: Consumption by type of user, by form of energy, local energy production and GHG emissions in 2010, 2017, 2020 and 2023.

	2010	2017	2020	2023	Variation 2010-2023
Final energy consumption per inhabitant [MWh/inhab]	**12,1**	**10,5**	**9,1**	**11,2**	**-7%**
GHG emissions [t CO2 eq)	**510 539**	**423 533**	**376862**	**468 202**	**-8%**
Final energy consumption [MWh]:	**1 340 498**	**1 130 633**	**964 229**	**1 208 624**	**-10%**
Municipal buildings, equipment/facilities	7525	7311	6687	7453	-1%

Public lighting	19282	17222	16240	14962	-22%
Tertiary (non municipal) buildings, equipment/facilities	361102	320713	248314	323285	-11%
Residential buildings	214409	179799	198181	197212	-8%
Industry	36249	51289	53898	57139	55%
Municipal fleet	9510	7731	7007	7778	1%
Public transport	83613	43640	42399	71095	-15%
Private and commercial transport	593412	491860	389776	525303	-11%
Agriculture, Forestry, Fisheries	15396	11068	1726	4398	-71%
Energy consumption by source of energy [MWh]:					
Electricity	419 529	390 030	348 735	413 107	**-2%**
Fuel Oil	18 370	38 766	37 692	39 915	**117%**
Petrol	489 160	383 978	313 741	409 888	**-16%**
Petrol	195 682	151 733	126 801	198 025	**1%**
LPG	182 962	138 177	114 799	117 972	**-36%**
Biomass	2 552	2 633	1 774	2 753	**8%**
Biofuels	32 244	25 317	20 686	26 963	**-16%**
Local energy production [MWh]:	**7983**	**9533**	**8 312**	**9645**	**21%**

Source: 1st Monitoring report of SECAP-Funchal

Between 2010 and 2023, final energy consumption will be reduced by 10% and greenhouse gas emissions by 8.3%.

Energy demand for H&C sector in ARM and Funchal

According to the preliminary analysis carried out, there is no official monitoring to assess the energy demand for H&C in the ARM and the municipality of Funchal for the different sectors.

Below is a table showing the H&C sectors, the main uses of H&C, the type of equipment and the sources of information used to determine the energy demand and H&C needs.

Table 39: H&C sector, the main uses of H&C and the type of equipment used

Sectors	Main end uses of H&C	Main technologies used	Source of information
Public and Private Buildings	Space heating and cooling Domestic Hot water (DHW)	Air conditioning Heat pumps Biomass boilers Solar thermal	Surveys (energy demand and ownership rate of space heating and cooling and DHW equipment) Energy certification system (energy needs for space heating and cooling and DHW)
Residential buildings	Space heating and cooling DHW	Air conditioning Heat pumps Salamanders Solar thermal Electric water heater Gas heater	Census and survey to assess energy demand and ownership rate of space heating and cooling and DHW equipment) Energy certification system (energy needs for space heating and cooling and DHW)
Industry	Industrial processes Bakery	Biomass boilers Thermal heat recovery steam Wood-fired ovens	Surveys to assess energy demand in industrial processes and baking

In 2021, censuses were carried out to assess the use of air conditioning in this sector. Below are data on the use of space heating and cooling equipment in dwellings for the ARM and the Municipality of Funchal.

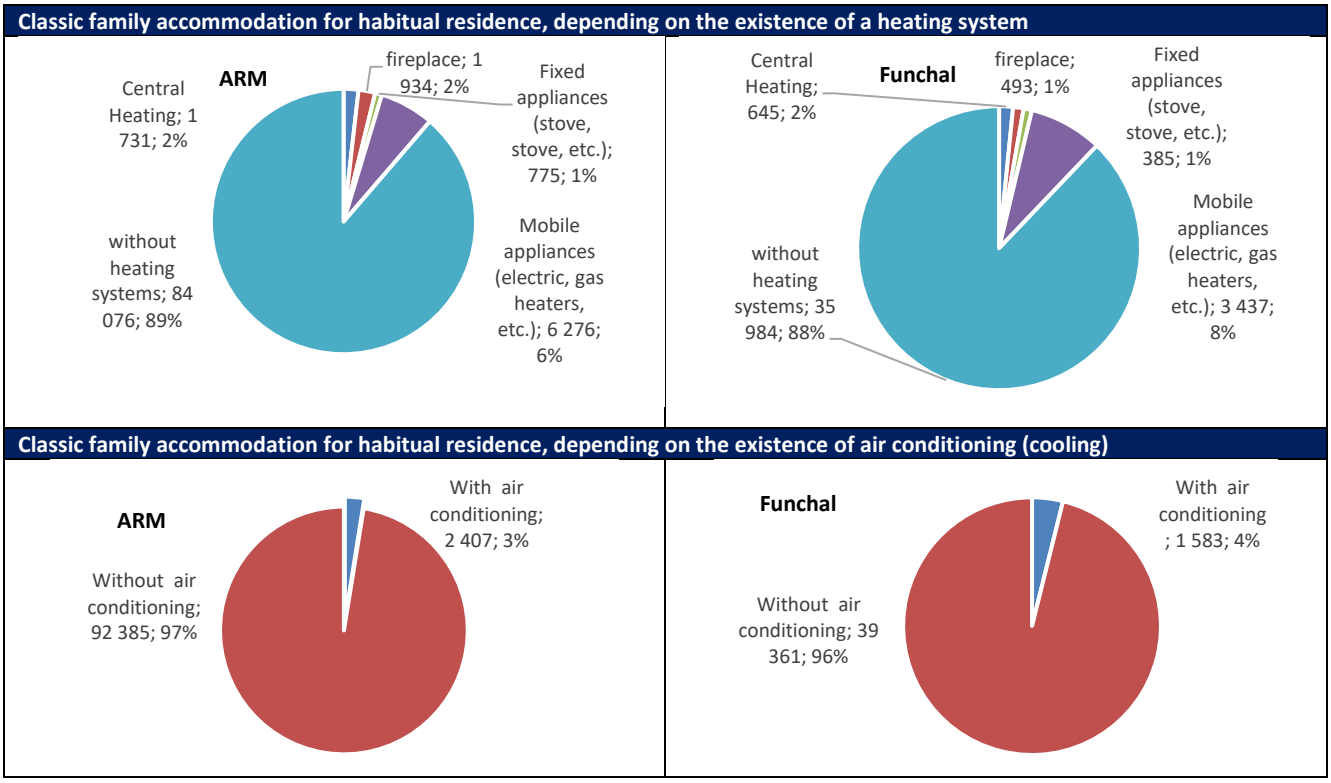


Figure 7: Use of space heating and cooling equipments in residential buildings

Source: Censos 2021

In the ARM and the Municipality of Funchal, there is little use of H&C equipment to maintain comfortable conditions in dwellings. In the ARM, around 89% and 97% of dwellings have no H&C, respectively, while in Funchal the figures are around 88% and 86%.

According to the 2021 census, there were 131,037 classic family dwellings in the ARM: 94,792 as primary residences (72.3%t), 18,266 as secondary residences (13.9%) and 17,979 vacant (13.7%). In Funchal, there were 52,234 conventional dwellings, 40,944 for main residence (78.4%), 4,407 for secondary residence (8.4%) and 6,883 vacant (13.2%).

With the aim of assessing the "habitability conditions of dwellings", the "Survey of Energy Consumption in the Domestic Sector (ICESD) / 2020" was carried out in 2020 for the ARM, promoted by INE/DGEG/DREM. This study showed a domestic energy demand of 502,044 MWh, or 456,222 MWh if we don't take into account the renewable energies that were not purchased or difficult to account for (25,423 MWh biomass and 20,339 MWh solar thermal). Some of the information included in this survey has a high quality standard deviation/coefficient of variation and the figures should be used with caution as the coefficient of variation is greater than 20% (or coefficient of variation < 20% and sample size <= 40 dwellings).

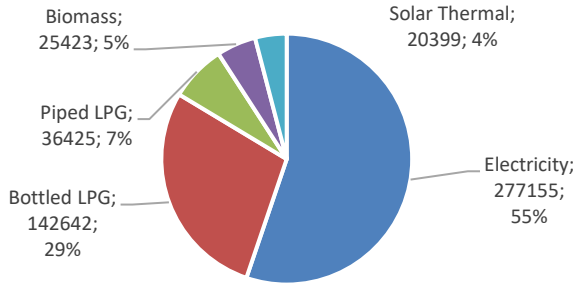


Figure 8: Distribution of residential energy consumption by energy source

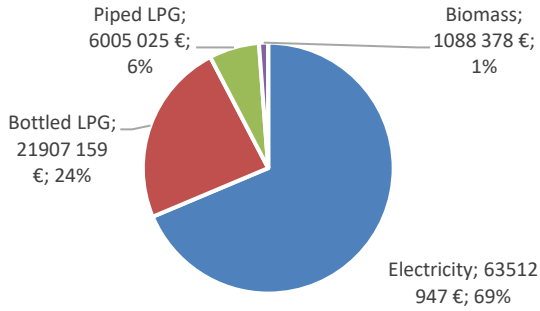


Figure 9: Distribution of household energy costs by energy source

Source: Inquérito ao Consumo de Energia no Sector Doméstico (ICESD) / 2020

The following tables summarise information on the use of H&C:

	Space heating			DHW		
	kWh	Dweeling	kWh/ dweeling	kWh	Dweeling	kWh/ dweeling
Electricity	940 329	16 171	58	10 411 607	30 870	337
LPG Bottle	825 730	602	1 372	69 419 470	41 741	1663
Piped LPG				23 329 780	16 443	1419
Biomass	6 082490	4 358	1 396	3 163 360	2 286	1384
Solar thermal				20 399 020	14 739	1384
Total	**7 848 549**	-	-	**126 723 237**	-	-

Energy consumption in dwellings, by type of use and by type of energy source

Type of use (electricity)	Consumption	Expense
	kWh	€
Space heating	940 329	212 590
Space cooling (air-conditioning)	2 458 552	553 300
Water heating	10 411 607	2 405 106
Total	**13 810 488**	**3 170 996**

Electricity consumption and expenditure in households, by type of use

Type of equipment	dweeling used	Number of equipment per dweeling
	%	equip/ dweeling
LPG water heater	60.2	1.0
Thermoaccumulator	33.0	1.0
Boiler	2.2	1.0
Solar termal system	15.5	1.0
Heat pump	0.4	1.0
Other	1.3	1.0

Equipment used for water heating, by type of equipment

Type of equipment	dweeling used	Number of equipment per dweeling
	%	equip/ dweeling
Air conditioning that only cools, fixed or mobile	8.9	1.1
Fan or ventilator	87.1	1.3
Air conditioning that heats and cools (Heat pumps)	6.6	1.7

Equipment used for space heating and cooling, by type of equipment

Source: Inquérito ao Consumo de Energia no Sector Doméstico (ICESD) / 2020

According to the survey, the estimated energy demand for air conditioning and water heating represents about 27.3% of the energy demand of the ARM residential sector, or 2.3% if air conditioning alone is considered.

Given that the survey sample has a high coefficient of variation and that the 2021 censuses do not have information broken down by new, renovated and existing dwellings, it was also decided to analyse the rate of equipment ownership using data from the ECS which has a consistent sample of 3,556 new, renovated and existing dwellings with an energy certificate issued between 2013 and 2024, representing around 24% of the universe of classic family dwellings.

Energy demand for H&C sector in ARM and Funchal

AREAM is the managing body of the ESC in the ARM, it was possible to carry out a survey of residential and service buildings with energy certificates issued between July 2013 and December 2024, analysing the distribution by energy class, the type of equipment used for H&C and the energy needs for air conditioning (heating, cooling) and DHW in the ARM and the municipality of Funchal, in order to maintain the thermal comfort of this residential and service building stock. The energy needs for H&C were also extrapolated to the universe of existing service and residential buildings.

The climatology used for the purposes of the ECS in the ARM implies an adjustment of temperatures for the location of the buildings according to altitude. In the ECS, the reference altitude for ARM is 380 metres, with the highest temperatures below this level and the lowest at higher altitudes. The following figure shows the average, maximum and minimum monthly temperatures for ARM for the reference altitude.

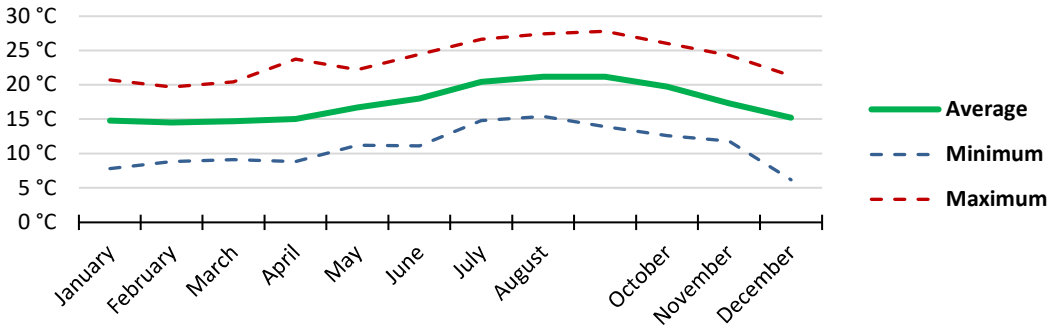


Figure 10: Average monthly temperature for the ARM for the reference altitude according to the ECS methodology

Source: Aclimac Project

According to the ECS methodology, most of these buildings are located in winter climate zone I1 and summer climate zone V2. The following figures show the different winter and summer climate zones for the islands of Madeira and Porto Santo, depending on their geographical location, as well as the respective criteria for determining these climate zones.

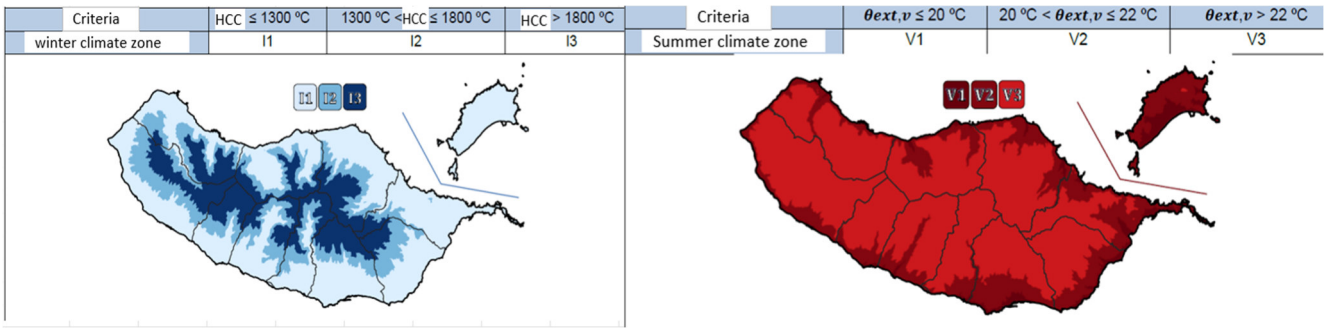


Figure 11: Winter and summer climate zones for ARM, according to their geographical location

Source: Aclimac Project

The distribution of energy classes of the certified building stock in Madeira is as follows:

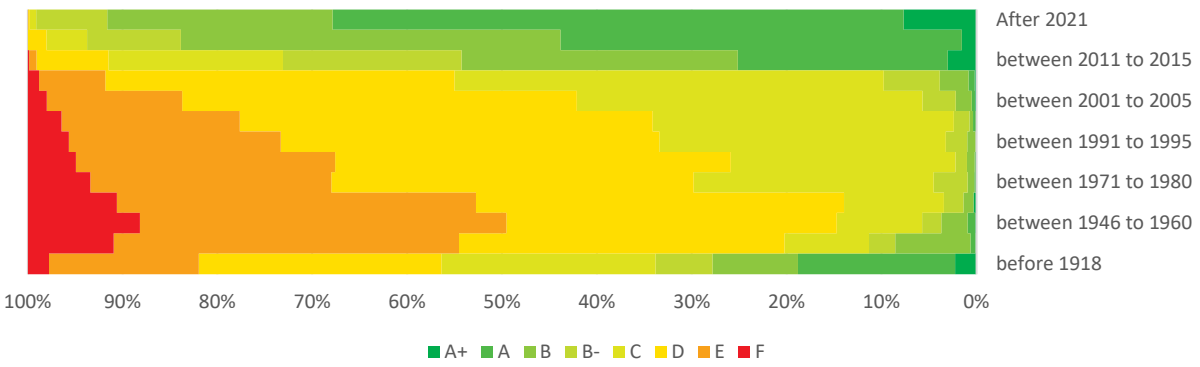


Figure 12: Distribution of energy labels in dwellings with an energy certificate in the ARM according to date of construction

Source: Energy Certification processing data -AREAM

The following figures show the distribution of energy classes by type of residential and service building with an energy certificate in the ARM and Funchal.

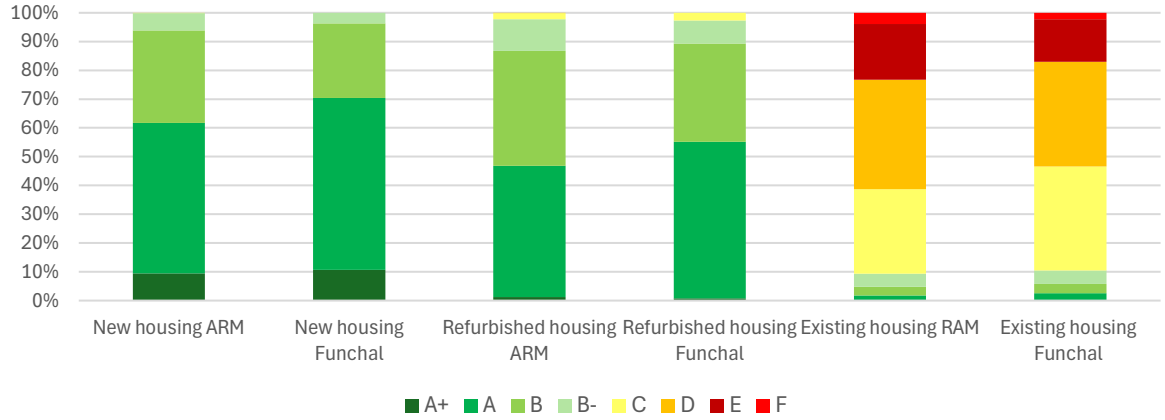


Figure 13: Distribution of energy labels in ARM and Funchal by type of certificate for residential buildings

Source: Energy Certification processing data -AREAM

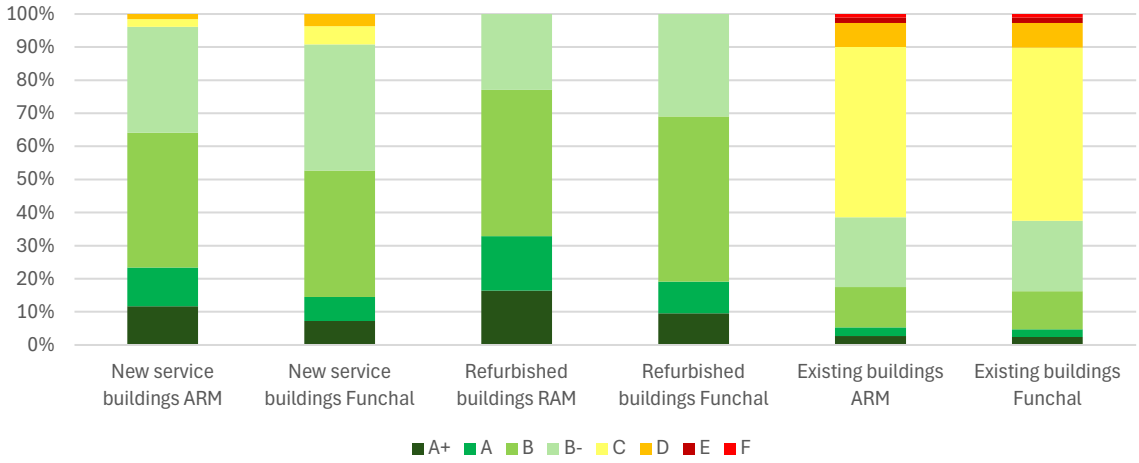
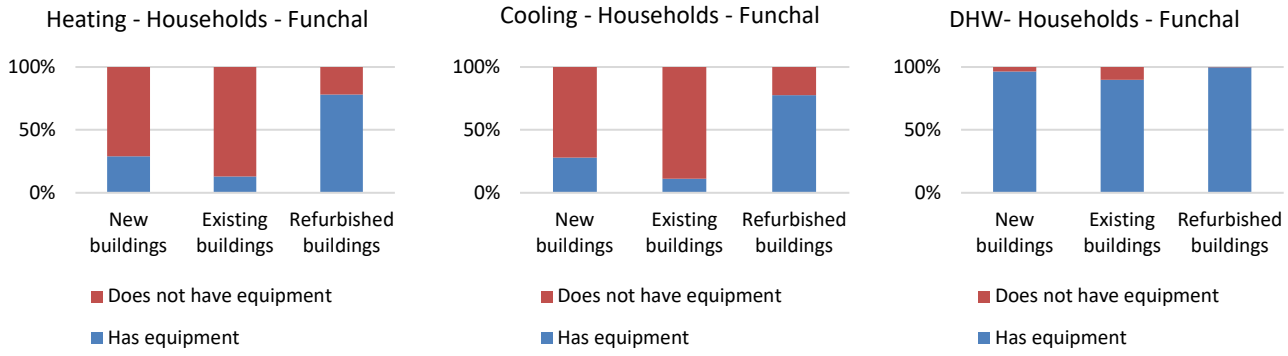


Figure 14: Distribution of energy classes in ARM and Funchal by type of certificate for service buildings

Source: Energy Certification processing data -AREAM

The following figures show the use of H&C equipment in residential and service building with an energy certificate in the ARM and Funchal.



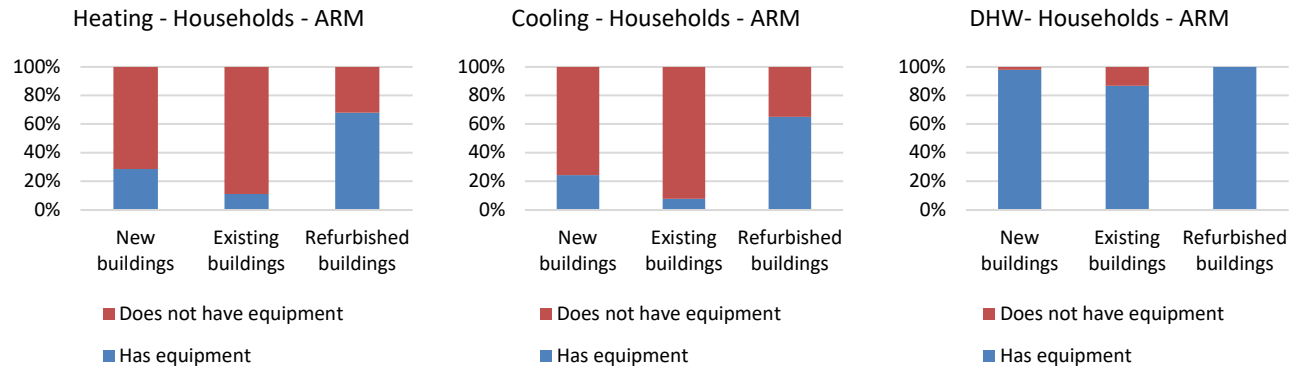


Figure 15: Share of H&C equipment in residential buildings with energy certification (ARM and Funchal)

Source: Energy Certification processing data-AREAM

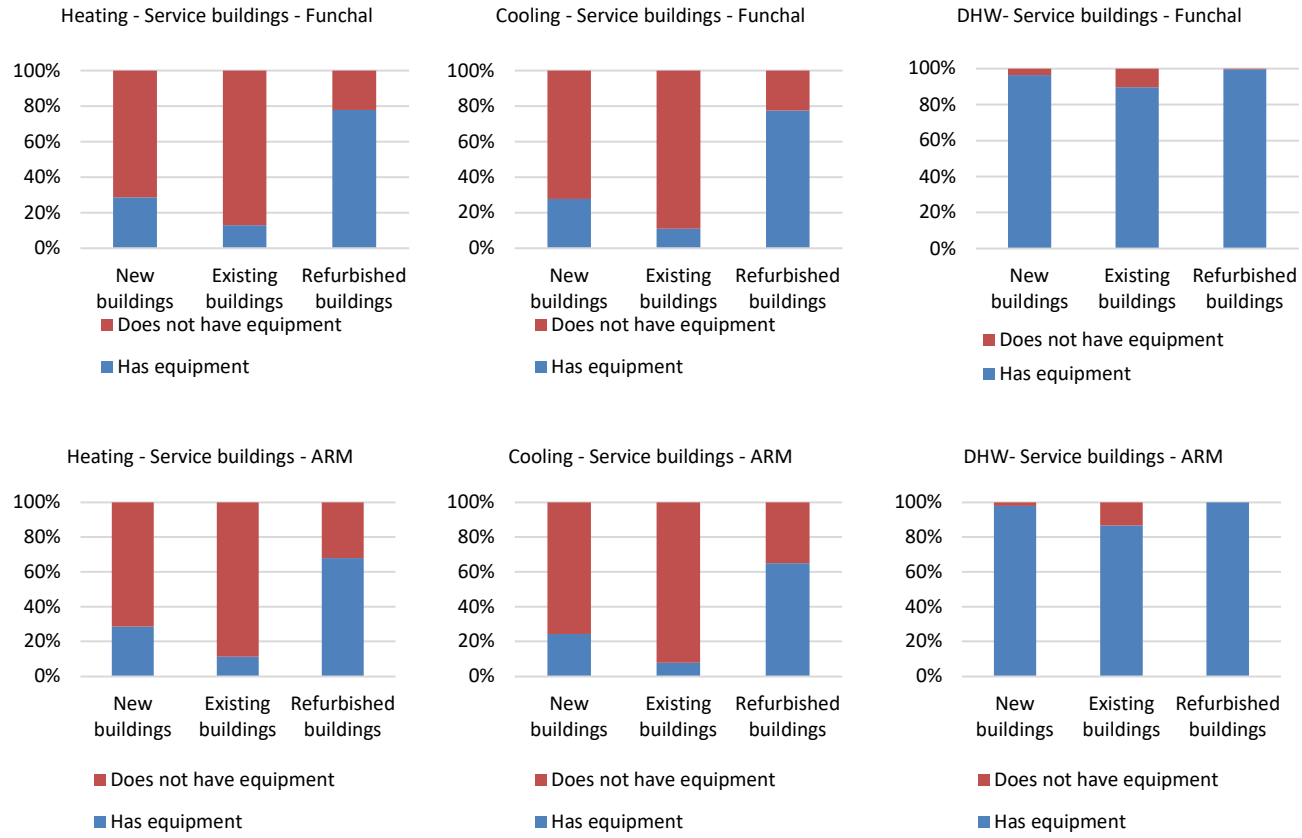


Figure 16: Share of H&C equipment in service buildings with energy certification (ARM and Funchal)

Source: Energy Certification processing data-AREAM

The following figures show the source of energy for H&C needs and type of equipment installed in residential and service building with an energy certificate in the ARM and Funchal.

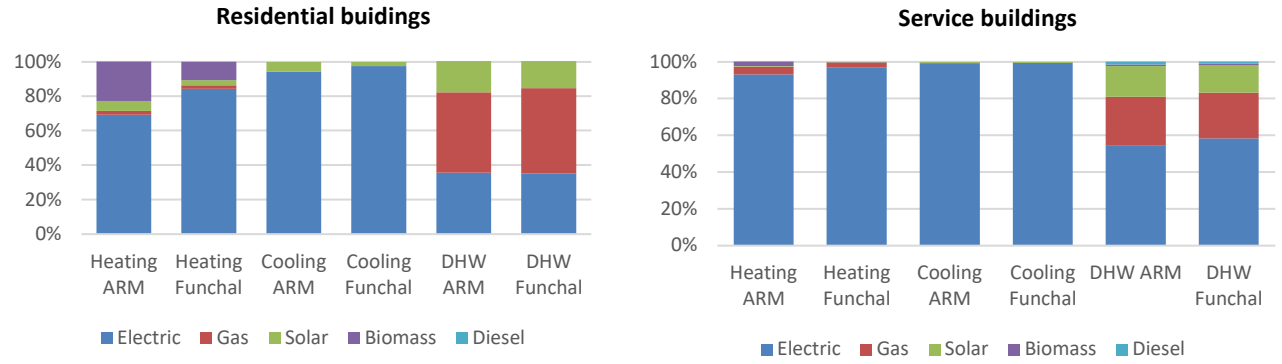


Figure 17: Source of energy for H&C needs in residential and services building with energy certification (ARM and Funchal)

Source: Energy Certification processing data-AREAM

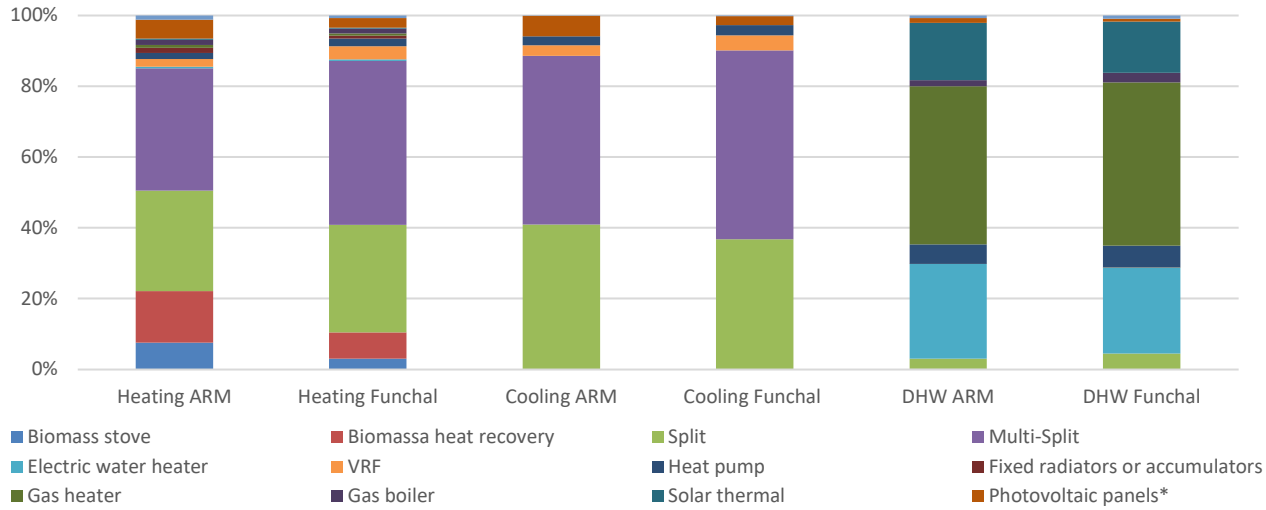


Figure 18: Type of equipment installed for H&C needs in residential buildings with energy certification (ARM and Funchal)

*Electricity production for H&C equipment support
Source:Energy Certification processing data-AREAM

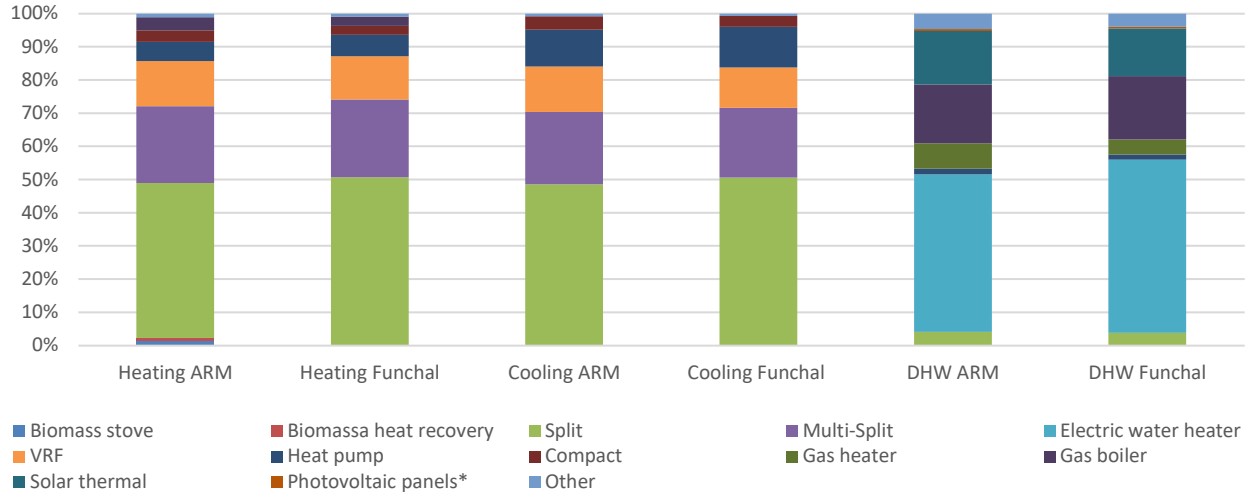


Figure 19: Type of equipment installed for H&C needs in service buildings with energy certification (ARM and Funchal)

*Electricity production for H&C equipment support
Source:Energy Certification processing data-AREAM

The following figures show the source of energy for H&C needs and type of equipment installed in tourist accommodation considered to be large service buildings with an energy certificate in the ARM and Funchal.

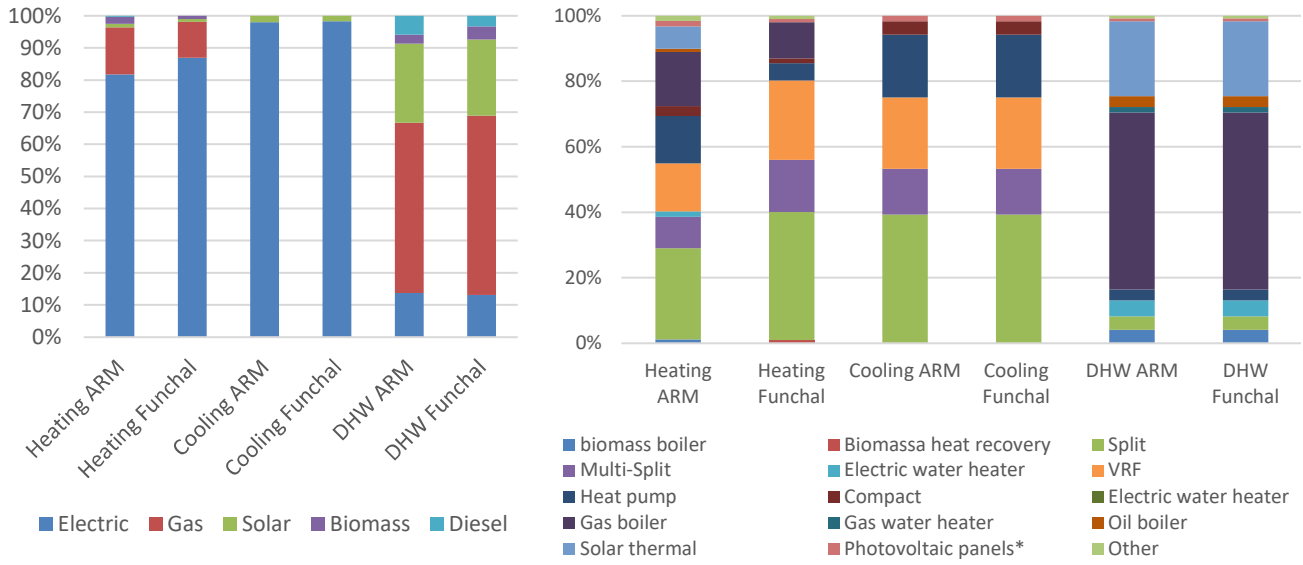
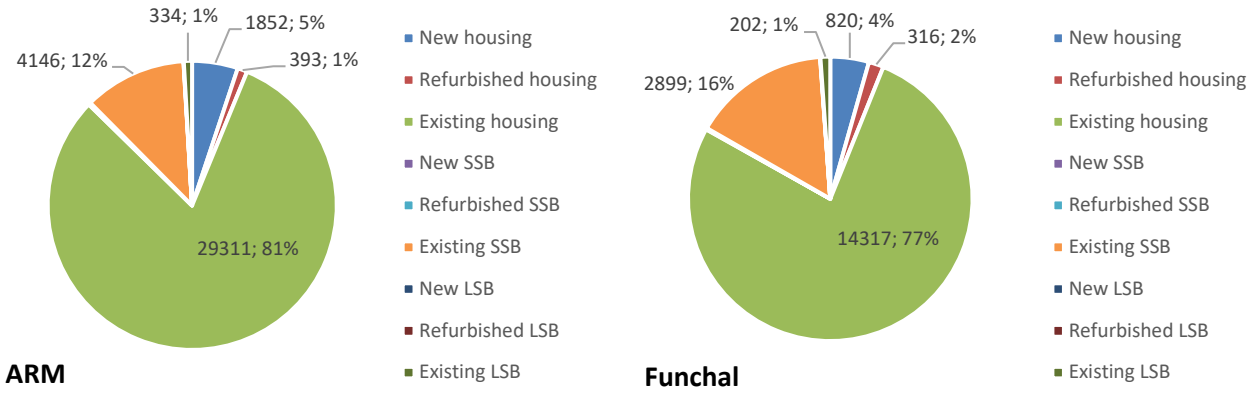


Figure 20: Source of energy for H&C needs and type of equipment installed in tourist accommodation in the ARM and Funchal

*Electricity production for H&C equipment support
Source:Energy Certification processing data-AREAM

By cross-checking the information with the 2021 census data, it can be seen that around 24% and 29% of the traditional family dwellings in the ARM and the Municipality of Funchal, respectively, have an energy certificate. The following table shows the distribution of energy certificates by type of certificate and building in the ARM and Funchal. This analysis does not include pre-certificates, as these are energy certificates issued at the design stage of the building, so there is no risk of duplication of information, as final energy certificates are issued after the building has been authorised for use.

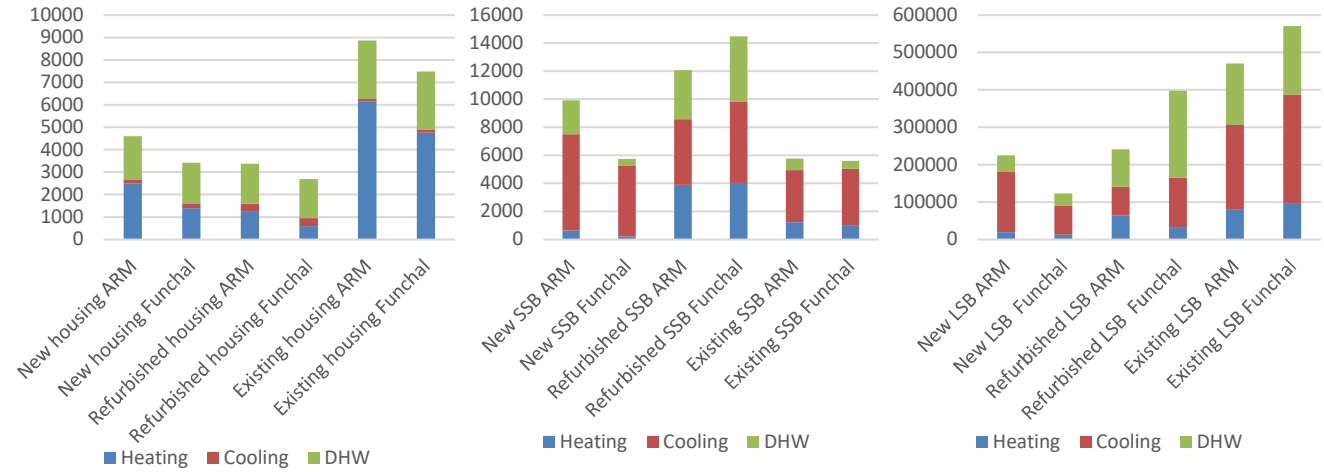


SSB- Small service buildings; LSB- Large service buildings

Figure 21: Distribution of energy certificates according to type of certificate and building in ARM and Funchal

Source: Energy Certification processing data -AREAM

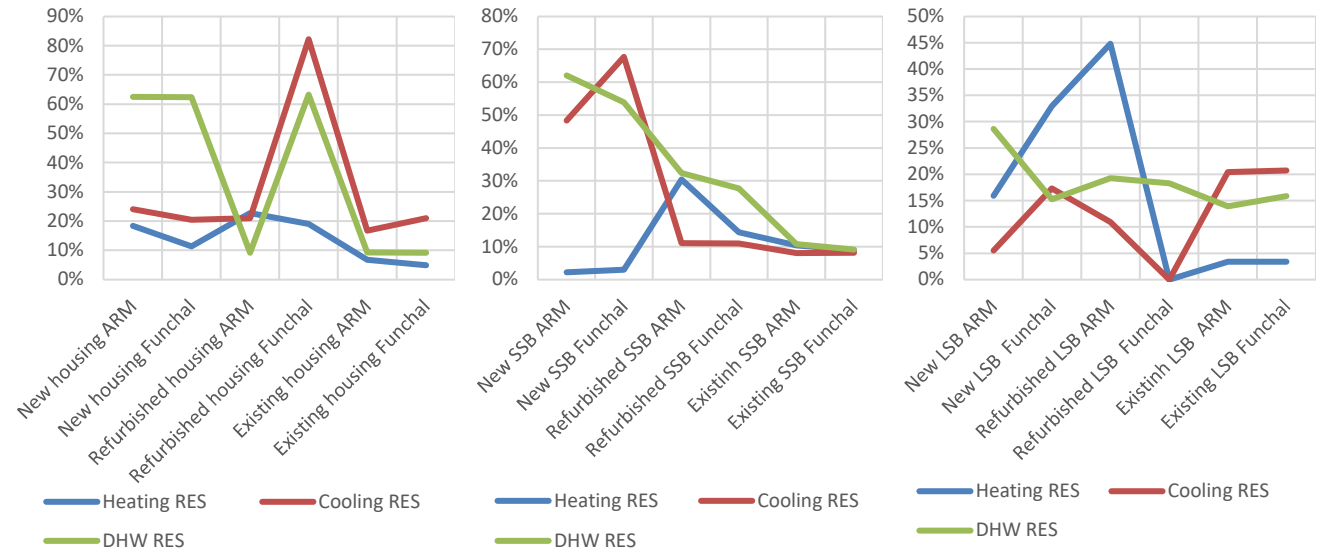
The following figures shows the average annual H&C demand according to the energy certificate framework and share of RES in H&C needs.



SSB- Small service buildings; LSB- Large service buildings

Figure 22: Average annual H&C energy needs according to the framework of the energy certificate (ARM and Funchal) per dweeling/building (kWh)

Source: Energy Certification processing data -AREAM



SSB- Small service buildings; LSB- Large service buildings

Figure 23: Share of RES in the average annual H&C needs according to the framework of the energy certificate (ARM and Funchal)

Source: Energy Certification processing data -AREAM

The following table shows the H&C demand for the certified building stock and the estimate for the total building stock (ARM and Funchal).

Table 40: H&C needs for the certified building stock and estimates for the entire building stock (ARM and Funchal)

		Energy needs (MWh)			Estimated energy needs for buildings universe (MWh)				
		Heating	Cooling	DHW	Nº	Heating	Cooling	DHW	Total
ARM	New, refurbished and existing housing	185058	3809	81008	132 406	804197	15341	344993	1164531
	New, refurbished and existing SSB	5211	15996	3620	Est. 17 430	21021	64249	14155	99425

Funchal	New, refurbished and existing LSB	27692	77297	55934	344	27692	77297	55934	160922
	Total	**217 961**	**97 103**	**140 562**	**150 180**	**852 910**	**156 887**	**415 082**	**1 424 879**
	New, refurbished and existing housing	69395	2309	39071	52 757	246755	7570	135555	389880
	New, refurbished and existing SSB	2909	11917	1755	Est. 9 957	9543	39438	5653	54634
	New, refurbished and existing LSB	19709	59397	37682	344	19709	59397	37682	116788
	Total	**92 013**	**73 624**	**78 508**	**3 058**	**276 007**	**106 405**	**178 890**	**561 302**

Source: Energy Certification processing data -AREAM

The total number of residential buildings in the ARM is estimated at 1,167 GWh (69.2% heating, 1.2% cooling and 29.6% DHW). The total number of residential buildings in the municipality of Funchal is estimated at 391 GWh (63.4% heating, 1.9% cooling and 34.7% DHW).

The estimated energy demand for heating, cooling and DHW took into account the methodology used by the ECS to ensure that the occupants of residential buildings have all the comfort conditions they need to use their dwellings all year round.

Table 41: Estimate of energy consumption and H&C needs in all dwellings in ARM and Funchal

	Estimated consumption in housing (MWh)			Energy needs of the residential building universe (MWh)			Share of energy consumption in relation to energy needs		
	Heating	Cooling	DHW	Heating	Cooling	DHW	Heating	Cooling	DHW
ARM	7 849	2 459	126 723	804 197	15 341	344 993	1,0%	16,0%	36,7%
Funchal	3 311	1 037	53 461	246 755	7 570	135 555	1,3%	13,7%	39,4%

Source: Inquérito "Condições de habitabilidade dos alojamentos" and Energy Certification processing data -AREAM

Given the importance of the tourism sector to the economy and energy demand of the ARM, an analysis of the energy demand for heating, cooling and DHW in tourist accommodation was carried out. Using ECS data as a reference (surface area, energy needs for heating, cooling and DHW) for hotels with a 'Large Service Buildings' energy certificate and data of rooms and beds per tourist accommodation, the following energy needs was obtained for the ARM and Funchal.

Table 42: Energy needs for tourist accommodation in ARM and Funchal

	Energy needs for LSB tourist accommodation with energy certificate (MWh)						Estimated energy needs for the universe tourist accommodation (MWh)					
	Nº	Beds	Heating	Cooling	DHW	Total	Nº	Beds	Heating	Cooling	DHW	Total
ARM	117	29536	17 476	43 045	37 374	97 895	440	38 930	22 901	52079	45 217	120 196
Funchal	64	19185	12755	34657	24921	72333	194	24 527	16307	44307	31860	92473

Source: Energy Certification processing data-AREAM

It was found that the sample of hotel units with energy certificates represents about 86% of the total beds in the universe of tourist accommodations in the ARM. According to estimates, tourist accommodation represents about 46% of the total needs identified for the universe of service buildings. The following figures present indicators of energy needs in hotel accommodations in the ARM and Funchal.

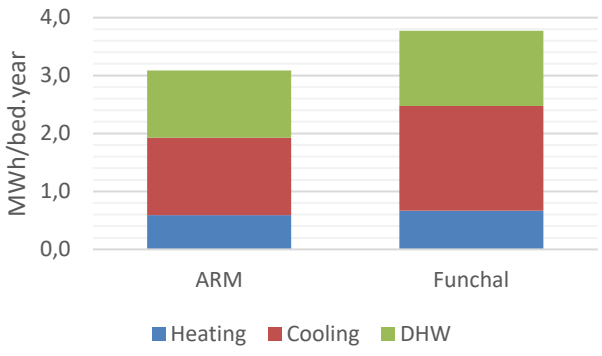


Figure 24: Energy requirement per bed per year

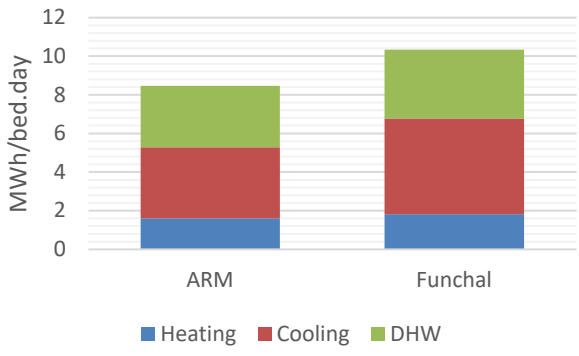


Figure 25: Energy requirement per bed per day

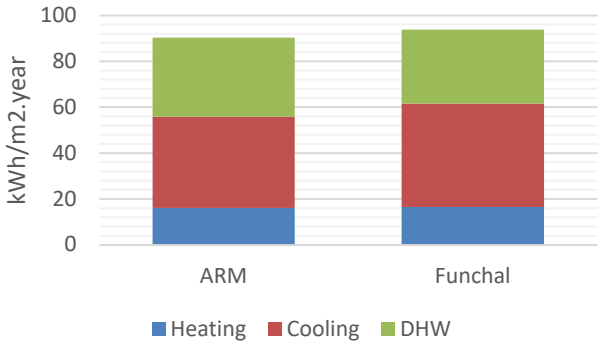


Figure 26: Energy needs per m2

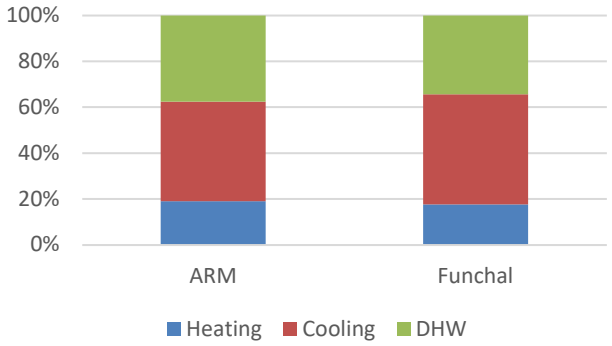


Figure 27: Share of energy needs per bed per year

Source: Energy Certification processing data-AREAM

According to the short, medium and long-term climate scenarios, an increase in average temperatures in the various seasons of the year is expected in the ARM, which will cause changes in the energy needs for H&C.

Table 43: Expected changes in energy needs for H&C in residential and service buildings

Heating	Cooling	DHW
SSP2 and SSP5 (autumn and winter): Temperature increase of between 0.9ºC-5.1ºC -Reduction in needs compared to the current situation	SSP2 and SSP5 (Spring and Summer): Temperature increase of between 0.4ºC-5.3ºC -Increase in needs compared to the current situation	Reduction in energy needs compared to the current situation

The local energy supply in RAM and Funchal

Between 2020 and 2023 the new installed power in a production unit for self-consumption (Residential, services and industry) (UPAC) on ARM is 13.8MW (1792 registered UPACs) with estimated production of 20.3 GWh. In Funchal the new installed power is 5MW (600 registered UPACs) with estimated production of 7.3 GWh. In Funchal, 9.7 GWh of electricity was generated through RES (through Hydro plants and surplus electricity from UPACs injected into the electricity grid), corresponding to 1% of Funchal's final energy consumption.

In the ARM there are three thermal power plants of regional scope, two under the responsibility of Empresa de Eletricidade da Madeira located in the municipality of Câmara de Lobos and another private under the responsibility of Atlantic Islands Electricity located in the municipality of Machico and Porto Santo Island.

The private thermal power plant in 2023 produced around 198 GWh, with all the electricity produced supplied to the Madeira Electricity Company (EEM), which subsequently transports and distributes it.

The following table presents the installed capacity and energy storage in 2023 and the increase in RES installed capacity and energy storage capacity foreseen in SECAP-ARM and SECAP-Funchal.

Table 44: Installed power capacity and energy storage in 2023 and the increase in RES installed capacity and energy storage capacity provided

ARM	Nº	Installed power 2023 (MW)	Production 2023 (GWh)	Increased capacity SECAP-ARM (2020-2030)
Fossil fuel plants	3	223.0	675.9	
Hydro	11	77.2	66.7	34.8 MW (reversible)
Wind	13	63.8	115.1	31 MW
Waste	1	8.8	43.0	
Photovoltaic[1]	2486	35.3	36.2	28.8 MW (28MWh of storage)
Biomass	-			1MW
Funchal	**Nº**	**Installed power (MW)**	**Production 2023 (GWh)**	**Increased capacity SECAP-Funchal (2020-2030)**
Hydro	2	2,4	7,5	-
Photovoltaic[2]	>600	> 5	2,1	10 MW

1 Includes PRE ('Special Regime Production'), micro-production, mini-production and registered UPACs. In ARM, 7.2 MW are installed in UPACs with a contract to sell surplus energy to the grid.

2 Includes microproduction, mini-production and registered UPACs. Production corresponds to surplus energy injected into the grid.

Source: EEM Annual Report 2023 and ARM and Funchal SECAPs

The following table presents the complementary support systems of the power generation system in 2023.

Table 45: Complementary support systems for the electricity generation system in 2023

	Socorridos pumping station	Calheta III pumping station	Madeira battery station	Porto Santo battery station
ARM	Madeira	Madeira	Madeira	Porto Santo
Installed capacity (MW)	11.3	16.5	15	4.3
Installed capacity (MWh)	40	100	16.4	3.3
Entrada em Operação	2006	2021	2022	2020

Source: EEM Annual Report 2023

In SECAP-ARM, an increase of about 180MW of RES for self-consumption is planned by 2030, accompanied by an increase of 150 MWh in storage capacity in the residential sector, tertiary, primary and secondary. In SECAP-Funchal, an increase of about 100 MW of RES for self-consumption for self-consumption is planned by 2030, accompanied by an increase of 80 MWh of storage capacity. The following table shows the increase in the installed capacity of RES for self-consumption and the energy storage capacity foreseen in the SECAP-ARM and SECAP-Funchal.

Table 46: Increase in installed RES capacity for self-consumption and energy storage capacity in ARM and Funchal

Expected increase in RES between 2020 and 2030 for self-consumption	SECAP-ARM		SECAP-Funchal	
	Solar PV	Battery	Solar PV	Battery
Residential sector	69 MW	45 MWh	57 MW	40 MWh
Tertiary sector	66MW	64 MWh	29 MW	27MW
Primary and secondary sectors	44MW	44MWh	15MW	15MWh

4. Activation of H&C target groups

According to the various sectors that will be included in the local H&C Plan, the following stakeholders and relevant local target groups and stakeholders have been identified, to involve them in the various stages of development and discussion of the ARM and Funchal SLHCPs. The following table shows the H&C stakeholders and target groups:

Table 47: H&C stakeholders and target groups

STAKEHOLDER	TARGET GROUP
Direção Regional de Energia	Regional Autority for Energy
Direção Regional de Ambiente e Mar	Regional Autority for Enviroment
Direção Regional de Estatística da Madeira	Regional Autority for Statistics
Secretaria Regional de Educação, Ciência e Tecnologia	Regional Autority
Secretaria Regional de Saúde e Proteção Civil	Regional Autority for Health and and Civil Protection
IPMA – Instituto Português do Mar e da Atmosfera - Delegação Regional da Madeira	National authority. Responsibilities at national level in the fields of the sea and the atmosphere ARM delegation
PATRIRAM – Titularidade e Gestão de Património Público Regional, S.A.	Regional Autority
Municipio do Funchal	Local Autority
Município de Câmara de Lobos	Local Autority
Município de Machico	Local Autority
Município de Santa Cruz	Local Autority
Município da Ribeira Brava	Local Autority
Município de Santana	Local Autority
Município de São Vicente	Local Autority
Município do Porto Moniz	Local Autority
Município do Porto Santo	Local Autority
Município da Calheta	Local Autority

Município da Ponta do Sol	Local Autority
AMRAM	Association of Municipalities
IDE	Financing bodies and institutions
IDR	Financing bodies and institutions
Instituto para a Qualificação, IP-RAM	Regional Autority
EEM	Infrastructure and public service providers
ACIF -CCIM - Associação Comercial e Industrial do Funchal	Business support and trade associations (turism and industry)
Investimentos Habitacionais da Madeira, EPERAM	Public entity with responsibility for implementing the housing policy of the Regional Government of Madeira
Sociohabita Funchal	Public entity with responsibility for implementing the housing policy of Funchal City Council
Universidade da Madeira	Academia and research organisations
Laboratório Regional de Engenharia Civil	Academia and research organisations
Ordem dos Engenheiros	professional association representing engineers
Ordem dos Engenheiros técnicos	professional association representing technical engineers
Ordem dos Arquitetos	professional association representing architects
Qualified energy certification experts	Technicians responsible for the energy assessment of buildings and issuing the Energy Certificate
DECO	Consumer association
Quercus	Environment associations and NGOs
APIERAM	Association of renewable energy producers
ASSICOM - Associação dos Industriais de Construção da Madeira	Industry and Construction association
FACTORENERGIA – Tecnologias de Energia e Ambiente, Lda.	ESCO
INTELSOL – Projectos e Instalações Eléctricas, Lda.	ESCO
Grupo Pestana	hotel group
Grupo Savoy	hotel group and construction companie

In an initial phase, a survey will be carried out aimed at regional and local stakeholders, with the aim of assessing the level of awareness and knowledge about the energy transition and climate change, the identification of problems, obstacles and needs in air conditioning (heating and cooling) and DHW. It also allows the identification of the training needs of technicians, to allow the development of personalized tools and materials, the active training of their local and regional authorities and direct cooperation. It is also planned to hold a close meeting with the working group (stakeholders) to prioritize the barriers and opportunities in the H&C area, as well as to highlight which improvement measures will be a priority to include in Funchal and ARM SLHCPs.

In this preliminary phase of analysis, the following barriers and opportunities to the development of the SLHCPs for Funchal and ARM were identified.

Table 48: Main barriers and opportunities identified to the development of SLHCPs

Main Barriers	Main Opportunities
Lack of data for H&C needs Lack of skills to develop energy efficient projects Lack of information and dissemination about the solutions to be adopted by buildings users	Tools to promote building renovation Improved information on the solutions to be adopted by buildings users Improved knowledge of energy consumption to H&C Access to incentives and supporting schemes

5. Summary in national language

A) Contexto territorial local

O Arquipélago da Madeira é constituído por duas ilhas habitadas, a Madeira e o Porto Santo, que distam entre si cerca de 42 quilómetros. A ilha da Madeira tem uma superfície de 736,75 km2, sendo o concelho do Funchal responsável por cerca de 10% da superfície total da ilha (76 quilómetros quadrados). O concelho do Funchal caracteriza-se por possuir declives acentuados desde o nível do mar até uma altitude de 1 800 metros, com uma população muito dispersa. Segundo dados de amostra do Sistema de Certificação Energética (SCE), cerca de 75% dos edifícios residenciais existentes no Funchal situam-se a altitudes inferiores a 300m, com uma altitude média de cerca de 205m.

De acordo com os resultados preliminares dos censos de 2021, a população residente na Região Autónoma da Madeira (RAM) era, à data, de 251 060 habitantes, concentrando o concelho do Funchal cerca de 43% da população da Ilha da Madeira, com 105 782 habitantes, e apresenta uma densidade populacional de 1 449 habitantes/km2, o que evidencia a elevada concentração populacional no Funchal.

Em 2022, o maior contributo para o VAB da RAM provém das atividades do sector terciário (82% do VAB), com uma forte presença de atividades relacionadas com o turismo e o comércio. Embora não existam dados disponíveis para o concelho do Funchal, o peso do sector terciário é ainda maior, uma vez que aí se concentra uma grande parte das atividades de serviços.

A RAM é caracterizada por um clima subtropical (ameno tanto no inverno como no verão), o que significa que é necessária mais energia para arrefecer do que para aquecer. Relativamente ao nível do mar, verifica-se um gradiente térmico de cerca de 1°C /100m com o aumento da altitude. Entre 1976 e 2019, a temperatura média anual na estação Funchal/Observatório variou entre 18,1°C (temperatura registada em 1976 e 1984) e 20,6°C (valor registado em 2004 e 2019). Comparando o período 1976-1980 com o período 2015-2019, a temperatura média anual no primeiro período foi de 18,5°C, enquanto no segundo foi de 20,3°C, um aumento de 1,8°C.

B) Contexto político e estratégico de referência

B.1) Contexto nacional

No contexto nacional, o consumo final total de energia (TFEC) para o setor do aquecimento e arrefecimento foi de quase 6,2 Mtep em 2018, representando 36% do consumo final de energia (CFE) de Portugal. A quota de energias renováveis no CFE no setor do aquecimento e arrefecimento foi de 41,2 % em 2018. As trajetórias estimadas para o CFE no setor do aquecimento e arrefecimento mostram uma diminuição de 7,4% de 2020 a 2030 (fonte: PNEC/2024).

Nas principais políticas de promoção das fontes de energias renováveis (FER) no setor do aquecimento e arrefecimento destaca-se a promoção de sistemas solares térmicos, caldeiras renováveis e sistemas híbridos que combinam duas ou mais tecnologias e a promoção da adoção de tecnologias mais eficientes, incluindo a ventilação, a combustão, a recuperação de calor e o arrefecimento industrial.

B.2) Contexto Regional

No contexto regional, a RAM dispõe de Plano de Ação para a Energia e Clima (PAESC-RAM) aprovado em 2022, que está alinhado com as políticas Nacionais e Europeias e define os objetivos e metas para os horizontes temporais 2030 e 2050 nos domínios da Energia e Clima, de acordo com o Regulamento (EU) 2018/1999 do Parlamento Europeu e do Conselho e com o PNEC, o que permitirá à Região realizar de forma eficaz a monitorização e o reporte de informação dos seus contributos para o plano nacional. O PAESC-RAM apresenta-se como um instrumento orientador da estratégia regional para a segurança do abastecimento, a redução da dependência do exterior, a eficiência energética, o aproveitamento dos recursos energéticos endógenos e a minimização dos impactes ambientais negativos associados à utilização de combustíveis fósseis.

Indicadores	Metas	
	2030	2050
Recursos energéticos renováveis na procura de energia primária	18%	60%
Recursos energéticos renováveis na produção de eletricidade	55%	95%
Redução do consumo de combustíveis fósseis em relação a 2005	45%	85%
Redução das emissões de gases com efeito de estufa em relação a 2005	55%	85%

O PAESC-RAM apresenta um conjunto de ações com impacto na procura de energia para o setor do aquecimento e arrefecimento e no combate à pobreza energética. A RAM dispõe de 6 PAESC locais, com destaca-se para o PAESC-Funchal, sendo a tipologia de ações muito semelhantes às do PAESC-RAM. Destacam-se as seguintes ações: desenvolvimento uma estratégia regional de longo prazo para o combate à pobreza energética; reforço de proteção de consumidores vulneráveis, criação e renovação do parque edificado de habitação social e de habitações de famílias vulneráveis; promoção da eficiência energética e as energias renováveis para mitigação da pobreza energética; fomentar soluções de elevada eficiência e sistemas de gestão de energia nos edifícios; fomentar a eletrificação dos consumos de energia nos edifícios; melhorar o conforto térmico nos edifícios; promover a renovação dos edifícios; promover os edifícios NZEB; promover soluções de elevada eficiência e sistemas de gestão de energia na indústria e construção; melhorar a eficiência energética nos serviços públicos; criar incentivos para a eficiência energética; atenuar o efeito de ilha de calor e promoção de formação de técnicos e especialistas e de campanhas de informação e sensibilização da população.

B.3) Contexto Local

Em 2011 o Município do Funchal aderiu ao Pacto de Autarcas e elaborou um PAES. Em 2018, o Município renovou o seu compromisso com a adesão ao Pacto de Autarcas Energia e Clima e elaborou um PAESC onde definiu objetivos e metas mais ambiciosos em resposta à emergência climática, e comprometeu-se a reduzir as emissões com gases com efeito de estufa em pelo menos 40% até 2030.

Objetivos		Metas Monitorização 2023	Metas	
			2030	2050
1.	Reduzir o consumo de energia final em relação a 2010	**10%**	39%	77%
2.	Aumentar a utilização de energias renováveis em relação a 2010	**8%**	170%	244%
3.	Reduzir o consumo de combustíveis fósseis em relação a 2010	**14%**	51%	92%
4.	Redução das emissões de gases com efeito de estufa em relação a 2010	**8%**	45%	86%

C) Sistema energético local

Sendo a RAM uma ilha com sistema elétrico isolado é pertinente apresentar o sistema energético da RAM e do concelho do Funchal. Nos balanços energéticos foi considerada a energia elétrica e os combustíveis que são efetivamente adquiridos, não se considerando o solar térmico, a energia solar fotovoltaica para autoconsumo no consumo final, a fração renovável das bombas de calor e a biomassa consumida na habitação por ser difícil de contabilização, mas considerando-se a biomassa consumida nas caldeiras das indústrias, nos equipamentos de panificação, e nas caldeiras a biomassa das unidades hoteleiras, devido a esta informação ser relativamente fácil de recolher.

A energia renovável produzida localmente integra a energia excedente elétrica produzida pelos sistemas solares fotovoltaico que é injetada na rede elétrica, uma vez que o produtor é remunerado por essa energia. Não existe rede de calor na RAM para os edifícios de habitação e serviços, no entanto, é produzido vapor na central térmica do Caniçal, sendo fornecido a instalações fabris da Zona Franca Industrial da Madeira, no havendo preceptivas de aumentar a produção do futuro.

C.1) Procura de energia final na RAM

Ano	Residential	Primary Sector	Secondary Sector	Tertiary Sector	Transport	Energia		Emissoes GEE
	[MWh]					[MWh]	[Tep]	[t CO2 eq]
2009	473 583	32 274	146 007	667 014	1 964 318	**3 283 196**	**282 304**	**1 239 972**
2019	452 775	29 244	174 818	560 900	1 759 344	**2 977 081**	**255 983**	**1 048 095**
2023*	469 394	26 524	156 517	588 488	1 702 503	**2 943 425**	**253 089**	**1 037 484**
Variation 2009-2023	-0,9%	-17,8%	7,2%	-11,8%	-13,3%	-10,3%	-10,3%	-16,3%

C.2) Procura de energia final no Funchal

	2010	2017	2020	2023	Variação 2010-2023
Consumo final de energia [MWh]:	**1 340 498**	**1 130 633**	**964 229**	**1 208 624**	**-9,80%**
Edifícios municipais, equipamentos/instalações	7525	7311	6687	7453	-1%
Iluminação pública	19282	17222	16240	14962	-22%
Edifícios terciários (não municipais), equipamentos/instalações	361102	320713	248314	323285	-11%
Edifícios residenciais	214409	179799	198181	197212	-8%
Indústria	36249	51289	53898	57139	55%
Frota municipal	9510	7731	7007	7778	1%
Transportes públicos	83613	43640	42399	71095	-15%
Transportes privados e comerciais	593412	491860	389776	525303	-11%
Agricultura, silvicultura, pesca	15396	11068	1726	4398	-71%

C.3) Procura de energia para o setor do aquecimento e arrefecimento na RAM e no Funchal

De acordo com a análise preliminar realizada foi possível constatar que não existe monitorização oficial que permita avaliar a procura de energia para aquecimento e arrefecimento na RAM e no Funchal nos diversos setores.

Os censos 2021 permitiram avaliar a utilização de equipamentos para aquecimento e arrefecimento no setor residencial, verificando-se uma reduzida utilização de equipamentos para o aquecimento e arrefecimento para manter as condições de conforto nas habitações na RAM e no Funchal. Na RAM cerca de 89% e 97% das habitações não possuem equipamentos para aquecimento e arrefecimento, respetivamente, enquanto no Funchal são cerca de 88% e 86%.

Em 2020 foi realizado na RAM o "Inquérito ao Consumo de Energia no Sector Doméstico (ICESD). Deste inquérito resultou uma procura de energia estimada na habitação de 502 044MWh, 456 222 MWh se não contabilizarmos as energias renováveis não adquiridas/difícil contabilização (25 423 MWh biomassa e 20 339 MWh solar térmico). Parte da informação incluída neste inquérito apresenta um desvio padrão de qualidade/ coeficiente de variação elevado, sendo que os valores devem ser usados com precaução, pois o coeficiente de variação é superior a 20% (ou o coeficiente de variação < 20% e dimensão amostral <= 40 alojamentos). De acordo com o inquérito, a procura de energia estimada para climatização e AQS representa cerca de 27,3% da procura de energia do setor doméstico da RAM, 2,3% contabilizando somente a climatização.

Devido à amostra do inquérito apresentar coeficiente de variação alto e referir somente a RAM e os censos 2021 não ter a informação desagrupada para habitação nova, renovada e existente, optou-se também por analisar a taxa de posse de equipamentos através dos dados do Sistema de Certificação Energética (SCE), que apresenta uma amostra consistente de 31 556 alojamento de habitação novas, renovadas e existentes com

certificado energético emitido entre 2013 e 2024, representando cerca de 24% do universo dos alojamentos familiares clássicos.

C.4) Necessidade de energia para o setor do aquecimento e arrefecimento na RAM e no Funchal (dados SCE)

Realizando o cruzamento de informação com os dados dos censos 2021, verifica-se que cerca de 24% e 29% dos alojamentos familiares clássicos possuem certificado energético na RAM e no concelho do Funchal, respetivamente.

Necessidades de aquecimento e arrefecimento do parque edificado certificado e estimativas para todo o parque edificado (RAM e Funchal)

		Necessidade de energia (MWh)			Estimativa das necessidades energéticas do universo dos edifícios (MWh)		
		Aquecimento	Arrefecimento	AQS	Aquecimento	Arrefecimento	AQS
RAM	Habitação nova, remodelada e existente	185058	3809	81008	804197	15341	344993
	Pequenos serviços novos, remodelados e existentes	5211	15996	3620	21021	64249	14155
	Grandes serviços novos, remodelados e existentes	27692	77297	55934	27692	77297	55934
	Total	**217 961**	**97 103**	**140 562**	**852 910**	**156 887**	**415 082**
Funchal	Habitação nova, remodelada e existente	69395	2309	39071	246755	7570	135555
	Pequenos serviços novos, remodelados e existentes	2909	11917	1755	9543	39438	5653
	Grandes serviços novos, remodelados e existentes	19709	59397	37682	19709	59397	37682
	Total	**92 013**	**73 624**	**78 508**	**276 007**	**106 405**	**178 890**

No universo dos edifícios de habitação da RAM estima-se uma necessidade de energia para aquecimento e arrefecimento de 1 167 GWh (69,2% aquecimento, 1,2% arrefecimento e 29,6% AQS). No universo dos edifícios de habitação do concelho do Funchal estima-se uma necessidade de energia para aquecimento e arrefecimento de 391 GWh (63,4% aquecimento, 1,9% arrefecimento e 34,7% AQS).

Considerando-se que o setor do turismo apresenta um peso relevante na economia da RAM, foi realizada uma análise para as necessidades de energia para o aquecimento, arrefecimento e AQS dos alojamentos turísticos. Utilizando como referência dos dados do SCE (área útil, necessidade de energia para aquecimento, arrefecimento e AQS) de unidades hoteleiras com certificado energético de "Grande Edifício de Serviços" e os dados de quartos e camas por alojamento turístico, obtivemos as seguintes necessidades de energia para os alojamentos turísticos na RAM e Funchal.

Necessidades de energia para aquecimento e arrefecimento de alojamentos turísticos na RAM e Funchal

	Necessidades de energia os alojamentos turísticos com certificado energético (MWh)						Estimativa de necessidade de energia para o universo de alojamentos turísticos (MWh)					
	Nº	Camas	Aquecimento	Arrefecimento	AQS	Total	Nº	Camas	Aquecimento	Arrefecimento	AQS	Total
RAM	117	29536	17 476	43 045	37 374	97 895	440	38 930	22 901	52079	45 217	120 196
Funchal	64	19185	12755	34657	24921	72333	194	24 527	16307	44307	31860	92473

Source: Energy Certification processing data-AREAM

D) Fornecimento local de energia na RAM e no Funchal

Entre 2020 e 2023 a nova potência instalada em unidade de produção para autoconsumo (Residencial, serviços e indústria) (UPAC) na RAM foi de 13,8MW (1792 UPACs registadas) com produção estimada de 20,3 GWh. No Funchal a nova potência instalada foi de 5MW (600 UPACs registadas) com uma produção estimada de 7,3 GWh.

No Funchal, 9,65 GWh de eletricidade foram produzidos através de FER (através de centrais hidroeléctricas e excedentes de eletricidade das UPACs injectados na rede eléctrica), correspondendo a 1% do consumo final de energia do Funchal.

No PAESC-RAM está previsto até 2030 um aumento cerca de 180MW de FER para autoconsumo acompanhado por um aumento de 150 MWh de capacidade de armazenamento no setor da habitação, terciário, primário e secundário. No PAESC-Funchal está previsto até 2030 aumento de cerca de 100 MW de FER para autoconsumo para autoconsumo acompanhado por um aumento de 80 MWh de armazenamento de capacidade de armazenamento. A tabela seguinte apresenta o aumento de capacidade instalada de RES para autoconsumo e da capacidade de armazenamento de energia prevista nos PAESC-RAM e PAESC-Funchal.

E) Criação de grupos-alvo para o setor do aquecimento e arrefecimento

De acordo com os vários os setores que serão incluídos nos foram identificadas as partes interessadas e os grupos-alvos locais relevantes e partes interessadas, de modo a envolvê-los nas várias fases de desenvolvimento e discussão dos planos para aquecimento e arrefecimento da RAM e Funchal. Destaca-se nos grupos-alvos local a inclusão das 11 autoridades locais e de autoridades regionais dás várias áreas, AMRAM (Associação de Municípios da RAM), organismos e instituições de financiamento, operador público de energia, empresas de serviços energéticos, associação de consumidores, associação e ONG do sector do ambiente, instituições de investigação, etc.

Numa fase inicial será realizado um inquérito direcionado a partes interessadas regionais e locais, tendo como objetivo a avaliação do nível de consciencialização e de conhecimentos acerca da transição energética e alterações climáticas, a identificação de problemas, obstáculos e necessidades na área da climatização (aquecimento e arrefecimento) e AQS e de necessidades de capacitação dos técnicos.

Prevê-se ainda a realização de uma reunião de proximidade com as partes interessadas de forma a priorizar as barreiras e oportunidades no setor do aquecimento e arrefecimento, bem como para destacar que medidas de melhoria serão prioritárias incluir nos Planos de aquecimento e arrefecimento da RAM e Funchal. Nesta fase preliminar de análise, foram identificadas as seguintes barreiras e oportunidades ao desenvolvimento dos Planos de aquecimento e arrefecimento da RAM e Funchal.

Principais barreiras	Principais oportunidades
Falta de dados sobre as necessidades de H&C Falta de competências para desenvolver projetos de eficiência energética Falta de informação e divulgação sobre as soluções a adotar pelos utilizadores dos edifícios	Ferramentas para promover a renovação dos edifícios Melhoria da informação sobre as soluções a adotar pelos utilizadores dos edifícios Melhoria do conhecimento sobre o consumo de energia para aquecimento e arrefecimento Acesso a incentivos e regimes de apoio

D2.1

LOCAL CONTEXT TO DEVELOP SLHCPS

ITALY

Deliverable D2.1 – Annex 1

THE REGIONAL REFERENCE POLICY AND STRATEGIC CONTEXT IN FRIULI VENEZIA GIULIA

Friuli Venezia Giulia has positioned itself as a leader in the energy transition with the ambitious goal of achieving carbon neutrality by 2045, as outlined in the "FVG Green" law. This comprehensive legislation underscores the region's commitment to sustainability by promoting renewable energy adoption, enhancing energy efficiency, and fostering systemic changes across key sectors. The law serves as a foundational pillar for the region's decarbonization strategy, aligning with both national climate objectives and the EU's Green Deal targets.

Despite this decidedly consistent stance, in practice there are major difficulties related to the lack of adequate depth in the environmental impact assessment of new projects, still little clarity in suitable areas, and the difficulty in the implementation of energy communities given the extreme complexity of national legislation.

Friuli Venezia Giulia (FVG) has implemented several regional decrees and regulations to advance energy transition and the adoption of renewable energy sources. These measures align with national and EU directives, aiming to promote sustainability and reduce greenhouse gas emissions.

In accordance with Legislative Decree 387/2003, Article 12, the construction of renewable energy plants and associated infrastructure are considered works of public utility, urgency, and non-deferrable. FVG has established specific authorization procedures to streamline the development of such installations, ensuring compliance with national legislation and facilitating the deployment of renewable energy projects.

Then, FVG actively promotes the establishment of Renewable Energy Communities (CER), in line with Decree-Law 162/2019, Article 42bis, and subsequent provisions, including ARERA Resolution 318/2020/R/eel and the Ministerial Decree of September 16, 2020. These communities enable collective energy production and sharing, fostering local participation in the energy transition. The publication of the Ministerial Decree by the Ministry of Environment and Energy Security on December 7, 2023, and its entry into force on January 24, 2024, along with operational guidelines from the GSE released on February 23, 2024, have further facilitated the development of CERs in the region.

Through Regional Government Resolution No. 444 of March 10, 2023, FVG has allocated funds under the Regional Program FESR FVG 2021-2027 to support the use of renewable energy in enterprises. This initiative aims to enhance the competitiveness of regional businesses while contributing to environmental sustainability.

A cornerstone of this strategy is the Regional Law No. 25/2016, complemented by Regulation No. 2038/2017, which provides a methodological framework for estimating the costs associated with the development or connection to biomass-based district heating (DH) networks. By promoting DH systems powered by renewable energy sources (RES), this regulation aims to decouple energy supply from fossil fuels while ensuring affordability and accessibility.

Building on this foundation, the region offers a wide array of targeted incentives to accelerate the adoption of renewable energy and energy-efficient technologies. For example, through Regional Law No. 1/2023, individuals, condominiums, parishes, and ecclesiastical entities can access financial support for installing photovoltaic and solar thermal systems. This program, active until 2025, reflects the region's long-term commitment to decentralized renewable energy production.

In the residential sector, Regional Law No. 1/2016 provides capital contributions for constructing or renovating primary residences. While not exclusively focused on energy efficiency, these funds can also support energy performance improvements, contributing indirectly to the region's decarbonization goals.

FVG has also addressed the environmental impacts of traditional biomass heating systems, introducing a scheme under Regional Law No. 14/2023 to replace high-emission domestic biomass systems with cleaner alternatives. Although applications for this program have closed, its successful implementation marks a significant step in reducing particulate emissions and improving air quality.

In the agricultural sector, FVG promotes renewable energy adoption through incentives such as those outlined in Resolution No. 1371/2023, supporting small and medium-sized farms in installing photovoltaic systems. These measures not only decarbonize agricultural operations but also enhance the sector's resilience to energy price fluctuations.

The region is also developing new legislation targeting the energy efficiency of building envelopes, aimed at reducing energy demand and improving the performance of the existing building stock.

Despite its progressive policies, FVG faces challenges in fully integrating intersectoral strategies and addressing financing dependencies on national and EU sources. The complexity of coordinating policies across sectors, such as energy, transport,

and industry, highlights the need for enhanced governance and stakeholder engagement to ensure the long-term success of its initiatives.

Despite the progress made in the industrial sector in terms of RES use, the Regional Energy Plan (PER FVG) highlights the need for further interventions to maximize efficiency and decarbonization potential, particularly in medium- and low-temperature processes.

Last but not least, the Regional Energy Plan (PER) serves as a strategic framework guiding FVG's energy policies. Since 2008, there has been significant incentivization of renewable energy sources, both in consumption and production, leading to substantial changes in the regional energy landscape. The PER takes into account legislative and regulatory developments at the national and EU levels, addressing issues related to greenhouse gas emissions and anthropogenic global warming.

Specific actions of the PER FVG:

1. Action 05.2 – Reduce Energy Poverty

One of the key objectives of the PER FVG is to reduce energy poverty by encouraging citizens to connect to existing district heating networks. To achieve this goal, the Region is establishing dedicated funds for connections to existing networks, with a particular focus on the cascading use of local biomass and waste heat from sectors that are difficult to decarbonize. This program is managed by the Energy Transition Service of the Department of Infrastructure and Territory, as outlined in the annex to Resolution No. 996 of July 4, 2024.

2. Action 11.3 – Develop the Wood Biomass Supply Chain

The Region aims to expand district heating networks powered by wood biomass plants, providing contributions for the construction of new plants and the strengthening of existing networks. Financial resources are also allocated to support the creation of new connections to networks powered by biomass plants. Currently, the Energy Transition Service offers contributions to municipalities, but the goal is to extend these opportunities directly to citizens. This initiative is supported by a dedicated fund of 5 million euros for interventions to be carried out over six years.

Expected Impacts and Overall Strategy

These actions aim to strengthen the Region’s ability to make the most of local resources, such as biomass and waste heat, to improve energy efficiency and contribute to the decarbonization of the heating and cooling (H&C) sector. The outlined actions not only support the growth of DH networks but also contribute to achieving environmental and economic sustainability goals, while simultaneously providing concrete solutions to reduce social inequalities related to energy costs.

Through these strategies and programs, Friuli Venezia Giulia sets itself as an example of the integration between local policies and European directives, demonstrating how synergies can be created between technological innovation, sustainability, and social inclusion.

MUNICIPALITY OF PORDENONE

1. The local territorial context

Main Geographic, Territorial and Urbanistic Features

The city of Pordenone is a municipality in the Friuli Venezia Giulia region, and it is located on the border between the lower and upper Friulian plains. Like the entire lower Friulian plain, the area is characterized by an abundance of water and the phenomenon of groundwater springs – the first evidence of the settlement highlights the past vocation of the city as a river port.

Most of the territory is covered by arable and cultivated land and by discontinuous built-up areas predominantly designated for residential and industrial purposes, as shown in the two maps in Fig. 1.

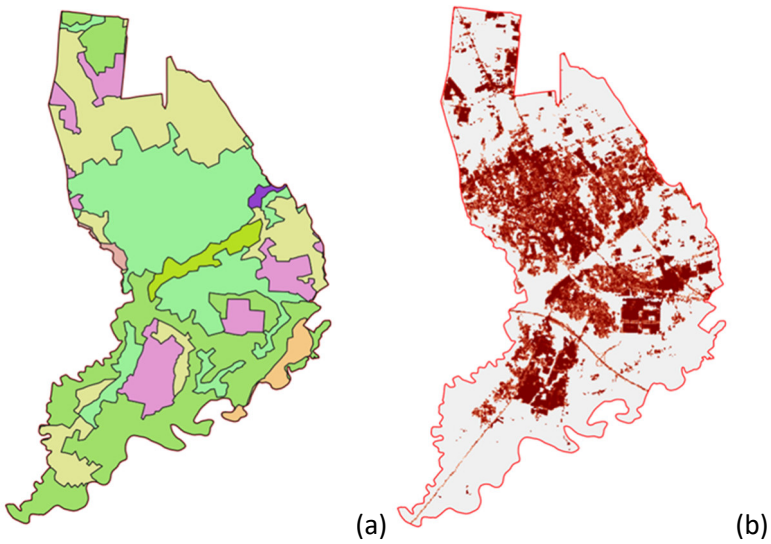


Fig. 1 Land use map (a) and degree of imperviousness (b) of the territory of Pordenone (source: Copernicus Land Monitoring Service).

	Land use	%
	Discontinuous urban fabric	32,4
	Urban green spaces	2,5
	Sport and leisure facilities	0,5
	Industrial, commercial and transport units	10,5
	Non-irrigated arable land	26,5
	Land principally occupied by agriculture, with significant areas of natural vegetation	2
	Complex cultivation patterns	25,2
	Mixed forests of conifers and broadleaf trees	0,4

CLIMATE FRAMEWORK

The region is characterized by significant climatic variability, but overall, its climate is defined as moderately continental with a humid characteristic. Within the scope of the project, only data related to external air temperature were analyzed, a climatic variable that directly affects the energy balance of buildings, determining heating and cooling needs. The annual average data for minimum, mean, and maximum temperatures recorded at the Pordenone weather station during the period 1995-2021 show an upward trend (*Fig. 2 Trends in the average annual minimum, mean, and maximum temperatures recorded at the weather station in Pordenone.*Fig. 2).

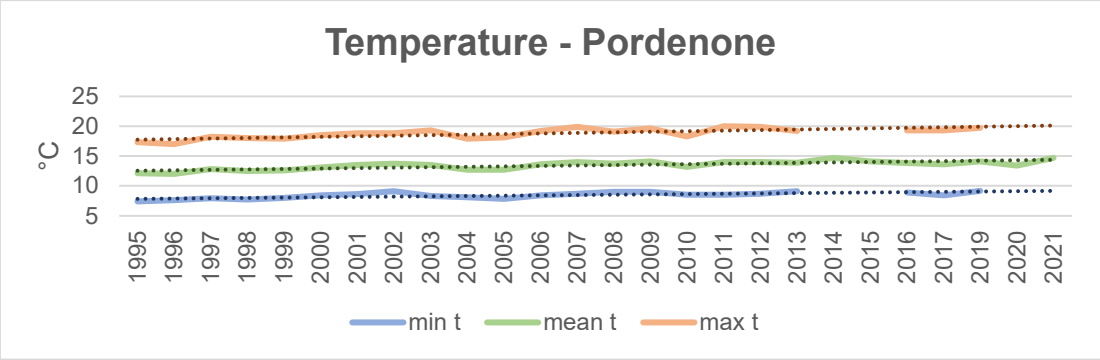


Fig. 2 Trends in the average annual minimum, mean, and maximum temperatures recorded at the weather station in Pordenone. Data from ARPA FVG

The number of Hot days, defined as days when the maximum temperature exceeds 30 °C, and Tropical nights, defined as days when the minimum temperature never drops below 20°C, have shown a significant increase (Fig. 3). Comparing data from the beginning to the end of the period, reveals an increase of 40 Hot days and 30 Tropical nights.

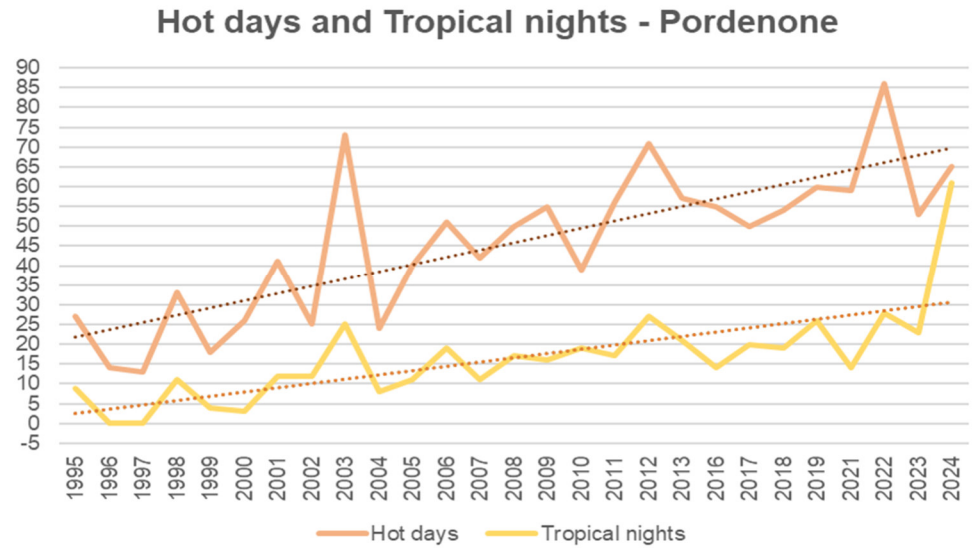


Fig. 3 Number of days with air maximum temperature above 30°C (Hot days) and number of days with minimum temperature above 20°C (Tropical nights) recorded at the weather station in Pordenone. Data from ARPA FVG

In line with the average temperature increase, the number of days with a minimum air temperature below 0°C is decreasing (called “Cold Days”), with an average difference of more than 10 days between the period 1995 and 2023 (4).

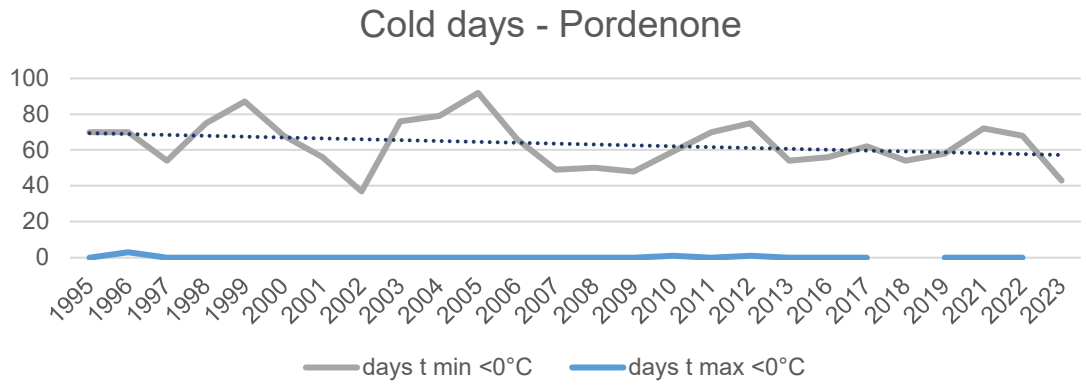


Fig. 4 Number of days with air minimum temperature below 0°C and number of days with air maximum temperature below 0°C - recorded at the weather station in Pordenone.
Data from ARPA FVG

Heating Degree Days (HDD) is a useful indicator for determining heating needs, as they represent the annual difference between the base indoor comfort temperature (20°C) and the average daily outdoor temperature. A low HDD value indicates daily average temperatures close to the base temperature. For Pordenone, HDD values are significantly decreasing (Fig. 5).

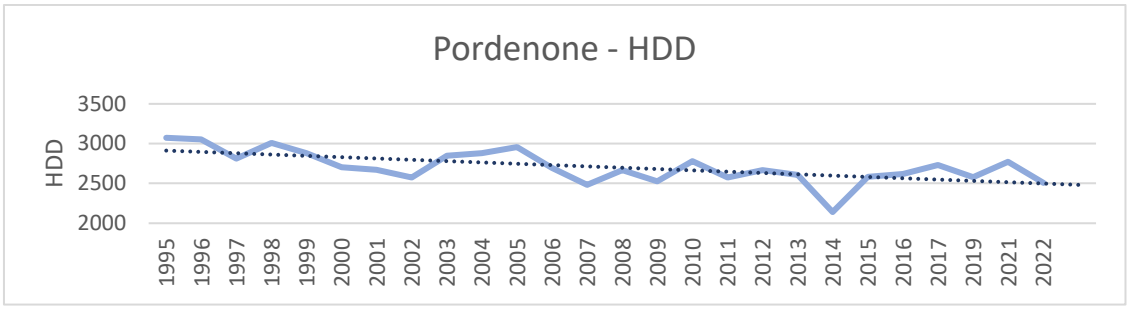


Fig. 5 Heating Degree Days recorded at the weather station in Udine.
Data from ARPA FVG

Socio-Economic Framework

Pordenone is the third most populous city in Friuli Venezia Giulia and the most populous city in the whole province. In the last 20 years the number of inhabitants has increased slightly, from almost 49,000 to more than 52,000 (Fig. 6). The highest population density is concentrated in the historic centre and its surroundings (Fig. 7).

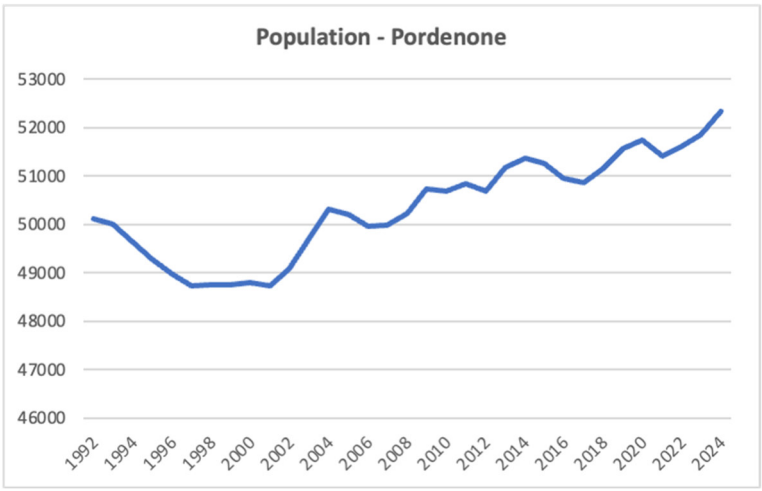


Fig. 6 Inhabitants of Pordenone 1992-2024.
Data from ISTAT

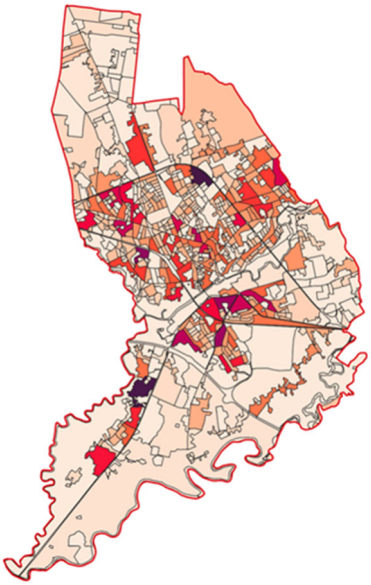


Fig. 7 Population density of Pordenone by census section, 2021. Data from ISTAT

From an economic point of view, Pordenone is one of the most dynamic cities in the region. The production structure is based on an active industrial plant diversified across the mechanical, electromechanical, metallurgical and chemical sectors. The household appliance production sector is of particular importance. In the tertiary sector, banking and sales are highly developed. According to INPS data for 2022, employees are distributed as follows: 52.1% in the tertiary sector, 44.5% in industry, and 3.3% in the primary sector.

2. The local reference policy and strategic context

The energy strategies of the Municipality of Pordenone are outlined in the SEAP (Sustainable Energy Action Plan), a document drafted and approved by the Municipal Council. The Municipality has also started preparing the SECAP (Sustainable Energy and Climate Action Plan), which updates the SEAP by introducing new emission reduction targets and incorporating measures for climate adaptation.

The evaluation of strategies for energy efficiency begins with the assumption of a progressive energy retrofit of existing buildings. To promote incentive mechanisms based on the results of efficiency improvements, the Administration has conducted an analysis of building performance aimed at optimizing incentives according to building type and construction period. The interventions considered in the plan (replacement of windows, insulation of perimeter walls, roof insulation, and replacement of systems) are eligible for tax deduction schemes.

The target set in the SEAP (a 20% reduction in greenhouse gas emissions) was monitored in 2015 by comparing the baseline year (2010) with the subsequent two years. The choice of 2012 was due to the availability of comprehensive data for public assets and the municipal territory at that time.

Total energy consumption in the area was 6% lower than in 2010, while emissions decreased by 5%. For natural gas, the most significant reduction was in the tertiary sector (-46%), with a smaller decline in industry (-9%). In contrast, consumption increased in the residential and public sectors (10-11%).

Electricity consumption increased (by 8-11%) in public buildings, industry, and the tertiary sector, while it slightly decreased in the residential sector (-1%) and for public lighting (-3%).

In the SECAP currently being prepared, for which the Municipality has kindly provided some data, several actions with a 2030 timeline have already been identified, which are related to the urban adaptation of the H&C sector.

Sector	Action
Municipal assets	Management system ISO 50001
	Energy efficiency in public buildings – Project Financing
	Three-Year Plan for Public Works - Energy Efficiency Projects under the NRRP
	Renewable energy production from municipal photovoltaic systems
Municipal territory	Promotion of measures for temperature regulation and heat metering in private residential buildings
	Potential for boiler renovation based on UCIT (authority for thermal systems) data
	Support for energy efficiency improvement actions in private buildings - Tax deduction programs (Ecobonus and Bonus Casa)
	Support for energy efficiency improvement actions in private buildings (residential and tertiary sectors)
	Support for energy efficiency actions for appliance use in the residential sector
Use of energy from renewable sources	Promotion of the use of energy from photovoltaic systems in the civil sectors (residential and tertiary)
	Promotion of the use of energy from photovoltaic systems in the private sectors
	Promotion of the use of energy from photovoltaic systems in the industrial sector

No scenarios on H&C demand and supply have been developed so far for the city of Pordenone, and therefore, it is not possible to provide details on the tools that promote the increase of efficiency and the spread of RES in the H&C sector. The actions identified in the SEAP related to energy efficiency in buildings across various sectors and renewable energy production, along with the associated values of consumption and emission reductions and potential energy production from RES, are listed in the following table.

Sector	Action	Energy savings	RES Production	CO_2 Reduction
		(MWh/a)	(MWh/a)	(tCO_2 /a)
Municipal buildings	Energy efficiency interventions and installation of RES systems in public buildings	1.368	275	383
Residential buildings	Energy savings in the social housing sector (ATER)	724		156
Residential buildings	Energy efficiency in the residential sector through tax deductions	10.112		2.043
Residential buildings	Energy efficiency measures included in the PRGC (Piano Regolatore Generale Comunale - Municipal Master Plan)	3.015		603
Public and private buildings	Promotion of district heating and cooling networks – identification of suitable areas	-		-
Energy production	Installation of photovoltaic systems in parking areas		1.944	764
Energy production	Installation of photovoltaic systems in the residential, tertiary, and industrial sectors		4.143	1.630
Energy production	Installation of mini-hydroelectric systems		440	173
Energy production	Energy valorization of biomass from urban green maintenance and use of dry waste for waste-to-energy purposes		3.512	1.015

Energy production	Installation of solar thermal systems in the residential and tertiary sectors	841		168
Tertiary buildings	Energy efficiency interventions for electricity consumption (air conditioners and lighting)	641		252

The General Municipal Master Plan (PRGC) of Pordenone, a land-use planning tool, was approved with D.C.C. no. 15 on March 22, 2016.
The PRGC consists of two components (structural and operational).
For the structural component, the following are among the documents that make it up:
- Intermunicipal framework
- Land use
- Landscape and environmental system (unbuilt system)
- Settlement system
- Mobility plan
- Urban planning forecasts: current PRGC
- Ecosystem services
- Energy consumption of residential buildings
- Geoenergy map
- Energy infrastructures
- Urban criticality map
- Landscape map
- Structure plan
- Objectives and strategies of the Plan
- Verification and coherence between directives, objectives, and strategies of the Plan

For the operational component, the following are among the documents:
- Survey of landscape assets
- Constraints
- Components of the local landscape
- Equipment for various sectors (education, green spaces, roads and parking, etc.)
- Technological infrastructure
- Built-up and urbanized areas
- Technical implementation rules
- Report on housing needs and calculation of settlement capacity
- General report
- Energy consumption of residential buildings

In general, the PRGC defines the urban planning regulations of the territory and recalculates the total settlement capacity. The general objectives pursued by the Plan are those of a general nature set by the Regional Landscape Plan, the P.A.I.L., the higher-level urban planning regulations, and specific objectives defined by the directives of the Municipal Council, with particular attention to protecting the quality of the territory, the local landscape, the built heritage, improving the use of available resources, and strategies for regeneration, enhancement of the territory, and the city.
Subsequently, 27 amendments were adopted and approved by the Municipal Council.
It is noteworthy that the General Amendment for the regeneration of the existing building stock in compliance with the Regional Landscape Plan (PPR) was approved with D.C.C. on April 21, 2021.
The adopted General Amendment works on both the Structural and Operational Components.
In particular, the Amendment strengthens the sustainability objectives and the enhancement of the environmental and urban system, adopting the objectives of the PPR and introducing tools to support the regeneration processes of the existing building stock and urban systems.

Specifically, the Amendment extended the promotion of the regeneration processes of the existing building stock, initially intended only for certain priority areas, to the entire residential fabric. This way, each improvement intervention that can contribute to reducing pollutants and the consequent improvement of environmental quality is promoted.

3. The local energy system

The energy balance and the resulting emissions inventory developed in the draft SECAP refer to the year 2021 and monitor energy consumption trends in the Pordenone area compared to the initial balances created for the SEAP (referenced to 2010) and the subsequent monitoring (referenced to 2012).
Energy consumption related to the Municipality's energy uses (buildings, plants, and municipal vehicles) decreased from 3% in 2012 to 2% of the total energy consumption in the area by 2021. Analysis of data on private sector consumption reveals that three sectors have a very similar share of total territorial consumption: the non-municipal tertiary sector (30.7%), the residential sector (29.7%), and public and private transport (28.6%), together accounting for 89% of Pordenone's total energy consumption. In addition to the aforementioned municipal sector (2%), the industry sector (7.8%) and waste disposal (0.8%) also contribute to consumption data in the PAESC, with waste disposal being a separate category.
Regarding the energy carriers, an analysis can only be made for the 2012 monitoring data: the majority of consumption is attributed to natural gas (49.5%), followed by electricity (23.7%), then diesel (14.4%) used for heating and primarily for vehicle fuel, electricity again (15%), gasoline (10%), and finally LPG (2.4%).

The local energy demand

For the territory of Pordenone, the most comprehensive consumption data, broken down not only by sector but also by energy carrier, are those contained in the SEAP monitoring report, which refers to 2012. These data are presented in the following table.

2012	Electricity	Fossil fuels				**TOTAL**
SECTOR		Natural Gas	GPL	Diesel	Gasoline	
Municipal buildings	5.923	24.788				30.711
Tertiary buildings	118.819	110.879				229.865
Residential buildings	60.582	347.423	10.882	167		419.388
Public lighting	6.408			501		6.408
Industry and agriculture	50.892	22.929				73.821
Municipal fleet			1	19	468	488
Private and commercial transport			13.607	146.498	101.368	261.473
TOTAL	**242.624**	**506.019**	**24.490**	**147.185**	**101.836**	**981.340**

The most recent data, related to 2021, provided by the Municipality of Pordenone, which is drafting the PAESC, do not include details on the energy carrier. The available data are presented in the following table.

2021	**TOTAL**
SECTOR	
Municipal buildings	19.164
Tertiary buildings	301.375

Residential buildings	291.718
Public lighting	6.408
Industry and agriculture	73.821
Municipal fleet	488
Private and commercial transport	261.473
Waste disposal	7.936
TOTAL	**981.340**

It was not possible to specify the level and type of consumption for H&C (heating and cooling) and the portion of energy for these purposes covered by renewable energy sources (RES).

The final H&C uses in Pordenone are, as in other cities, related to the winter and summer climate control of buildings. A significant percentage of the consumption due to summer cooling is certainly attributable to the air conditioning of shopping centers, supermarkets, and other activities in the tertiary sector. However, in a context like that of Pordenone, the percentage of consumption attributable to industrial processes of companies operating in the area is far from negligible, as the industrial sector is more developed compared to other cities.

Unlike the Municipality of Udine, data regarding the survey of heating systems is not available, and therefore, it is not possible to provide data on the systems. The only information that can be provided in this context is that the vast majority of buildings in the city are heated with methane.

Regarding the building stock, useful information for understanding the energy performance of buildings can be obtained from the CasaClima certification protocol, which, however, pertains to a very small portion of the entire building stock in the city.

The following table shows the certifications issued from 2009 onwards, categorized by class (GOLD, A, B, C), which allow the identification of the energy consumption level of a building.

YEAR	CLASS GOLD	CLASS A	TOTAL CERTIFICATIONS
2010	2	3	**5**
2011		1	**1**
2013	1		**1**
2014		3	**3**
2015		2	**2**
2016		1	**1**
2018		2	**2**
2019		2	**2**
2020		1	**1**
2022		1	**1**
TOTAL	3	16	**19**

It was not possible to find other information on the private construction sector, which will be more easily obtained once the municipality's involvement in the project reaches a more advanced stage.

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The local energy supply

The following table presents data on renewable energy production systems for the municipality of Pordenone.
The largest number of systems and the most significant electricity production is naturally due to photovoltaics, with 930 systems (data updated to 2024) installed on public and private structures (residential, tertiary, and industrial sectors), producing approximately 13,800 MWh annually.
The 6 hydroelectric plants for which data has been found have nominal powers ranging from 19 to 375 kW. The total capacity of these 6 plants is 958 kW, with an average annual electricity production of 3,970 MWh.
No biogas or biomass-powered electricity production plants are active in Pordenone, as the urban context imposes significant limitations on the energy valorisation of such resources.
In addition to the aforementioned electricity production systems, around 320 renewable energy systems for the production of sanitary hot water (solar panels) have been estimated across the municipality of Pordenone, mostly on residential buildings. The estimated annual production totals approximately 380 MWh thermal.

RES plants	Number	MWh_e/year	MWh_{th}/year
Solar photovoltaic systems	930	13.820	
Solar thermic systems	320		380
Biogas plants	2	1.350	
Hydroelectric plants	6	3.970	

For the Pordenone context, it is important to mention the combined energy production (electricity and heat) derived from the treatment of organic waste for energy purposes.
The organic wet waste produced within the municipal territory of Pordenone has been sent to the Bioman Biodigester since 2012. To report the energy production of the biodigester, an average production of 99 kWh per ton of organic wet waste sent to the biodigester has been considered. The waste sent to the biodigester in anaerobic conditions produces biomethane, which is then utilized in a cogenerator to produce combined electricity and heat (estimated combined energy production of 45% electricity, 55% heat).
For the calculation of energy production, the amount of biomass sent to the biodigester is considered, averaging around 5,000 tons. If only 25% of the biomass is used for energy valorisation, it is estimated that 1,250 tons of biomass are sent to the biodigester annually. With a calorific value of 3.4 kWh/kg for the biomass chips, an annual production of 4,250 MWh is estimated.
According to data from the Atlaimpianti portal of the GSE (Gestore Servizi Energetici), there are no fossil fuel-based energy production plants in the municipality of Pordenone.

As general considerations, it is clear that, especially in the residential sector, the spread of new systems has significantly slowed since 2013, following the closure of the Fifth Energy Account. An impulse for the installation of new systems could come from the availability of regional funds allocated for the establishment of new plants as part of the initiatives for the creation of Renewable Energy Communities.
Regarding the potential for renewable energy development, the Municipality of Pordenone has conducted studies within the PRGC to estimate the qualitative and quantitative potential of the total surface areas of existing building roofs for the installation of photovoltaic and solar thermal systems. In this study, a distinction was made between residential and non-residential buildings and potentially available public parking areas.
The study shows that the energy hypothetically produced by covering all available roof surfaces of residential buildings would allow the generation of electricity equivalent to approximately 4.5 times the electricity consumption of the residential sector (total installed capacity of 306 MW).
The study also highlights that covering all available surfaces of non-residential areas could generate an amount of electricity equal to 107% of the industrial sector's consumption (total capacity of 44 MW).
Finally, covering all parking area surfaces could generate an amount of electricity equivalent to 3.27 times the consumption of public administration buildings and facilities (total installed capacity of 35 MW).

Based on the estimate for available surfaces for photovoltaic systems, a potential estimate for the spread of new solar thermal systems was calculated. By dedicating 10% of the above surface area to the installation of solar panels, an annual production of about 168 MWh of thermal energy could be expected.

4. Mapping of H&C target groups

CITY	STAKEHOLDER	TARGET GROUP	CONTACT PERSON(S)
Pordenone	Giorgio Boz – Municipality of Pordenone	Local authority	giorgio.boz@comune.pordenone.it
	Mattia Tirelli – Municipality of Pordenone	Local authority	mattia.tirelli@comune.pordenone.it
	Daniele Florean – Efficienta (Polo tecnologico Alto Adriatico)	SME	daniele.florean@efficienta.eu
	Alessandro Boz – Banca 360 FVG	Financial institution	relazioni@banca360fvg.it
	Francesco Marangon – Università di Udine	University	francesco.marangon@uniud.it
	Roberto Tomasini – GEA	Utility company (urban waste)	roberto.tomasini@gea-pn.it
	Italgas Pordenone	Utility company (gas)	……
	Renato Marcon o Martina Bellucci – Legambiente Pordenone	Civil society association	pordenone@legambientefvg.it
	Terraè association	Civil society association	info@terra-e.it

5. Summary in national language

Pordenone, situata nel Friuli-Venezia Giulia, ha un territorio caratterizzato da abbondanza di acqua e sorgenti sotterranee, con un passato come porto fluviale. La maggior parte delle sue terre è agricola o edificata, soprattutto per usi residenziali e industriali. Il clima è continentale moderato e umido, con un aumento delle temperature medie annuali e dei giorni caldi (oltre 30°C) e delle notti tropicali (minima sopra 20°C). I giorni freddi sono diminuiti, mentre i "Heating Degree Days" (HDD) sono in calo. Con una popolazione di oltre 52.000 abitanti, Pordenone è la città più popolosa della provincia e una delle più dinamiche economicamente, con un settore industriale diversificato, in particolare nella produzione di elettrodomestici e nei servizi bancari e commerciali.

Per la transizione energetica, l'Italia ha fatto buoni progressi nella promozione dei sistemi di teleriscaldamento (TLR), con il 77% del calore prodotto da fonti rinnovabili, calore di scarto e cogenerazione ad alta efficienza. Tuttavia, sono necessari ulteriori passi per raggiungere gli obiettivi di decarbonizzazione fissati per il 2050. La Regione Friuli-Venezia Giulia ha sviluppato un quadro normativo e azioni specifiche per incentivare l'uso della biomassa e del calore di scarto, supportando anche la riduzione della povertà energetica e l'espansione delle reti di teleriscaldamento.

Deliverable D2.1 – Annex 1

Il Friuli-Venezia Giulia ha sviluppato un quadro normativo e strategico solido per promuovere la transizione energetica e la decarbonizzazione, con particolare attenzione al settore del teleriscaldamento (DH). La Legge Regionale n. 25/2016, insieme al regolamento associato approvato dalla Delibera n. 2038 del 2017, fornisce una metodologia per stimare i costi medi di costruzione o di connessione alle reti di teleriscaldamento alimentate da biomassa. Questo quadro normativo è fondamentale per favorire l'adozione di sistemi di teleriscaldamento che utilizzano fonti di energia rinnovabile (FER), sostenendo l'efficienza energetica e contribuendo alla decarbonizzazione del settore.
Nonostante i progressi già compiuti, il Piano Energetico Regionale (PER FVG) evidenzia la necessità di ulteriori interventi per migliorare l'efficienza energetica e il potenziale di decarbonizzazione, in particolare nei processi industriali a media e bassa temperatura. Tra le azioni previste, due si distinguono per il loro impatto e ambizione:

1. Azione 05.2 – Ridurre la povertà energetica: Uno degli obiettivi principali del PER FVG è ridurre la povertà energetica, incentivando i cittadini a connettersi alle reti di teleriscaldamento esistenti. A tal fine, sono previsti fondi regionali specifici per sostenere le connessioni alle reti già attive, con un'attenzione particolare all'utilizzo della biomassa locale e al recupero di calore da fonti difficili da decarbonizzare. Questo programma è gestito dal Servizio Transizione Energetica del Dipartimento Infrastrutture e Territorio, con il supporto di una delibera regionale che prevede anche incentivi per il recupero di calore di scarto da settori industriali.
2. Azione 11.3 – Sviluppare la filiera della biomassa legnosa: La Regione intende espandere le reti di teleriscaldamento alimentate da impianti a biomassa legnosa. A questo scopo, vengono previsti contributi finanziari per la costruzione di nuovi impianti e il rafforzamento delle reti esistenti, con l'obiettivo di estendere le opportunità di finanziamento anche ai cittadini, in aggiunta ai comuni. L'iniziativa è supportata da un fondo di 5 milioni di euro, destinato a interventi che si svilupperanno nel corso di sei anni.

Le azioni delineate puntano a valorizzare le risorse locali come la biomassa e il calore di scarto, migliorando l'efficienza energetica e contribuendo alla decarbonizzazione del settore del riscaldamento e del raffreddamento (H&C). L'obiettivo complessivo è non solo la crescita delle reti di teleriscaldamento, ma anche il raggiungimento di un equilibrio tra sostenibilità ambientale ed economica, riducendo al contempo le disuguaglianze sociali legate ai costi energetici.
Il Comune di Pordenone ha redatto il PAES (Piano d'Azione per l'Energia Sostenibile) e sta lavorando sul PAESC (Piano d'Azione per l'Energia Sostenibile e Climatica), che include obiettivi di riduzione delle emissioni e misure per l'adattamento climatico. Le strategie di efficientamento energetico si concentrano sulla riqualificazione del patrimonio edilizio esistente, con interventi come la sostituzione di infissi, l'isolamento delle pareti, la coibentazione delle coperture e la sostituzione degli impianti. Gli interventi sono incentivati tramite detrazioni fiscali e monitorati per ottimizzare i risultati in base alla tipologia edilizia.
Nel PAES, l'obiettivo di ridurre le emissioni di gas serra del 20% è stato monitorato nel 2015, mostrando una riduzione del 5% delle emissioni e una diminuzione del 6% dei consumi tra il 2010 e il 2015. Per quanto riguarda il gas naturale, i consumi sono diminuiti significativamente nel settore terziario (-46%) e nell'industria (-9%), mentre sono aumentati nel residenziale e nel pubblico. I consumi di energia elettrica sono aumentati nel pubblico, nell'industria e nel terziario, ma sono diminuiti nel residenziale e nell'illuminazione pubblica.
Nel PAESC in fase di redazione, sono già state individuate azioni da attuare entro il 2030 per il miglioramento dell'efficienza energetica, inclusi interventi sul patrimonio comunale e sul territorio, come la gestione ISO 50001, l'efficienza energetica negli edifici pubblici, l'installazione di impianti fotovoltaici, la promozione di termoregolazione negli edifici residenziali e il miglioramento dell'efficienza energetica nel settore privato. In particolare, sono previsti impianti fotovoltaici per i settori residenziale, terziario e industriale, la valorizzazione energetica della biomassa, l'installazione di impianti solari termici e mini-idroelettrici.
Il Piano Regolatore Generale Comunale (PRGC), approvato nel 2016, definisce la disciplina urbanistica del territorio, includendo componenti strutturali come l'uso del suolo, il sistema paesaggistico e ambientale, la mobilità e i consumi energetici degli edifici. Il PRGC mira alla sostenibilità, alla valorizzazione del territorio e della città, e al miglior utilizzo delle risorse, con attenzione alla qualità del paesaggio e del patrimonio costruito. Nel 2021 è stata approvata la Variante Generale per la rigenerazione del patrimonio edilizio, in conformità con il Piano Paesaggistico Regionale (PPR), che promuove la riqualificazione del patrimonio edilizio esistente e l'adozione di misure per il miglioramento ambientale e la riduzione degli inquinanti.

Deliverable D2.1 – Annex 1

Il bilancio energetico e l'inventario delle emissioni del PAESC di Pordenone, riferiti al 2021, monitorano i consumi energetici del territorio rispetto ai dati iniziali del PAES (2010) e al successivo monitoraggio (2012). I consumi comunali sono passati dal 3% del 2012 al 2% nel 2021, mentre i settori privati e pubblici insieme costituiscono l'89% dei consumi territoriali. Tra questi, il terziario, il residenziale e i trasporti pesano rispettivamente 30,7%, 29,7% e 28,6%. I consumi principali sono attribuibili al gas naturale (49,5%) e all'energia elettrica (23,7%).

A differenza del Comune di Udine, non sono disponibili dati sul censimento degli impianti termici, quindi non è possibile fornire informazioni sugli impianti. L'unica informazione disponibile è che la maggior parte degli edifici della città è riscaldata a metano.

Per quanto riguarda il patrimonio edilizio, è possibile ottenere informazioni utili sulle prestazioni energetiche degli edifici dai certificati energetici del protocollo CasaClima, che però riguardano solo una piccola parte del patrimonio edilizio complessivo della città.

Nel 2021, i dati sul consumo di energia non distinguono per tipo di vettore, ma mostrano un totale di 981.340 MWh per vari settori, tra cui edifici comunali, terziari, residenziali, illuminazione pubblica, industria, trasporti e smaltimento rifiuti.

Per quanto riguarda l'approvvigionamento energetico, Pordenone ha impianti fotovoltaici (930 unità, 13.800 MWh annuali), idroelettrici (6 impianti, 3.970 MWh), e circa 320 impianti solari termici (380 MWh annuali). Non sono presenti impianti a biogas o biomassa. Inoltre, il trattamento dei rifiuti organici al biodigestore Bioman produce annualmente circa 4.250 MWh di energia combinata (elettricità e calore).

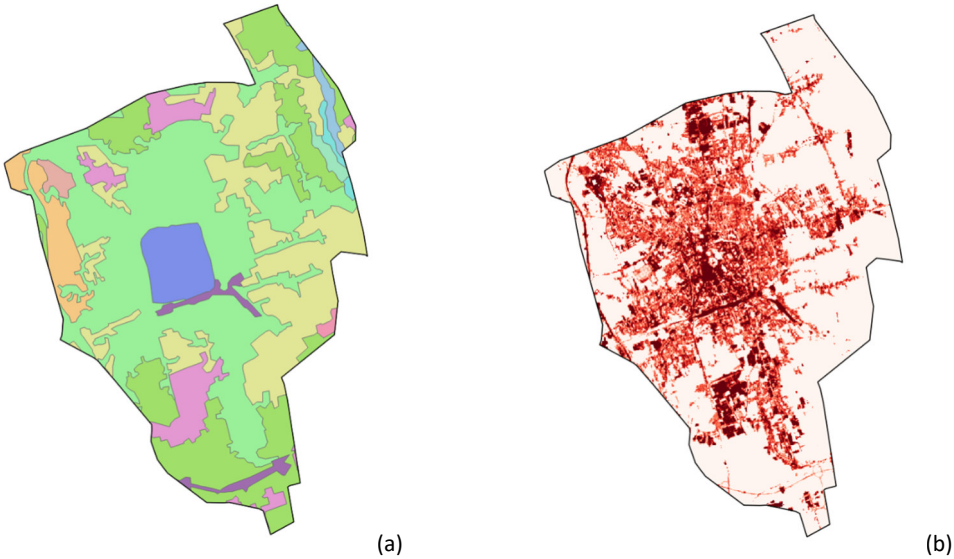
Lo studio sul potenziale di sviluppo delle rinnovabili, condotto nel PRGC, stima che coprendo le superfici disponibili dei tetti degli edifici residenziali, si potrebbe produrre energia elettrica pari a 4,5 volte il consumo del settore. Inoltre, l'installazione di impianti solari termici potrebbe generare circa 168 MWh termici annui. Il rallentamento della diffusione di impianti dal 2013 potrebbe essere contrastato da fondi regionali per le Comunità Energetiche Rinnovabili.

MUNICIPALITY OF UDINE

1. The local territorial context

Main Geographic, Territorial and Urbanistic Features

Udine, a municipality in the Friuli Venezia Giulia region, is located in the upper Friulian plain at 113 meters above sea level and covers an area of approximately 57 km². The territory is completely flat, except for the hill rising at the center of the city. The main hydrographic network consists of the Torre Stream to the east and the Cormor Stream to the west, accompanied by other minor waterways. Most of the territory is covered by built-up areas, as shown in the two maps in Fig. 1, predominantly designated for residential zones.



(a) (b)

Fig. 8 Land use map (a) and degree of imperviousness (b) of the territory of Udine.

	Land use	%
	Continuous urban fabric	4,3
	Discontinuous urban fabric	39,8
	Sport and leisure facilities	0,7
	Industrial, commercial and transport units	5,7
	Road and rail networks and associated land	1,6
	Non-irrigated arable land	19,2
	Land principally occupied by agriculture, with significant areas of natural vegetation	3,8
	Complex cultivation patterns	22,5
	Broad-leaved forest	0,5
	Transitional woodland-shrub	0,7
	Beaches, dunes, sands	0,8

The region is characterized by significant climatic variability, but overall its climate is defined as moderately continental with a humid characteristic. Within the scope of the project, only data related to external air temperature were analyzed, a climatic variable that directly affects the energy balance of buildings, determining heating and cooling needs. The annual average data for minimum, mean, and maximum temperatures recorded at the Udine weather station during the period 1992-2023 show an upward trend (Fig. 1).

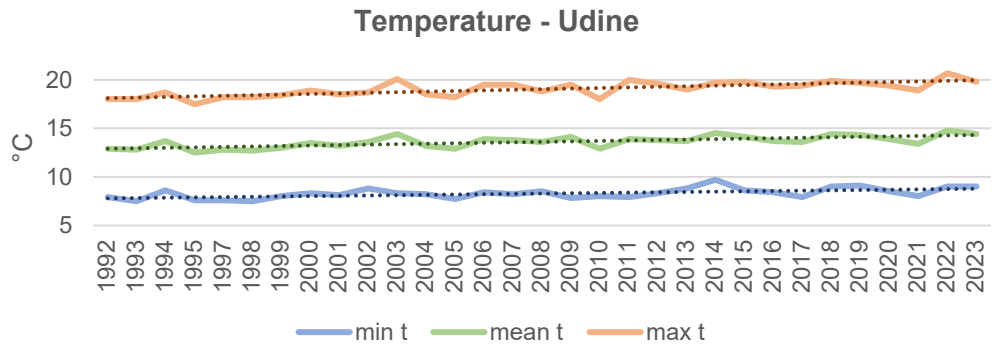


Fig. 9 Trends in the average annual minimum, mean, and maximum temperatures recorded at the weather station in Udine. Data from ARPA FVG

The number of tropical days, defined as days when the maximum temperature exceeds 30°C, and tropical nights, defined as nights when the temperature never drops below 20°C, have shown a significant increase (Fig. 2). Comparing data from the beginning to the end of the period reveals an increase of 15.9 tropical days and 6 tropical nights.

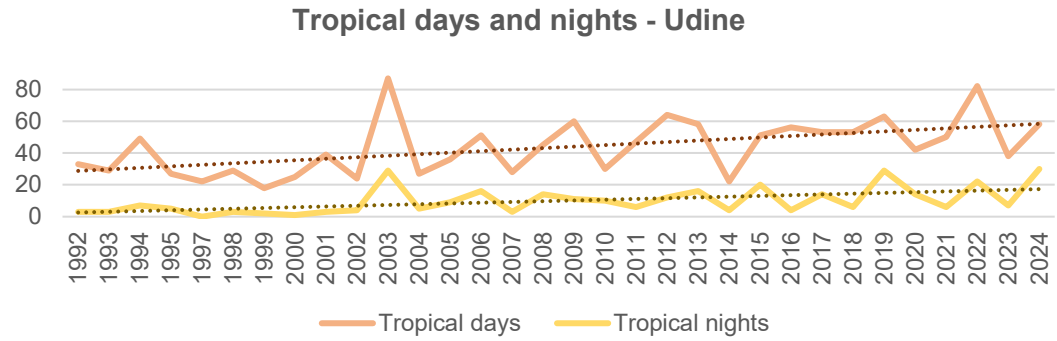


Fig. 10 Number of days with air maximum temperature above 30°C (tropical days) and number of days with air minimum above 20°C recorded at the weather station in Udine. Data from ARPA FVG

In line with the average temperature increase, the number of days with a minimum air temperature below 0°C (called “Cold days”) is decreasing, with a difference of 9.1 days between the two periods. However, the number of days with a maximum air temperature below 0°C does not follow the same trend, showing a slight increase of 0.2 days.

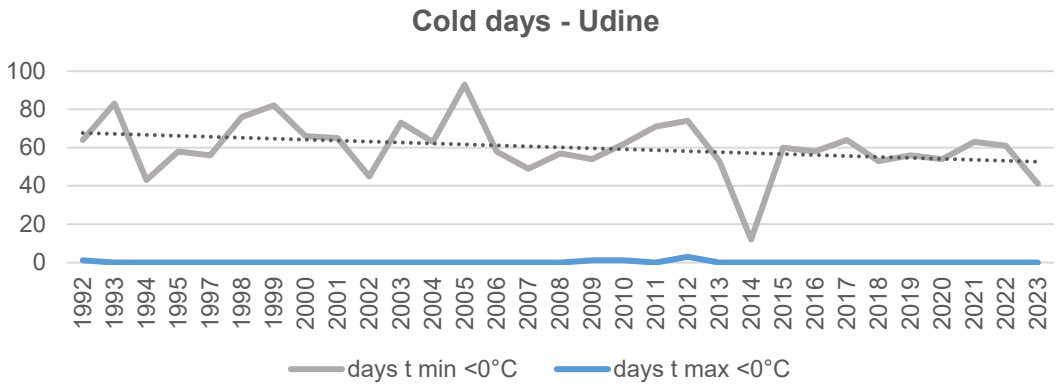


Fig. 11 Number of days with air minimum temperature below 0°C and number of days with air maximum temperature below 0°C - recorded at the weather station in Udine.
Data from ARPA FVG

Heating Degree Days (HDD) are another useful indicator for determining heating needs, as they represent the annual difference between the base indoor comfort temperature (20°C) and the average daily outdoor temperature. A low HDD value indicates daily average temperatures close to the base temperature. For Udine, HDD values are significantly decreasing.

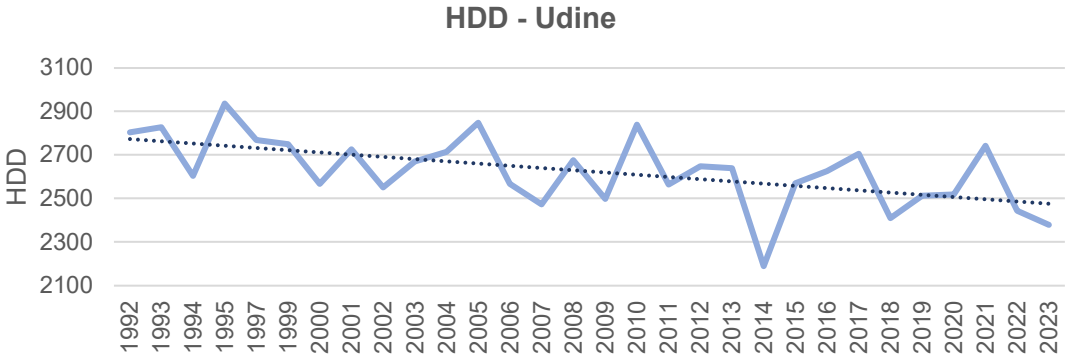


Fig. 12 Heating Degree Days recorded at the weather station in Udine.
Data from ARPA FVG

Socio-Economic Framework

Udine is the second most populous city in the region, after Trieste, with 98,430 inhabitants as of 2024, showing a slight demographic increase over the past four years. The highest population density is concentrated in the historic centre and its surrounding areas.

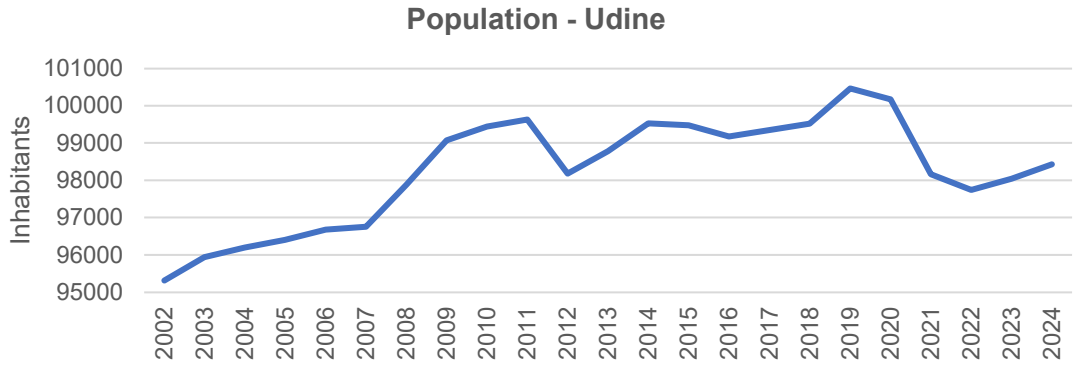


Fig. 13 Inhabitants of Udine 2002-2024.
Data from ISTAT

a) b)

Fig. 14 Population density (a) and business density (b) of Udine by census section, 2021. Data from ISTAT

Regarding the economic activities, the primary sector is dominated by viticulture and agriculture, while the industry focuses on metalworking, furniture, and food processing. The tertiary sector, encompassing commerce, tourism, and services, is complemented by a vibrant development in innovation and research, supported by the University and tech startups.
According to INPS data for 2022, the distribution of employees by economic sector is as follows: 68.1% in the tertiary sector, 28.5% in industry, and 3.2% in the primary sector.

2. The local reference policy and strategic context

The energy strategies of the Municipality of Udine are primarily outlined in the PAESC, the Sustainable Energy and Climate Action Plan, which the Municipality of Udine drafted and approved in the City Council in September 2021. The Municipality of Udine committed to preparing the PAESC after having adopted the SEAP (Sustainable Energy Action Plan) in 2010, which already contained energy strategies designed, as in the new PAESC, for municipal buildings and vehicles, as well as for the entire territory.
Thanks to activities carried out within the framework of the European Horizon 2020 Project Compete4SECAP, the Municipality of Udine has committed to improving its energy performance and that of its jurisdiction by adopting and implementing an Energy Management System (EMS) coordinated with the PAESC. This project also involved two primary schools and two secondary schools in the city.
In the energy domain, two main axes have been identified: "A More Efficient City" and "A Renewable Energy City," with the key sectors listed in the table below.

"A More Efficient City"	*"A Renewable Energy City"*
Energy Management of Public Assets	Publicly Initiated Renewable Energy Plants
Renovation of Private Buildings	Small Renewable Energy Systems for Civil Self-Production
Energy Efficiency in Manufacturing Enterprises	Renewable Energy Production in the Manufacturing Sector
Energy Efficiency in the Tertiary Sector	Renewable Energy Production in the Tertiary Sector

These main axes are divided into the following actions identified for the SECAP.

Sector	Action	Energy savings	RES Production	CO_2 Reduction
		(MWh/a)	(MWh/a)	(tCO_2 /a)
Municipal buildings	A1-2 Project financing on municipal buildings (EPC/PPP) - Thermal Energy Efficiency	4.722		944
Municipal buildings	A1-3 Energy Efficiency Improvement of Electrical Uses in Public Buildings	1.666		460
Municipal buildings	A2-1 Investments in Energy Production from Municipal Photovoltaic Systems	360	360	78
Residential and Tertiary buildings	A2-2 Promotion of Energy Use from Photovoltaic Systems in the Private Sectors		37.914	6.802
Residential buildings	A1-5 Measures for Thermoregulation and Heat Metering in Residential Buildings	2.225		445
Residential buildings	A1-10 Support for Energy Efficiency Improvement Actions in Buildings – Tax Deduction Program (Ecobonus and Home Bonus)	33.751		6.750
Residential buildings	A1-6 Support for Replacing LPG and Diesel Systems with Renewable Energy Systems			10.978
Municipal-tertiary and residential buildings	A1-14.1 Expansion of the District Heating Network in Northern Udine	3.000		600
Municipal-tertiary and residential buildings	A1-14.2 New District Heating Network in Southern Udine	180.000		15.000

The goal set in the SEAP (a 20% reduction in greenhouse gas emissions by 2020) has been achieved and exceeded: a reduction of 22.84% in emissions by 2019 compared to the baseline year has been calculated.
The two plans (SEAP and SECAP) were developed when the city was governed by the previous administration.
To understand the environmental and energy policy of the new administration elected in April 2023, reference can be made to a document approved in June 2023, in which the City Council outlined its environmental and energy policy. The energy-related action lines it aims to implement are as follows:
- Achieve improvements in the energy performance of the municipal building stock and promote the participation of citizens and public and private entities in Renewable Energy Communities (RECs).
- Include rewarding criteria and the pursuit of environmental and energy improvement goals in tender procedures.
- Invest in energy-related issues through the actions identified in the SECAP, to promote the use of renewable energy sources in the territory.
- Maintain the obligation to increase energy efficiency in residential buildings, introducing incentives for the construction of "nearly zero-energy" buildings and the renovation of old homes.
- Complete maintenance projects to improve the energy performance of school buildings and smaller sports facilities.

No scenarios have been developed for the city of Udine regarding heating and cooling (H&C) demand and supply, and therefore, it is not possible to provide details on the tools that promote the increase of efficiency and the spread of renewable energy sources (RES) in the H&C sector.

The General Municipal Master Plan (PRGC) of Udine, a tool for land use governance, consists of the following documents:
• Analysis Document, essential for defining the directives and the subsequent design phase of the new PRGC;

• General Report, containing the analyses carried out to acquire a comprehensive understanding of the state of the territory at the municipal and inter-municipal scale;
• Environmental, Landscape, and Historical Protection Maps; regulatory constraints; implementation planning; Normative Sheets; urbanized and built-up areas; road classification and zoning maps;
• Technical Implementation Regulations (NTA);
• Flexibility Report;
• Environmental Impact Assessment (VAS) – environmental report and non-technical summary, illustrating and explaining the consistency of the choices made by the new PRGC with the general planning objectives and the sustainability goals for the development of the territory outlined in the urban planning directives;
• Plan Dimensioning Document, which examines the projected demographic aspects and population evolution, intersecting them with the urban planning of the new PRGC and the choices made regarding the confirmation/consolidation of the built city and potential expansions;
• Facilities and Services Map;
• Structural Plan;
• Geological-Technical Report and Maps.

The PRGC pursues environmental and energy sustainability, primarily by supporting the development of the city within already urbanized areas, avoiding the encroachment on agricultural lands. Urban densification is simultaneously proposed, with attention to ensuring that all open spaces are not closed off, maintaining the permeability of the built environment. In industrial and commercial areas, the design of building envelopes plays an important role in energy performance and the efficiency of renewable energy systems. Additionally, the Plan seeks to protect residential settlements by identifying green areas for mitigation.

Among the regulations for private construction, the Municipal Building Code (REC) is mentioned, a tool that governs the construction methods of buildings, ensuring compliance with technical-aesthetic, health, safety, and liveability standards for buildings and their appurtenances. The Energy Regulation is an integral part of the building code and promotes bio-building, bioarchitecture, and energy savings. It defines the procedures, technical and minimum requirements, and incentives adopted by the Municipal Administration to promote energy efficiency and environmental sustainability in the construction sector. The energy regulation follows the objectives set by higher-level directives.
As part of urban adaptation strategies and measures, the Municipality of Udine aims to contribute to the need for strategic urban planning, redevelopment, and regeneration, rather than emergency responses, in order to prevent and adapt to the environmental and climatic challenges affecting the municipal territory. To address these issues and make the urban environment more resilient to the impacts of climate change, the Municipality of Udine believes it is strategic to have a Catalogue of Best Practices for interventions in the fields of building and urban planning, which integrate climate resilience through the use of Nature-based Solutions (NBS). These solutions are designed to counteract rising temperatures, the formation of heat islands, flooding, and to instead promote increased biodiversity and the restoration of ecosystem services.
The aim of this catalogue is, therefore, to guide the design of such interventions and, at the same time, contribute to improving local knowledge on these topics.
A Catalogue of Best Practices has been developed, and it includes:
- A collection of NBS selected based on their applicability in various urban and peri-urban contexts of the municipality of Udine, aimed at reducing various impacts of climate change and restoring ecosystem services (Annex 1).
- Sheets for the proposed urban regeneration interventions in public spaces for the city of Udine, referring to the collection of solutions described in Annex 1, to address the climate challenges affecting the identified areas (Annex 2).

3. The Local Energy System

The Local Energy Demand

The energy balance and the resulting emissions inventory developed in the PAESC refer to the year 2019 and monitor the trends of the territory of Udine in terms of energy consumption compared to the first inventory, which was based on 2006 data. Energy consumption attributed to the Municipality's energy uses (buildings, facilities, and municipal vehicles) decreased from 2.4% of total consumption in 2006 to 1.2% of the total consumption of the territory in 2019.
From the analysis of consumption data in the private sectors, it is observed that the sector still having the most significant impact is private and commercial transportation, accounting for approximately 42% of the total, followed by the residential sector (38%). The remaining consumption comes from the non-municipal tertiary sector (15%), industry (3.4%), and local public transport (less than 1%).
Analysing the share of different energy carriers, the majority of consumption is attributed to diesel (34%)—used for heating and, notably, as fuel for vehicles, -- followed by natural gas (29%), —then electricity (15%), gasoline (11%), and finally LPG (about 1%).

SECTOR	Electricity	Heat/cold	Fossil fuels				TOTAL
			Natural Gas	GPL	Diesel	Gasoline	
Municipal buildings	5.554		15.088				**20.642**
Tertiary buildings	156.657		147.826				**304.483**
Residential buildings	103.880		577.923	6.675	69.703		**758.181**
Public lighting	2.767						**2.767**
Industry	37.996		23.253		7.745		**68.994**
Municipal fleet			30	30	349	226	**635**
Public transport			14.095		2.656		**16.751**
Private and commercial transport				10.743	604.220	223.335	**838.298**
TOTAL	**306.854**		**778.215**	**17.448**	**684673**	**223.561**	**2.010.751**

It is difficult to determine the level and type of consumption for H&C as well as the share of energy for such purposes covered by RES.
The final uses of H&C in the city of Udine are mainly related to winter and summer climate control of buildings: a significant percentage of the consumption due to summer cooling is undoubtedly attributable to the air conditioning of shops, supermarkets, and other activities in the tertiary sector. A residual portion of such consumption is linked to the industrial processes of companies in this sector, which is not particularly developed in Udine.
Information relevant to this document pertains to the heating systems of buildings within the municipal territory, which can be obtained from data provided by U.C.I.T. s.r.l. (now FVG Energia). This company is responsible for inspections of winter and summer climate control heating systems. As a result, it has archived extensive information about the heating systems in the Province of Udine, broken down by municipality, including details such as fuel type, power output, and installation date.
The following table presents data on the heating systems in the municipal area of Udine, categorized by fuel type. For each fuel type, the table shows the total number of systems and the combined power output. The data on heating systems is updated to 2012.
As shown in the data, the vast majority of heating systems in Udine are powered by methane.

Fuel	Number of systems	Total power (kW)
METHAN	30.091	997.969
GASOLINE	574	74.973
GPL	137	12.076
TOTAL	**30.802**	**1.085.018**

Regarding the building stock, useful information on the energy performance of buildings can be obtained from the CasaClima certification protocol. It should be noted that the CasaClima certification process has been mandatory for new constructions in the municipality of Udine since 2009.
The following table lists the certifications issued since 2009, categorized by class (GOLD, A, B, C), which indicate the energy consumption level of a building.
This represents, of course, only a small portion of the entire building stock in the city of Udine.

YEAR	GOLD CLASS	CLASS A	CLASS B	CLASS C	TOTAL CERTIFICATIONS
2009	0	0	0	0	**0**
2010	1	0	0	0	**1**
2011	0	0	9	0	**9**
2012	0	4	13	0	**17**
2013	0	7	10	0	**17**
2014	1	7	18	0	**26**
2015	0	4	12	0	**16**
2016	0	10	13	0	**23**
2017	0	3	11	0	**14**
2018	0	11	13	0	**24**
2019	0	16	10	1	**27**
2020	0	12	9	0	**21**
2021	2	17	15	0	**34**
2022	3	23	7	0	**33**
2023	1	26	9	0	**36**
2024	1	13	7	0	**21**
TOTAL	**9**	**153**	**156**	**1**	**319**

It was not possible to gather other information on the private construction sector, which will be more easily obtained when the Municipality's involvement in the project reaches a more advanced stage.

The Local Energy Supply

The table below provides data on renewable energy production plants in the municipality of Udine.
The largest number of plants and the highest production of electric MWh are attributed to photovoltaics. With 1,540 plants (as of 2024) installed on public and private structures (in residential, tertiary, and industrial sectors), they generate approximately 16,000 MWh annually.

There are also two biogas plants in operation, with capacities of 210 kW and 480 kW respectively, producing about 1,350 MWh of electricity annually.

The 11 hydroelectric plants for which data was available have nominal capacities ranging from 19 to 375 kW. The total capacity of these 11 plants is 1,295 kW, generating an average annual production of 10,800 MWh of electricity.

In addition to the aforementioned electricity production plants, there are approximately 350 renewable energy systems for domestic hot water production (solar panels) in the municipality of Udine, mostly on residential buildings. These systems are estimated to produce a total of 413 MWh of thermal energy annually.

RES plants	Number	MWh_e/anno	MWh_{th}/anno
Solar photovoltaic systems	1.540	16.074	
Solar thermic systems	400		413
Biogas plants	2	1.350	
Hydroelectric plants	11	10.800	

4. Mapping of H&C target groups

CITY	STAKEHOLDER	TARGET GROUP	CONTACT PERSON(S)
Udine	Andrea Zini – Municipality of Udine	Local authority	assessore.zini@comune.udine.it
	Alessandro Colautti – Municipality of Udine	Local authority	?
	Rodolfo Londero – Municipality of Udine	Local authority	?
	Paola Rovella – Municipality of Udine	Local authority	paola.rovella@comune.udine.it
	Alessandro Boz – Banca 360 FVG	Financial institution	relazioni@banca360fvg.it
	Davide Bonetto o Giampiero Zanchetta – Net Spa	Utility company (urban waste)	davide.bonetto@netaziendapulita.it giampiero.zanchetta@netaziendapulita.it
	Francesco Marangon – Università di Udine	University	francesco.marangon@uniud.it
	Franco Campagna – Confindustria UD	Industry and business association	campagna@confindustria.ud.it
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5. Summary in national language

Udine, situata nella pianura friulana, ha una superficie di circa 57 km² ed è caratterizzata da un clima continentale moderato e umido. I dati climatici dal 1992 al 2023 mostrano un aumento delle temperature medie, minime e massime, con un incremento delle giornate tropicali e delle notti tropicali. La città sta affrontando una riduzione dei giorni con temperature minime sotto lo zero, ma un lieve aumento dei giorni con massime sotto lo zero.

Per quanto riguarda le attività economiche, il settore primario è dominato da viticoltura e agricoltura, mentre l'industria si concentra su metalmeccanica, arredamento e agroalimentare. Il terziario, con commercio, turismo e servizi, si affianca a un vivace sviluppo nell'innovazione e nella ricerca, sostenuto dall'Università e dalle startup tecnologiche.

Per la transizione energetica, l'Italia ha fatto buoni progressi nella promozione dei sistemi di teleriscaldamento (TLR), con il 77% del calore prodotto da fonti rinnovabili, calore di scarto e cogenerazione ad alta efficienza. Tuttavia, sono necessari ulteriori passi per raggiungere gli obiettivi di decarbonizzazione fissati per il 2050. La Regione Friuli-Venezia Giulia ha sviluppato un quadro normativo e azioni specifiche per incentivare l'uso della biomassa e del calore di scarto, supportando anche la riduzione della povertà energetica e l'espansione delle reti di teleriscaldamento.

Il Friuli-Venezia Giulia si distingue come leader nella transizione energetica con l'obiettivo di raggiungere la neutralità carbonica entro il 2045, come stabilito dalla legge "FVG Green". Questo quadro normativo promuove energie rinnovabili, efficienza energetica e cambiamenti sistemici nei settori chiave, allineandosi agli obiettivi climatici nazionali e al Green Deal europeo.

Nonostante i progressi, permangono sfide significative, tra cui valutazioni ambientali insufficienti per nuovi progetti, scarsa chiarezza sulle aree idonee e difficoltà nell'implementazione delle comunità energetiche (CER) a causa della complessità normativa.

La regione ha adottato misure per agevolare le installazioni di energie rinnovabili, sostenere le imprese con fondi specifici e promuovere reti di teleriscaldamento alimentate da fonti rinnovabili. Iniziative mirate incentivano anche sistemi fotovoltaici e termici, con programmi attivi fino al 2025 per cittadini e organizzazioni.

Il FVG supporta il settore agricolo e residenziale con incentivi per l'efficienza energetica e la riduzione delle emissioni, mentre nuovi progetti mirano a migliorare le prestazioni degli edifici esistenti. Tuttavia, restano criticità nel coordinamento intersettoriale e nella gestione delle risorse finanziarie, evidenziando la necessità di una governance più integrata e di un maggiore coinvolgimento degli stakeholder. Nonostante i progressi già compiuti, il Piano Energetico Regionale (PER FVG) evidenzia la necessità di ulteriori interventi per migliorare l'efficienza energetica e il potenziale di decarbonizzazione, in particolare nei processi industriali a media e bassa temperatura. Tra le azioni previste, due si distinguono per il loro impatto e ambizione:

1. **Azione 05.2 – Ridurre la povertà energetica**: Uno degli obiettivi principali del PER FVG è ridurre la povertà energetica, incentivando i cittadini a connettersi alle reti di teleriscaldamento esistenti. A tal fine, sono previsti fondi regionali specifici per sostenere le connessioni alle reti già attive, con un'attenzione particolare all'utilizzo della biomassa locale e al recupero di calore da fonti difficili da decarbonizzare. Questo programma è gestito dal Servizio Transizione Energetica del Dipartimento Infrastrutture e Territorio, con il supporto di una delibera regionale che prevede anche incentivi per il recupero di calore di scarto da settori industriali.
2. **Azione 11.3 – Sviluppare la filiera della biomassa legnosa**: La Regione intende espandere le reti di teleriscaldamento alimentate da impianti a biomassa legnosa. A questo scopo, vengono previsti contributi finanziari per la costruzione di nuovi impianti e il rafforzamento delle reti esistenti, con l'obiettivo di estendere le opportunità di finanziamento anche ai cittadini, in aggiunta ai comuni. L'iniziativa è supportata da un fondo di 5 milioni di euro, destinato a interventi che si svilupperanno nel corso di sei anni.

Le azioni delineate puntano a valorizzare le risorse locali come la biomassa e il calore di scarto, migliorando l'efficienza energetica e contribuendo alla decarbonizzazione del settore del riscaldamento e del raffreddamento (H&C). L'obiettivo complessivo è non solo la crescita delle reti di teleriscaldamento, ma anche il raggiungimento di un equilibrio tra sostenibilità ambientale ed economica, riducendo al contempo le disuguaglianze sociali legate ai costi energetici.

Il Comune di Udine ha elaborato strategie per affrontare le sfide energetiche e climatiche attraverso il PAESC, approvato nel 2021 e successivo al PAES del 2010. Questi piani includono azioni mirate per migliorare l'efficienza energetica di edifici pubblici e privati, promuovere l'uso di energie rinnovabili e ridurre le emissioni di gas serra. Il PAESC, in particolare, integra

un Sistema di Gestione dell'Energia (EMS) adottato grazie al progetto europeo Horizon 2020 Compete4SECAP, coinvolgendo edifici pubblici e scuole per ottimizzare le prestazioni energetiche.

Le iniziative del PAESC sono articolate su due assi principali: il miglioramento dell'efficienza energetica e l'espansione dell'uso di energie rinnovabili. Tra le azioni previste figurano la riqualificazione energetica degli edifici municipali mediante strumenti di finanziamento innovativo, l'espansione del teleriscaldamento in diverse aree della città, incentivi per sistemi fotovoltaici nel settore privato e il supporto alla sostituzione di impianti alimentati da combustibili fossili con tecnologie rinnovabili. Grazie a queste politiche, il Comune ha superato gli obiettivi del PAES, raggiungendo una riduzione delle emissioni del 22,84% nel 2019 rispetto al 2006.

Dal 2009 è obbligatoria la certificazione CasaClima per le nuove costruzioni, che valuta gli edifici in base al consumo energetico. Sono state emesse 319 certificazioni fino al 2024, suddivise in quattro classi di efficienza energetica, ma queste rappresentano solo una piccola parte del patrimonio edilizio cittadino. Il Comune promuove la costruzione di edifici a energia quasi zero e incentiva la riqualificazione energetica di quelli esistenti.

Un'analisi dei consumi energetici del 2019 mostra che il trasporto privato e commerciale rappresenta il 42% dei consumi totali, seguito dal settore residenziale con il 38%. Le principali fonti di energia consumata sono il diesel, il gas naturale e l'elettricità. La produzione locale di energia rinnovabile include 1.540 impianti fotovoltaici, che generano circa 16.074 MWh/anno, due impianti a biogas con una produzione complessiva di 1.350 MWh/anno, undici centrali idroelettriche che producono 10.800 MWh/anno e circa 400 impianti solari termici per l'acqua calda.

La sostenibilità energetica è un elemento chiave del Piano Regolatore Generale Comunale, che promuove la concentrazione dello sviluppo urbano in aree già edificate per evitare il consumo di suolo agricolo e preservare gli spazi verdi. Il Comune favorisce interventi basati sulla natura per incrementare la resilienza climatica, mitigare le inondazioni, ridurre l'effetto isola di calore, aumentare la biodiversità e migliorare i servizi ecosistemici. Tra questi interventi, un Catalogo delle Buone Pratiche identifica soluzioni progettuali per affrontare le sfide climatiche e integrare strategie di adattamento e rigenerazione urbana.

Deliverable D2.1 – Annex 1

THE REGIONAL REFERENCE POLICY AND STRATEGIC CONTEXT IN SICILY

Regional Context in Sicily for Energy and Climate Strategies

Sicily's regional energy and climate framework is driven by strategies and plans promoting energy efficiency and the adoption of renewable energy sources. Key tools include:

- **Regional Energy and Environmental Plan of Sicily (PEARS)**: it focuses on renewable energy use, CO_2 emission reductions, and energy consumption optimization. For the H&C sector, PEARS provides incentives to promote efficient and renewable technologies.
- **Climate Change Adaptation Strategies**: Sicily has implemented measures to address climate vulnerabilities such as heatwaves and water scarcity. These include measures improving the energy efficiency of public and private buildings and enhancing network infrastructures.
- **Regional Incentives**: Funded through EU structural funds, Sicily finances innovative projects to promote energy efficiency and decarbonization, including the POR FESR Sicilia 2021-2027 funds that support H&C technologies.
- **Urban and Building Regulations**: Regional regulations encourage the integration of sustainable energy systems in new constructions and the redevelopment of existing buildings. These regulations prioritize the use of waste heat recovery systems, heat pumps, and biomass- or renewable-powered boilers.

Legislative and Regulatory Framework on Energy and Climate

As an autonomous region, Sicily aligns its strategies with national and EU goals while tailoring plans to local needs. Key regional policies include:

- PEARS (the Regional Environmental Energy Plan) - it establishes objectives for the increase in energy efficiency and the use of renewable sources. For the H&C sector, PEARS promotes the adoption of technologies such as heat pumps, biomass boilers and district heating systems, considering the regional climate context with a significantly higher demand for cooling than for heating. Supports the transition to low energy buildings through building requalification.
- Regional building regulations – they promote the integration of H&C systems based on RES (mainly photovoltaic and solar thermal systems). They encourage the efficiency of public and private buildings, in line with national and European directives. Articles 33, 36, 68, 87 of the "SINGLE STANDARD BUILDING REGULATION" (Art.2 regional law 10 August 2016 n.16 and subsequent amendments - Art.29 regional law 13 August 2020, n.19 and subsequent amendments. Updated with the regulatory provisions referred to in Legislative Decree no. 76/2020 converted into law no. 120/2020 and the regional law of 6 August 2021, n.23) regulate everything relating to energy efficiency and therefore H&C systems:
    - Art.33 performance requirements of buildings paragraph 6: In order to ensure adequate thermal insulation and the containment of energy consumption, the construction characteristics of the buildings must correspond to the dictates of Law 9 January 1991 n. 10 and subsequent amendments, and the related implementing regulation, Presidential Decree. 26 August 1993 n. 412 and subsequent amendments, which regulate energy consumption in public and private buildings, whatever their intended use, as well as, through the provisions of article 31 of the aforementioned law, the operation and maintenance of the systems existing
    - Art.36 incentives: the Sicily Region, in line with state provisions, provides for the recognition of particular economic benefits or building availability (volumetric bonuses, exceptions to urban planning-building parameters, municipal taxation, reduction of construction contributions) for works aimed at increasing the energy-environmental sustainability of buildings. The Region

grants Municipalities the possibility of including the above-described rewards in order to raise the level of energy sustainability of buildings in their territory.

- Art.68 Production of energy from renewable sources, from cogeneration and district heating networks: In all new construction and significant renovation projects of existing buildings, as defined in Legislative Decree 3 March 2001, n.28, in all categories of buildings from E.1 to E.8 it is mandatory to provide for the installation of systems for the production of energy from renewable sources in an amount no less than that provided for by the higher-level legislation on the matter. In the case of a new cogeneration system and related heat (and possibly cold) distribution network, the energy performance values defined by Legislative Decree 20/2007 must be respected. Even in areas subject to landscape restrictions, subject to particular protection regulations, it is possible to install solar and photovoltaic panels.
- Art.87 Heat production and air conditioning: In new construction and building replacement interventions, concerning buildings belonging to category E1 listed in article 3 of the Presidential Decree of 26 August 1993, n. 412, with more than four residential units, the use of centralized heating and domestic hot water production systems, also powered by district heating networks, is preferable. It is preferable to use materials and surface finishes with a reflectivity coefficient that guarantees adequate control of the thermal gains of horizontal opaque structures and/or with an inclination of less than 10° and contributes to reducing the heat island effect. In newly constructed buildings and in building replacement interventions, the improvement of the microclimate must also be achieved through one or more of the following interventions concerning the external areas: shading with plant elements; flooring systems with draining elements and vegetation housed inside; use of "cold" type materials for external flooring (light stone, wood, reinforced lawn). In new construction, building replacement, renovation and extraordinary maintenance of existing buildings, all necessary measures must be adopted to limit the use of summer air conditioning.

- **Regional Climate Change Strategy** - The Sicily Region has developed a plan to address climate vulnerabilities, such as rising average temperatures, heat waves and water scarcity. It sets the objective of reducing greenhouse gas emissions by 40% by 2030, with specific actions in the energy and urban sectors.
- **Regional Mitigation and Adaptation Strategies**

Mitigation: Incentives for the installation of renewable energy systems in public and private buildings; promotion of district heating based on biomass and waste heat; development of local energy communities that exploit available renewable sources.

Adaptation: designing infrastructure resistant to heat waves and water scarcity; adoption of building materials and H&C technologies that reduce energy requirements for cooling; encouraging urban forestry interventions to improve the city microclimate and reduce the heat island effect.

Incentives and Support Mechanisms

- POR FESR Sicily 2021-2027 funds: they support energy efficiency projects in public and private buildings; Incentivize the adoption of technologies for decarbonization in the H&C sector, including passive cooling systems and biomass plants:
  - *2.1.1. Priority: 0002. A greener Sicily 2.1.1.1. Specific objective: RSO2.1. Promote energy efficiency and reduce greenhouse gas emissions (FERS)*

    Interventions aimed at eco-efficiency and reduction of primary energy consumption in buildings and public structures

    The action promotes interventions aimed at improving energy performance, with a consequent reduction in energy consumption, in the most energy-intensive buildings of the PA and of the bodies belonging to it or belonging to public heritage. The interventions should preferably allow primary energy savings in line with a medium-level renovation (ref. Recommendation (EU)

2019/786 of the Commission) and a reduction of at least 30% in direct and indirect greenhouse gas emissions compared to ex ante emissions. Among the possible actions aimed at achieving the objectives of reducing consumption and emissions of climate-altering gases, we could envisage, among others, shading interventions, solar shielding, thermal insulation and systems, the installation on buildings and their appurtenances of solar, thermal and/or photovoltaic, cogeneration/trigeneration systems, as well as the possible use of intelligent remote control systems for the regulation, monitoring and optimization of energy consumption. These energy efficiency interventions must, however, be coordinated with the interventions for the mitigation of seismic risk. Finally, for the implementation of the aforementioned interventions, the reuse of construction materials, the use of construction materials with recycled content, as well as the replacement of traditional construction materials with alternatives with a lower environmental impact will be encouraged.

Energy requalification in businesses

Energy requalification in companies is an action that can also be implemented through financial instruments or innovative business models. It promotes interventions aimed at both the production cycle and company buildings, encouraging the use of renewable energy for self-consumption and/or the production of energy necessary to power the production cycles, including through the installation of the corresponding plants. Priority will be given to interventions that involve the development of advanced energy consumption measurement systems and those carried out by companies that have established or intend to establish an energy management system in accordance with ISO 50001 standards, and that involve the figure of an Energy Manager or Energy Management Expert. Among the possible actions aimed at achieving the goals of reducing consumption and greenhouse gas emissions, the installation of high-efficiency cogeneration/trigeneration plants, interventions aimed at increasing the energy efficiency of the buildings where the production cycle takes place, and the installation of renewable energy-powered systems could be foreseen. Furthermore, energy efficiency projects should aim to equip companies with systems for detecting, monitoring, and modelling the strategic aspects of the production system, seeking any energy flows that can be recovered and reused within the production cycle. The implemented interventions should result in significant impacts on the reduction of direct and indirect greenhouse gas emissions, by at least 30% compared to ex-ante emissions. Considering the ambitious regional energy efficiency targets to combat climate change on one hand, and the increase in energy costs on the other, large companies may also be supported through appropriate financial tools.

Priorità	Obiettivo specifico	Fondo	Categoria di regione	Codice	Importo (EUR)
0002	RSO2.1	FESR	Meno sviluppate	01. Sovvenzione	164.555.163,00
0002	RSO2.1	FESR	Meno sviluppate	03. Sostegno mediante strumenti finanziari: prestito	17.500.000,00
0002	RSO2.1	Totale			182.055.163,00

- *2.1.1. Priority: 0002. A greener Sicily 2.1.1.1. Specific objective: RSO2.2. Promote renewable energy in accordance with Directive (EU) 2018/2001[1] on energy from renewable sources, including the sustainability criteria established therein*

Installation of systems for the energy valorisation of biomass and the organic fraction from Municipal Solid Waste (FORSU/OFMSW) with efficient and low environmental impact technologies

Although Sicily is characterized by a good availability of waste biomass and wood (which could derive from a more careful and planned maintenance of the forestry heritage) it is however, still today, among the last regions in Italy in terms of installed power. In addition to this, the disposal of residual biomass, deriving mainly from agro-industrial processes, such as those produced by the olive and wine industries, today represents not only an economic but also an environmental cost, considering the potential risks associated with their incorrect disposal. These biomasses, together with OFMSW which in Sicily represents 45% of separate waste collection, could, however, become precious resources if they were converted into energy using the correct technologies. In this context, the Sicilian Region, also to support the development of vast internal areas of the island, intends to focus on biomasses that originate from the maintenance and management of forests and/or from the energy valorisation of agricultural and biomass waste agro-industrial. The action will therefore support interventions for the production of biogas, with possible upgrade to biomethane, from OFMSW and agricultural and agro-industrial biomass waste (the latter to a minority extent) in line with Directive (EU) 2018/2001.

Promote the creation of Energy Communities

The action will have the aim of supporting the establishment of Energy Communities, even in a mixed public-private composition, activating, at district level, production models based on green and renewable energy and encouraging connections and collaborations between SMEs and consortia, with the possible contribution from research bodies/centres. The intervention will enable Local Authorities to produce and exchange energy and more generally to transform the regional territory into an attractive pole for research on renewables, channelling capital and skills through a new conception of the role of non-energy more as a mere market product, but as a primary resource to be used in the interest of the community itself, also with the aim of combating the phenomenon of energy poverty. In this context, it will be necessary to combine the promotion and diffusion of energy production systems from renewable sources with the opportunity to limit the consumption of regional land (e.g. photovoltaic systems on bodies of water, agrivoltaic systems, etc.), as well as foreseen by PEARS 2030. The action will contribute to supporting the expenses incurred for the drafting of the projects and documentation related to the establishment of the Energy Communities. Furthermore, investments in the production of renewable energy by the Communities themselves will be supported, compatibly with the national incentive system. The action will develop in complementarity and synergy with the interventions envisaged by the PNRR on the matter.

Priorità	Obiettivo specifico	Fondo	Categoria di regione	Codice	Importo (EUR)
0002	RSO2.2	FESR	Meno sviluppate	01. Sovvenzione	164.044.139,00
0002	RSO2.2	FESR	Meno sviluppate	03. Sostegno mediante strumenti finanziari: prestito	26.250.000,00
0002	RSO2.2	Totale			190.294.139,00

Expected Scenarios in the H&C Sector

Increasing demand for cooling: climate projections indicate an increase in average temperatures and heat waves, increasing the demand for energy for cooling. Energy efficiency and renewable sources: Sicily aims for a transition towards the use of renewable sources (solar thermal and biomass) to reduce dependence on fossil fuels and achieve decarbonisation objectives.

MUNICIPALITY OF RAGUSA

1. The local territorial context

Main Geographical, Territorial, and Urban Characteristics

Ragusa, located in the Hyblaean Mountains of southeastern Sicily, is Italy's southernmost provincial capital. With a population of 73,736 inhabitants (ISTAT, December 2023) and covering an area of 444.67 km², it is the seventh-largest municipality in the region by population and the third largest by area. It sits over 500 meters above sea level, about 20 km from the coast. The highest peak of the Hyblaean Mountains is Mount Arcibessi (906 m).

The city is bordered to the east by Mount San Cono and the Irminio River, the most significant in the area; to the north by Mount Patro and the San Leonardo River; and to the south by Mount Bollarito, separated by the Fiumicello stream. Ibla, the old part of the city, is perched on a hill to the west, while the modern area extends over an adjacent mountain.

In 1693, a devastating earthquake nearly obliterated the city, resulting in over five thousand fatalities. The 18th-century reconstruction divided Ragusa into two major districts: Ragusa Superiore, situated on the plateau, and Ragusa Ibla, rebuilt on the medieval ruins, retaining the original urban layout. The Baroque architectural masterpieces built after the earthquake, along with others in the Val di Noto, were declared a UNESCO World Heritage Site in 2002.

Originally covered in Mediterranean vegetation, the area was adapted for cereal cultivation and pastoralism. The Irminio River, flowing through the territory and separating the municipalities of Giarratana and Ragusa, has experienced a decline in water levels over time. However, the dam has created Lake Santa Rosalia, an artificial reservoir. Ragusa is now renowned for its Baroque art, thanks to its 18th-century churches and palaces.

Climate Overview

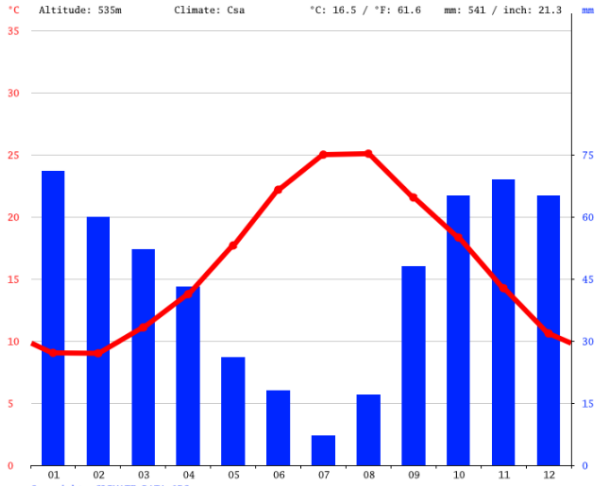
Ragusa enjoys a Mediterranean hill-type climate. Its altitude results in lower average temperatures compared to the coastal area. Snowfall is rare in the lower parts of the city, such as Ibla, while more frequent in the higher areas on the plateau, which features a Mediterranean mountain climate. Winters are very rainy, with precipitation periods stretching from October to March, making Ragusa one of the rainiest provincial capitals in the region. Heavy rainfall is common during the intense thunderstorms of autumn.

Ragusa's climate classification: Zone C

Degrees Days: 1,324

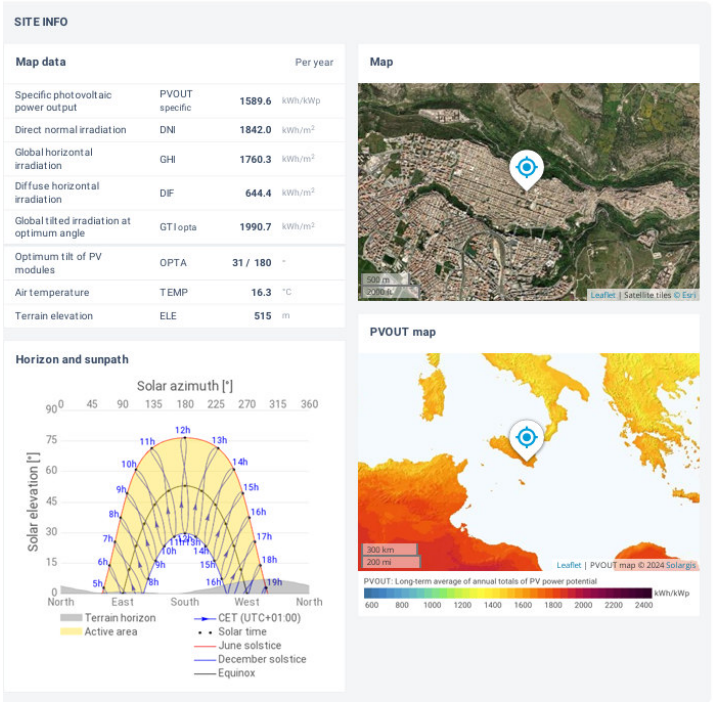
Heating systems in buildings can operate for up to 10 hours a day between November 15 and March 31. The coastal subdivision of Marina di Ragusa falls under Zone A of the climatic classification.

The chart and table (source: https://it.climate-data.org/ for the 1991–2021 period) illustrate the distribution of rainfall and temperatures throughout the year. January is the rainiest month, with 71 mm of rainfall, while July is the driest, with 7 mm of rain. As for temperatures, the data show that August is the hottest month of the year, with an average temperature of 25.1°C, while January has the lowest average temperature of 9.0°C.



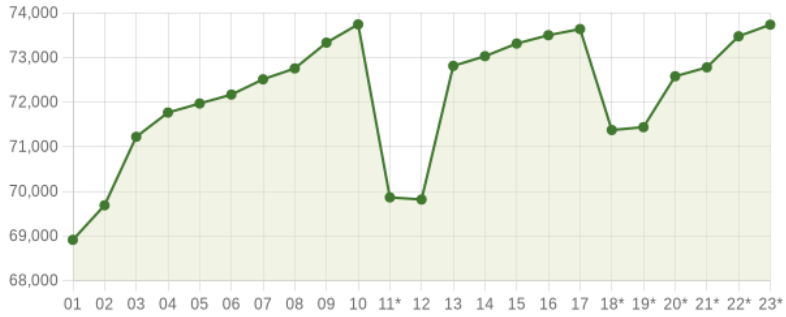
	Gennaio	Febbraio	Marzo	Aprile	Maggio	Giugno	Luglio	Agosto	Settembre	Ottobre	Novembre	Dicembre
Medie Temperatura (°C)	9	9	11.1	13.8	17.7	22.2	25	25.1	21.5	18.3	14.2	10.6
Temperatura minima (°C)	6.3	6.1	7.7	10.1	13.6	17.7	20.4	20.9	18.2	15.4	11.7	8.1
Temperatura massima (°C)	12	12.1	14.6	17.5	21.8	26.4	29.4	29.4	25.2	21.7	17.1	13.4
Precipitazioni (mm)	71	60	52	43	26	18	7	17	48	65	69	65
Umidità(%)	79%	77%	75%	71%	64%	57%	55%	60%	71%	77%	79%	78%
Giorni di pioggia (g.)	7	6	6	6	4	2	1	3	5	7	7	7
Ore di sole (ore)	6.3	6.9	8.4	9.9	11.7	12.6	12.7	11.7	9.4	7.7	6.5	6.2

The annual solar radiation (GHI) in the municipality of RAGUSA is 1,760 kilowatt-hours per year. (https://globalsolaratlas.info 2023)

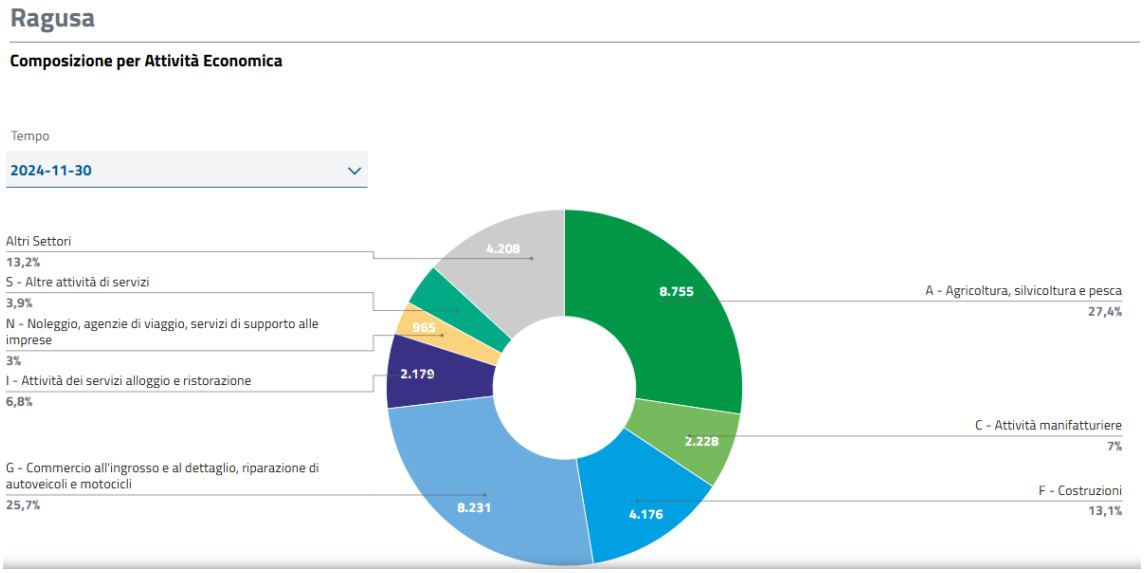


Socio-Economic Overview

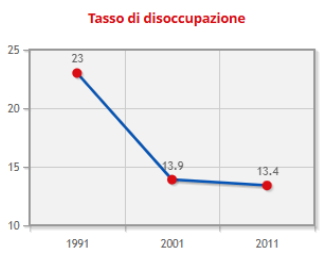
Ragusa is a municipality with 73,736 inhabitants (as of December 31, 2023, ISTAT). An analysis of demographic trends and their comparison at the provincial and regional levels shows: a steady population increase from 2001 to 2010, a reversal of this trend in 2011, and a gradual recovery until 2013. From then on, the population maintained a slightly increasing trend until 2017, followed by a slight decline in 2018. When comparing municipal data with provincial and regional figures (Graph 2), a significant parallelism between the displayed values emerges.



In the province of Ragusa, the most developed economic sectors are Agriculture, Forestry, and Fishing, along with Wholesale and Retail Trade and the Repair of Motor Vehicles and Motorcycles. (Source: Opendata, November 2024)



The average income in Ragusa is €18,116 (Ministry of Economy and Finance, 2023). The following charts illustrate the trends in employment and unemployment rates, sourced from https://ottomilacensus.istat.it/.



2. The local reference policy and strategic context

Ragusa has committed to decarbonization by adopting a Sustainable Energy Action Plan (SEAP) and updating it with a more ambitious SECAP (Sustainable Energy and Climate Action Plan - 2021). The city aims for a 40.9% reduction in CO2 emissions by 2030, in line with the Covenant of Mayors for Climate and Energy.

Sector/filed of intervention	Action (PAESC 2022)	Energy savings (MWh/a)	RES production (MWh/a)	CO2 reduction (t/a)
Municipal buildings, equipment/facilities	EC 01 ENERGY REDEVELOPMENT OF MUNICIPAL BUILDINGS AND RATIONAL USE OF ENERGY	3160	0	973
Municipal buildings, equipment/facilities	EC 04 THERMAL SOLAR - HEAT PUMPS - PHOTOVOLTAIC FOR CITY SPORTS CENTRES	855	0	173
Municipal buildings, equipment/facilities	EC 07 PROGRESSIVE REPLACEMENT OF GAS-OIL OR METHANE BOILERS WITH MORE EFFICIENT HEATING SYSTEMS	136	0	36
Municipal buildings, equipment/facilities	EC 08 GREEN PURCHASES (GPP) WITH MINIMUM ENVIRONMENTAL CRITERIA (CAM)	0	0	772
Tertiary	TER 01 ENERGY EFFICIENCY AND FER PORT MARINA DI RAGUSA	40	89	40
Tertiary	TER 02 ENERGY RENOVATION OF ACCOMMODATION FACILITIES	75813	0	29276
Residential buildings	RE 01 INCENTIVES FOR ENERGY RENOVATION OF BUILDINGS	78730	0	22670
Residential buildings	RE 02 EFFICIENT BOILERS AND HYBRID SYSTEMS	7200	0	1640
Residential buildings	RE 03 THERMOSTATIC VALVES ON AUTONOMOUS SYSTEMS	16573	0	3496
Residential buildings	RE 04 INSTALLATION OF AUTOMATIC SWITCH-OFF DEVICES	1680	0	518
Residential buildings	RE 05 LED RESIDENTIAL	8407	0	4060
Residential buildings and Tertiary	EC 09 PROMOTING THE REALISATION OF GREEN ROOFS	69376	0	22813
Residential buildings and Tertiary	TER 03 INTERVENTIONS TO REDUCE ELECTRICITY CONSUMPTION	6122	0	2957
Public lighting	EC 02 EFFICIENCY ENHANCEMENT OF THE PUBLIC LIGHTING SYSTEM	4662	0	1436
Industry	IND 01 PROMOTION OF ENERGY EFFICIENCY IN THE INDUSTRIAL SECTOR	61798	0	29848
Industry	IND 02 ELECTRIC VARIABLE SPEED DRIVES (VSD)	23174	0	11193
Municipal fleet	TRA 05 MOBILITY MANAGER	0	0	0
Public transport	TRA 01 SUSTAINABLE PUBLIC TRANSPORT	38922	0	9618
Private and commercial transport	TRA 02 CONSTRUCTION OF CYCLE PATHS	19461	0	4809
Agricolture, Forestry, fisheries	TRA 03 BIKE SHARING	279	0	69
Private and commercial transport	TRA 04 INSTALLATION OF CHARGING STATIONS FOR ELECTRIC OR HYBRID CARS	111	0	31
Agricolture, Forestry, fisheries	AG 01 PRECISION AGRICULTURE	20567	0	5491
Agricolture, Forestry, fisheries	AG 02 TRAINING FOR FARMERS	0	0	0
Agricolture, Forestry, fisheries	AG 03 ECO-FRIENDLY WINE GROWING	4113	0	1098
Agricolture, Forestry, fisheries	AGR 04 AGROENERGY	17676	0	4660
Local electricity production	EC 05 WIND ENERGY PRODUCTION	0	300	116
Local electricity production	EC 06 INSTALLATION OF PHOTOVOLTAIC SYSTEMS ON MUNICIPAL BUILDINGS	204	45	63
Local heat/cold production	/	/	/	/
Other (integrated water service)	EC 03 IMPROVING THE EFFICIENCY OF THE INTEGRATED WATER SERVICE	6413	0	1975
Other (education and information)	EC 10 TRAINING AND EDUCATION ACTIVITIES IN SCHOOLS	0	0	0
Other (education and information)	EC 11 RAISING AWARENESS THROUGH EDUCATIONAL ACTIVITIES	140	0	40
Other (CER)	CER PROMOTION OF RENEWABLE ENERGY COMMUNITIES			

Actions highlighted in yellow that promote increased efficiency and deployment of renewables in the H&C sector. In particular:

- EC 01 ENERGY REDEVELOPMENT OF MUNICIPAL BUILDINGS AND RATIONAL USE OF ENERGY: The Municipal Administration intends to carry out the energy requalification of its real estate assets by

intervening, among other things, on the efficiency upgrading of energy generation systems for heating and air conditioning, favouring the installation of centralised and highly efficient technological solutions. The interventions of this action are partly ongoing and are financed by FSC 2007-2013/PO ERDF 2014-2020 ACTION 4.1.1

- EC 04 THERMAL SOLAR - HEAT PUMPS - PHOTOVOLTAIC FOR CITY SPORTS CENTRES: Considering that municipal and private sports centres represent, due to their own functional characteristics, one of the most energy-wasting points, i.e. facilities for which energy needs (thermal and electrical) are difficult to rationalise, the Administration intends to reduce consumption in these centres by upgrading and improving the energy class of buildings by replacing oil boilers with more efficient RES systems and installing photovoltaic or solar thermal systems on the same buildings. The action has not started yet and is to be financed by national funds.
- EC 07 PROGRESSIVE REPLACEMENT OF GAS-OIL OR METHANE BOILERS WITH MORE EFFICIENT HEATING SYSTEMS: action not initiated to be financed by national funds or royalties.
- EC 08 GREEN PURCHASES (GPP) WITH MINIMUM ENVIRONMENTAL CRITERIA (CAM) The Administration is committed to improving the environmental quality of its purchases also with regard to heating and cooling systems. Action not started to be financed with municipal own funds.
- EC 09 PROMOTING THE REALISATION OF GREEN ROOFS Green roofs are man-made structures that integrate with the building, providing the building with various functions and benefits: they provide insulation and shade for buildings, help reduce energy demand, limiting the need for heating and cooling and improving a building's energy performance. The municipal administration intends to promote the implementation of green roofs in its territory. A MAPPING of intervention potential will be developed and operational measures will be undertaken, through specialists in the field, and financial support will be provided to those interested. Action not initiated to be financed by own/European/national/regional funds.
- TER 02 ENERGY RENOVATION OF ACCOMMODATION FACILITIES The municipal administration intends to promote energy redevelopment in the tertiary sector to contain energy consumption and reduce emissions. The real estate linked to hospitality facilities is articulated and is made up of buildings from different periods of construction with the presence of substantial margins for energy savings, even if in some cases there are architectural constraints that make the action complex to implement. Preliminary energy audits will have to be prepared in order to identify technological solutions for the envelope, systems and for the optimal management of the building from an energy point of view. The performance of the audits will make it possible to identify different types of intervention that will concern both the envelope and the plant engineering part and that are indicated below: insulation of walls and horizontal elements; replacement of windows and doors; identification of systems for shading the most exposed walls and for transparent openings; elimination of thermal bridges; making the energy generation systems for heating and air conditioning more efficient by favouring the installation of centralised and high-efficiency technological solutions (limiting the installation of isolated systems) insertion of regulation and control systems for the plant engineering part and, where possible, partialisation of distribution systems for more effective management of air conditioning, including thermostatic valves; interventions to improve the efficiency of internal lighting of spaces; interventions for the external lighting of buildings. Action started at national level but not in Ragusa to be financed with national funds (Superbonus hotels).
- RE 01 INCENTIVES FOR ENERGY RENOVATION OF BUILDINGS Promotion of energy efficiency interventions in private buildings through the use of state incentives. The Relaunch Decree raised to 110% the rate of deduction of expenses incurred for specific energy efficiency interventions,

earthquake-proof interventions, installation of photovoltaic systems or infrastructure for recharging electric vehicles in buildings. Ongoing action with a lower and decreasing rate. Financed by national funds.

- RE 02 EFFICIENT BOILERS AND HYBRID SYSTEMS The municipality, in order to achieve the set target of complete the replacement of obsolete boilers in the residential sector, will intensify its control activities and promote the replacement of obsolete boilers with more efficient systems. In addition, the Administration will promote awareness-raising activities in the area and training of technicians for control activities and of craftsmen/installers/maintenance of heating systems to ensure optimal maintenance of boilers. Action to be initiated, to be financed by national funds.
- RE 03 THERMOSTATIC VALVES ON AUTONOMOUS SYSTEMS The municipal administration intends to promote the installation of thermostatic valves on radiators in homes with autonomous systems served by different fuels through awareness-raising campaigns. The effectiveness of this action takes into account the fact that the intervention can be carried out on any system without significant economic costs.
- IND 01 PROMOTION OF ENERGY EFFICIENCY IN THE INDUSTRIAL SECTOR The municipal administration intends to promote energy efficiency in the industrial sector by focusing on innovation, green investments in line with the objectives of the new Italian industrial policy, more inclusive and attentive to sustainability, called Transition 4.0. Promoting Transition 4.0 favours a production and business management model whose characterising elements are the use of connected machinery, analysis of information obtained from the Net, and the possibility of a more flexible management of the production cycle. The opportunities present in the Budget Law 2021 allow companies that invest in assets using solutions in line with the Transition 4.0 policy to be supported by incentives (through tax credits from 6% to 50% depending on the assets purchased). In addition, it is possible to take advantage of the tax credit for research and development and training. In particular, the municipality intends to promote the types of interventions envisaged that involve the purchase of 'components, systems and intelligent solutions for the management, efficient use and monitoring of energy and water consumption and the reduction of emissions. Further opportunities are intended for small, medium and large enterprises that want to invest in machinery, plant and equipment for new production facilities or aimed at increasing production capacity thanks to the 'Bonus investimenti al Sud' tax credit. This transition is aimed at a sustainable modernisation of the industrial sector in the municipality with obvious positive repercussions on the related environmental energy impact. The municipality also intends to raise the awareness of existing businesses in the area on the rational use of energy, promoting the installation of photovoltaic panels on industrial warehouses in order to reduce the electrical consumption of plants.
- AGR 04 AGROENERGY Agro-energy refers to all energy sources that can be derived from agricultural processes. In general, when we speak of agro-energy, we refer to the production of biofuels or bioethanol such as biobutanol and bioethanol. Considering that these are renewable sources with a very low impact on the environment, agro-energy could represent an opportunity to protect agricultural land. Non-started action to be financed with European/national/regional funds.
- Renewable Energy Communoties (RECs) The objective of RECs is to minimise exchanges with the grid through maximum sharing of locally self-produced energy. This objective is more widely achieved the greater the involvement of the population, both in terms of the number of adhesions and the degree of participation, e.g. in adapting one's energy habits to the needs of CERs or in the availability of areas useful for photovoltaic production). The administration intends to promote this activity by means of meetings with citizens, webinars, information or web applications and to participate to the extent of its competence in the creation of RECs. Ongoing action.

PRG - Building Regulations

The Building Regulations of the current General Regulatory Plan (2017) state the following in Article 72. A new PRG has been implemented and has yet to be approved. In the new PRG, the municipal building regulation faithfully follows the single regional building regulation already described in the previous paragraphs.

Article 72 - Thermal and hygrothermal requirements

'Buildings must be designed and constructed in such a way that air temperatures and internal surface temperatures of opaque parts of the walls, appropriate to their intended use, are reached in every room, especially in cold and warm months. The design temperature of heated rooms and interior spaces must not exceed 20 °C. Higher temperatures may be envisaged: a) in rooms in hospitals, clinics, nursing homes and similar, intended for healthcare activities; b) in rooms intended for swimming pools, saunas and similar activities; c) in rooms in buildings intended for production activities or similar functions, where required by the technological cycle. The value of these higher temperatures must be justified with objective elements. The design temperature shall be the same for all heated rooms and spaces in the accommodation and shall not be less than 17 °C. The design air velocity for the areas of the rooms used by people, where these are served by air conditioning or ventilation systems or where they are equipped with ventilators or ventilation ducts, shall not exceed the following values: a) 0,25 m/s, if the rooms are not used for production or similar activities; b) 0,50 m/s, except for any higher values required by the technological cycle, if the rooms are used for production or similar activities. The opaque parts of the walls of the accommodation shall not be the site of permanent condensation under the conditions of occupancy and use provided for in the project. The opaque parts of the walls of living rooms must not be the site of transient condensation under the same conditions.'

Renewable Energy Communities

The Municipality of Ragusa, with Act of Address no. 88/2020, has ordered the implementation of a programme of interventions pertaining to the legal instrument of the CER for the realisation of new photovoltaic plants. By Executive Determination no. 1785/2020 a public notice of expression of interest was issued for the acquisition of preliminary applications for the establishment of CERs. By Act of the Municipal Council no. 412/2021, the outline of the collaboration agreement with ENEA on the Development of Energy Communities, signed on 29/09/2021, was approved. Municipal Council Resolution No. 45/2022 approved the bylaws and internal regulations for the establishment of the Renewable Energy Community called 'CER ZONA ARTIGIANALE COMUNALE ETS', which groups together a number of SMEs connected to the same secondary substation that feeds the municipal office complex of the Artisan Zone in Via On.le C. Diquattro in c.da Mugno Pendente. As of May 2023, requests have been received from private individuals and SMEs concerning the pilot projects in the Zona Artigianale, Via Forlanini and the rural district of S. Giacomo (for which a community technical assistance project called 'INTERREG-MED RENEWABLE ENERGY PROJECT - ECOSYSTEMIC TRANSITION UNIT', - D.G.M. 169/21 in which the Municipality participates, is active). Numerous applications were received from the Ibla and Ragusa Centro districts.

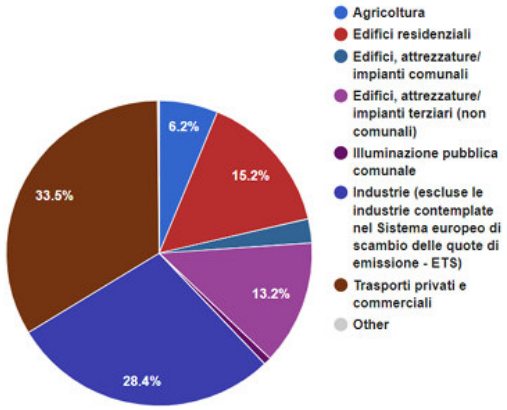
3. The local energy system

PAESC SOURCE

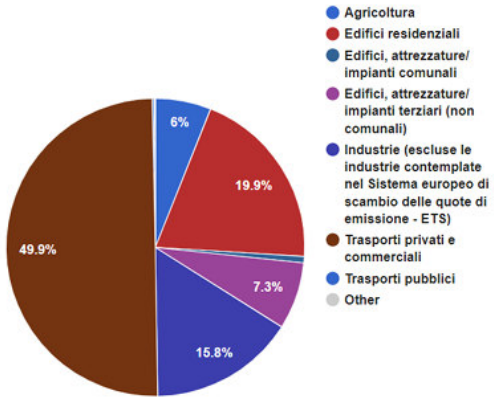
The total consumption of the entire Ragusa municipal territory in the year 2011 was about 1,233 GWh, while that for the year 2017 was about 1,304 GWh, showing an increase to 2017 of about 6%. With regard to

emissions, in 2011 they were about 390,649 tCO2, while in 2017 they were about 352,017 tCO2, thus determining a decrease of about 10%.

In 2017, consumption was distributed as in the following graph.



In 2017, emissions were respectively broken down according to the following chart.



In the public sector, electricity is the vector used in the vast majority of cases (86.6%) in 2017, while in the residential sector, this percentage, again with reference to the same year, drops to 40.9%. In the residential sector, consumption of natural gas (28.4%), LPG (15.7%) and biomass in general (13.0%) is very high. In the tertiary sector, as of 2017, electricity was the vector used for 66.6% of cases, followed by natural gas (21%), and diesel (7%). Finally, in the industrial sector, electricity consumption as of 2017 was 75.7 %, while fuel oil stood at 8.9 % and natural gas at 8.5 %.

The local energy demand

Sector	FINAL ENERGY CONSUMPTION (MWh) - 2017 (PAESc 2022)																
	Elettricity	Heat/cold	Fossil fuels								Energia rinnovabile						Total
			Natural gas	GPL	Heating oil	Diesel	Gasoline	Lignite	Coal	Other fossil fuel	Plant oil	Biofuel	Other biomass	Solar Thermal	Geothermal	Other	
Municipal buildings, equipment/facilities	38022,15	/	5605,64	/	287	/	/	/	/	/	/	/	/	/	/	/	43914,79
Tertiary	114377,045	/	36128,5425	8114,7056	11952,2875	/	/	/	/	1144,0533	/	/	/	/	/	/	171716,634
Residential buildings	80812,505	/	56150.5	31130,4	2635,51	/	/	/	/	/	/	/	25658,05	1364,4	/	/	141600,865
Public lighting	10297,15	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	10297,15
Industry	280468,303	/	31690,33	12424,53	/	13258,43	/	/	/	32886,83	/	/	/	/	/	/	370728,423
Municipal fleet	/	/	225	/	/	195,87	275,77	/	/	/	/	42	/	/	/	/	738,64
Pubblic transport	/	/	/	/	/	1724	/	/	/	/	/	73	/	/	/	/	1797
Private and commercial transport	/	/	7441,95	19989,2	/	272493	120518	/	/	/	/	16500	/	/	/	/	436942,15
Agricolture, Forestry, Fisheries	13915,28	/	5314,8181	1145,6452	/	60728,1986	/	/	/	/	/	/	/	/	/	/	81103,9419
Other	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	0
Total	537892,433	0	86406,2806	72804,4808	14874,7975	348399,499	120793,77	0	0	34030,8833	0	16615	25658,05	1364,4	0	0	1258839,59

The main end uses are for building air-conditioning and DHW production, where the prevailing technologies for the latter and for space heating systems are individual natural gas (methane) heat generators that replaced diesel and LPG (the latter also for DHW use) generators (collective - condominium type) when urban areas were converted to methane (about 25 years ago). In summer air-conditioning applications, individual air-to-air or air-to-water heat pump (PdC) systems and electrically powered air conditioners are used to a very large extent. In the last two years, individual PdC systems have tended to supplement and/or replace heating systems in civil buildings during energy and/or functional upgrades of the technological systems present there. There is a clear prevalence of high-temperature radiant type emission subsystems (radiators - room heating) and of the air type (fan coils - air conditioning). There are few examples of low-temperature radiant systems (floor and/or ceiling). Collective systems with heat or cooling metering are not worth mentioning in numerical terms. There are no low-enthalpy geothermal systems or district heating or cooling networks in the area. Individual solar thermal systems for the production of DHW are growing strongly; collective systems and systems for space heating are also not noteworthy.

The characteristics for the building sector are listed in the previous point. There is no note to be made of building energy certification systems, which are generally carried out in accordance with the relevant UNI standards. More detailed information on the local energy needs of air-conditioning systems can be obtained from the data of methane gas (2i rete gas s.p.a.) and electricity (E-Distribuzione s.p.a.) distribution service managers from LPG sales companies (Hybleagas s.r.l., etc.) that also have information on user systems for thermal energy use (Declarations of conformity DM 37/2008 ex L. 46/90). Further data can be obtained from the regional register CURI (Catasto Unico Regionale Impianti termici) where documents relating to energy efficiency checks of systems pursuant to Presidential Decree 74/2013 are gathered and finally through data on the activities carried out by the entity entrusted with the service on efficiency checks (Ditta N.E.C. s.r.l.) operating at provincial and regional level.

Current trends in the area are related to a general increase in system efficiency with increasing use of renewable sources (solar PV and solar thermal) and conventional heat pumps or hybrid systems. Energy demand is also growing in relation to summer air-conditioning uses, which have increased both in number and intensity.

Opportunities related to collective building systems and energy management (also in connection with Renewable Energy Communities - CERs), radiant systems, low-enthalpy geothermal and greater exploitation of heat from solar sources and locally-sourced biomasses remain to be investigated as they are substantially unexplored. Certain industrial applications create the conditions for the exploitation of waste heat for civil or tertiary use (e.g.: sports facilities)

The local energy supply

RES plant					
plants	N°	Electric power (MW)	Thermal power (MW)	Electricity production (MWh/a)	Thermal energy production (MWh/a)
PHOTOVOLTAICS	2874	72	/	87254	/
WIND POWER	6	2,14	/	4490	/
BIOGAS	3	7,925	/	39625	/

Fossil fuels plants					
plants	N°	Electric power (MW)	Thermal power (MW)	Electricity production (MWh/a)	Thermal energy production (MWh/a)
THERMOELECTRIC (landfill biogas cogeneration plant with turbo-generator located at the Cava dei Modicani municipal MSW landfill)	1	0,981	N.D.	4000	N.D.

4. Mapping of H&C target groups

STAKEHOLDER	TARGET GROUP	Geographical Scope
CNA - National Confederation of Artisans (Confederazione Nazionale Artigianato)	Professionale associations - productive	Provincial
ANCE - National Association of Building Contractors (Associazione Nazionale Costruttori Edili)	Professional associations - construction	Provincial
ConfCommercio - General Italian Confederation of Enterprises	Professional associations - Tertiary/trade	Provincial
FederConsumatori - Italian Consumer Association	Professional associations - consumers	Provincial
BAPS - Banca Agricola Popolare di Sicilia (Bank)	Economy and finance	Provincial
ASSISTAL - National Association of Plant Builder and Energy Services (Associazione Nazionale Costruttori di Impianti e dei Servizi di efficienza Energetica)	Professionale associations - productive	National
ASSOUTENTI	Professional associations - consumers	Provincial
CODACONS - Coordination of Associations for the Protection of the Environment and the Rights of Users and Consumer (Coordinamento delle Associazioni per la difesa dell'ambiente e dei diritti degli utenti e dei consumatori)	Professional associations - consumers	Regional
ADOC - National Association for the Protection and Guidance of Consumers (Associazione Nazionale per la Difesa e l'Orientamento dei Consumatori)	Professional associations - consumers	Regional
SiciliESCO	Energy and service companies	Regional
REGRAN - Sistema energia	Energy and service companies	Regional
Compagnia per l'Energia Rinnovabile s.r.l.	Energy and service companies	Regional
Musa Progetti s.r.l.	Energy and service companies	Provincial
Macs s.r.l.	Energy and service companies	Regional
Confagricoltura	Professional associations - agriculture	Provincial

CIA - Italian Confederation of Farmers (Confederazione Italiana Agricoltori)	Professional associations - agriculture	National
Coldiretti	Professional associations - agriculture	National
SICINDUSTRIA	Professional associations - Tertiary/trade	Provincial
Confesercenti	Professional associations - Tertiary/trade	Provincial
Confartigianato	Professional associations - Tertiary/trade	Provincial
Lega Cooperative	Cooperatives/associations	Provincial
Confcooperative	Cooperatives/associations	Provincial
ANACI - National Association of Condominium and Property Managers (Associazione Amministratori Condominiali Immobiliari)	Professional associations - construction	Provincial
Superintendency for Cultural and Environmental Heritage of Ragusa	Amministrazioni pubbliche - Enti e agenzie territoriali	Provincial
Order of Engineers Ragusa	Professional orders	Provincial
Order of Architects Ragusa	Professional orders	Provincial
Order of Geologists Sicily	Professional orders	Regional
Order of Geometers Ragusa	Professional orders	Provincial
Order of Agronomists/foresters	Professional orders	Provincial
FEDERALBERGHI	Professional associations - consumers	Provincial
National Confederation of Artisans (CNA) - Vittoria	Professional associations - Tertiary/trade	Municipal
College of Agricultural Experts	Professional orders	Provincial
College of Industrial, Electrical, and Building Experts	Professional orders	Regional
CERSU - Regional Centre for Urban Studies of Sicily (Centro Regionale Studi Urbanistici di Sicilia)	Public administrations - Territorial authorities and agencies	Regional
Province of Ragusa	Public administrations - Territorial authorities and agencies	Provincial
Zipelli Foundation	Economy and finance	Provincial
Con il Sud Foundation	Economy and finance	National
Southeastern Horticultural District	Professionale associations - productive	Provincial
Distretto SUD-EST	Professionale associations - productive	Provincial
CORFILAC - Research Consortium in the Dairy and Agro-food Supply Chain Sector of Ragusa (Consorzio di Ricerca nel settore della Filiera Latterio Casearia e Agroalimentare Ragusa)	Professionale associations - productive	Provincial
IRSAP - Regional Institute for the Development of Productive Activities (Istituto Regionale Sviluppo Attività Produttive - ex ASI)	Public administrations - Territorial authorities and agencies	Provincial

SOSVI - Società Sviluppo Ibleo	N.A.	Provincial
Local Action Group (GAL) - Valli del Golfo	N.A.	Inter-municipal
Local Action Group (GAL) - Terra Barocca	N.A.	Inter-municipal
ARPA - Regional Environmental Protection Agency (Agenzia regionale per la protezione ambientale)	Energy and service companies	Provincial
ENEA - National Agency for New Technologies, Energy and Sustainable Economic Development Agenzia nazionale per le nuove tecnologie, l'energia e lo sviluppo economico sostenibile)	Energy and service companies	Regional
Sicily Energy Manager	Public administrations - Territorial authorities and agencies	N.A.
Sicily Department of Energy and Public Utility Services.	Public administrations - Territorial authorities and agencies	Regional
Department of Energy - Sicilian Regional - Service 1.	Public administrations - Territorial authorities and agencies	Regional
IACP - Autonomous Institute of Public Housing (Istituto Autonomo Case Popolari)	Public administrations - Territorial authorities and agencies	Provincial
AOG Assocciation	Cooperatives/associations	Provincial
Ainlu Kat	Professional orders	Provincial
Co-Governance Laboratorio Civico di Sussidiarietà Politica Ragusa Association	Cooperatives/associations	Municipal
Barocco Garden Club	Cooperatives/associations	Municipal
Bureau Veritas Italia SPA	N.A.	Provincial
CNN TRE PONTI	Cooperatives/associations	Municipal
Chimetec s.r.l.	Energy and service companies	Provincial
Ocra Collective	Cooperatives/associations	Municipal
Laboratorio Verde Fare Ambiente Provinciale Ragusa	Cooperatives/associations	Provincial
Libero Professionista	Freelancer	Provincial
Libero Professionista	Freelancer	Provincial
Libero Professionista	Freelancer	Provincial
Plastic Free	Cooperatives/associations	Provincial
Guardie Ambientali Volontarie GAV Ragusa	Cooperatives/associations	Provincial
Verde Bruscé Commitee	Cooperatives/associations	Municipal
Sorella Natura Foundation	Cooperatives/associations	National

5. Summary in national language

Ragusa, situata nella parte sud-orientale della Sicilia, è una città che vanta circa 73.700 abitanti e una superficie di 444,67 km². Il suo centro urbano è caratterizzato da un patrimonio storico-artistico di grande valore, con il Barocco siciliano che è stato riconosciuto Patrimonio dell'Umanità dall'UNESCO. Il clima mediterraneo, con inverni piovosi ed estati calde e secche, contribuisce alla qualità della vita nella regione. Dal punto di vista economico, l'agricoltura, la pesca e il commercio sono settori chiave per l'economia provinciale.

A livello regionale, la Sicilia sta perseguendo strategie orientate verso la sostenibilità, con un forte impegno nell'efficienza energetica e nell'utilizzo di fonti rinnovabili, come indicato nel Piano Energetico Ambientale Regionale Siciliano (PEARS). L'obiettivo principale è ridurre le emissioni di CO_2 e incentivare l'uso di tecnologie innovative, tra cui pompe di calore, caldaie a biomassa e sistemi di teleriscaldamento. Ragusa, in linea con le politiche regionali, sta cercando di ridurre i consumi energetici e promuovere edifici a basso impatto ambientale attraverso una serie di interventi di riqualificazione.

Nel 2021, Ragusa ha aggiornato il suo Piano d'Azione per l'Energia Sostenibile (PAESC), fissando l'obiettivo di ridurre del 40,9% le emissioni di CO_2 entro il 2030. Tra le principali azioni da intraprendere, ci sono la riqualificazione energetica degli edifici pubblici e privati, in particolare l'adozione di impianti ad alta efficienza energetica e l'installazione di fonti rinnovabili. Gli interventi riguardano anche i centri sportivi, che stanno sostituendo le caldaie a gasolio con sistemi a fonti rinnovabili e impianti fotovoltaici. Per le strutture ricettive, si prevede di promuovere l'uso di tecnologie come l'isolamento e la sostituzione di serramenti, con l'obiettivo di ottenere edifici più efficienti dal punto di vista energetico.

Un'altra iniziativa interessante riguarda i tetti verdi, che contribuiscono a migliorare l'isolamento termico degli edifici e a ridurre la domanda di energia per il riscaldamento e il raffrescamento. Inoltre, Ragusa sta incentivando le imprese locali a investire in tecnologie ecologiche, come pannelli fotovoltaici e impianti a basso consumo, attraverso incentivi fiscali. La promozione delle agroenergie è un'altra priorità, con particolare attenzione alla valorizzazione dei biofuel derivati dai processi agricoli.

La città ha anche intrapreso la creazione di Comunità Energetiche Rinnovabili (CER), che permetteranno ai cittadini e alle piccole imprese di condividere l'energia autoprodotta, contribuendo alla sostenibilità a livello locale. I progetti sono già attivi in alcune zone, come il quartiere di Ibla, con adesioni da parte di privati e PMI.

Il regolamento comunale per l'efficienza energetica prevede misure come il controllo delle temperature interne e l'ottimizzazione dell'isolamento termico negli edifici. Negli ultimi anni, Ragusa ha registrato un aumento dei consumi energetici, ma le emissioni di CO_2 sono diminuite grazie agli interventi di efficientamento, riducendo l'impatto ambientale complessivo.

La domanda di energia in città è prevalentemente legata alla climatizzazione estiva e alla produzione di acqua calda sanitaria, settori che hanno visto un'evoluzione significativa grazie alla diffusione delle caldaie a gas naturale. Nonostante ciò, si registra un crescente utilizzo di pompe di calore e condizionatori elettrici, in risposta al riscaldamento globale e all'aumento delle temperature estive.

Ragusa sta facendo progressi anche nell'ambito delle energie rinnovabili, in particolare con l'adozione di impianti solari termici e fotovoltaici. Tuttavia, ci sono ancora ampie opportunità di sviluppo, come l'introduzione di sistemi collettivi di riscaldamento e raffrescamento che potrebbero migliorare ulteriormente l'efficienza energetica. Le tecnologie innovative, come i sistemi radianti a bassa temperatura, la geotermia e l'uso delle biomasse locali, sono soluzioni promettenti per ottimizzare i consumi e ridurre le emissioni.

Il Comune, in collaborazione con enti come ENEA e partecipando a programmi europei, continua a perseguire l'obiettivo di rendere Ragusa una città sempre più sostenibile, puntando sulla transizione energetica e

sull’adozione di tecnologie a basso impatto ambientale. Nonostante i progressi compiuti, la città ha ancora ampie opportunità di miglioramento, in particolare nel recupero energetico e nell’integrazione di fonti rinnovabili, per una gestione energetica più efficiente e sostenibile.

MUNICIPALITY OF MODICA

1. The local territorial context

Geographical, Spatial and Urban Characteristics

Modica, located in south-eastern Sicily, is a municipality in the province of Ragusa, characterised by a unique topography and a remarkable cultural heritage. The city lies on a plateau curved by deep gorges, locally known as 'cave', which have influenced its urban and infrastructural development.

The historical centre is divided into two main areas:

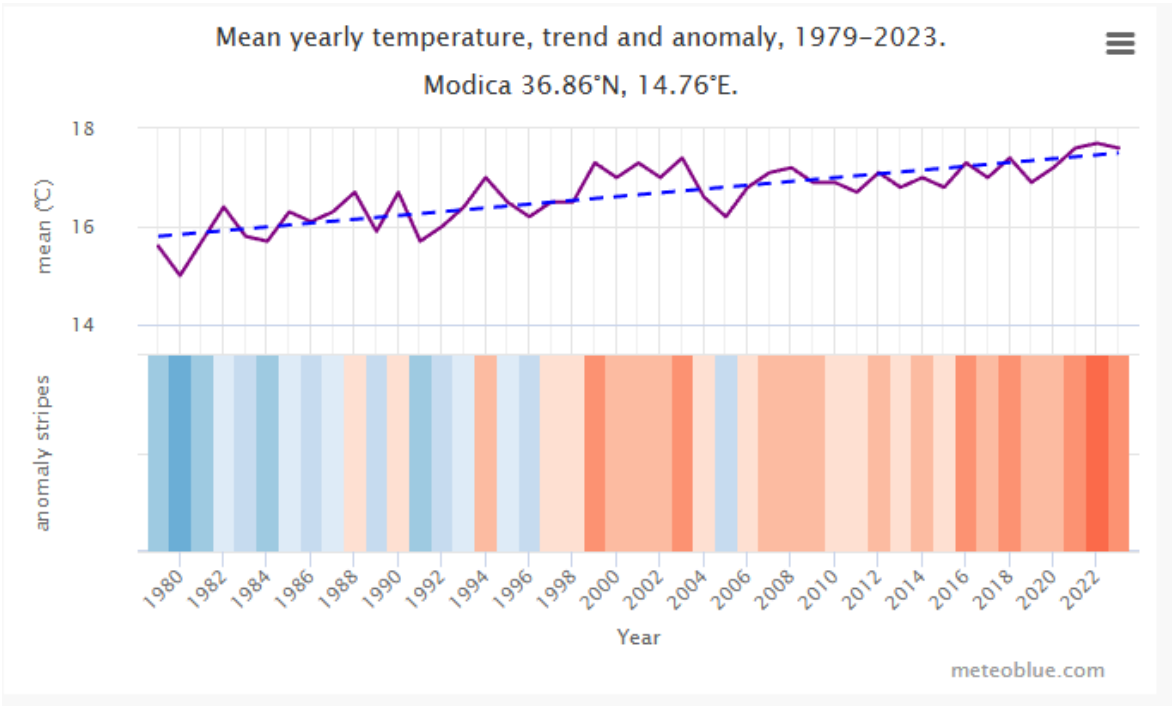
- Modica Alta, which extends over the hills around the Conti Castle, with a dense urban fabric, narrow streets and a strong medieval imprint.
- Modica Bassa, which extends along the valleys of streams (now covered) and is home to much of the Baroque architecture that has earned the town UNESCO World Heritage status.

In the 1960s, the residential district of Sacro Cuore, known as 'Sorda', was born and is now a major residential and commercial centre. The city is famous for its production of traditional Modican chocolate, a cultural peculiarity that attracts visitors and supports the local economy.

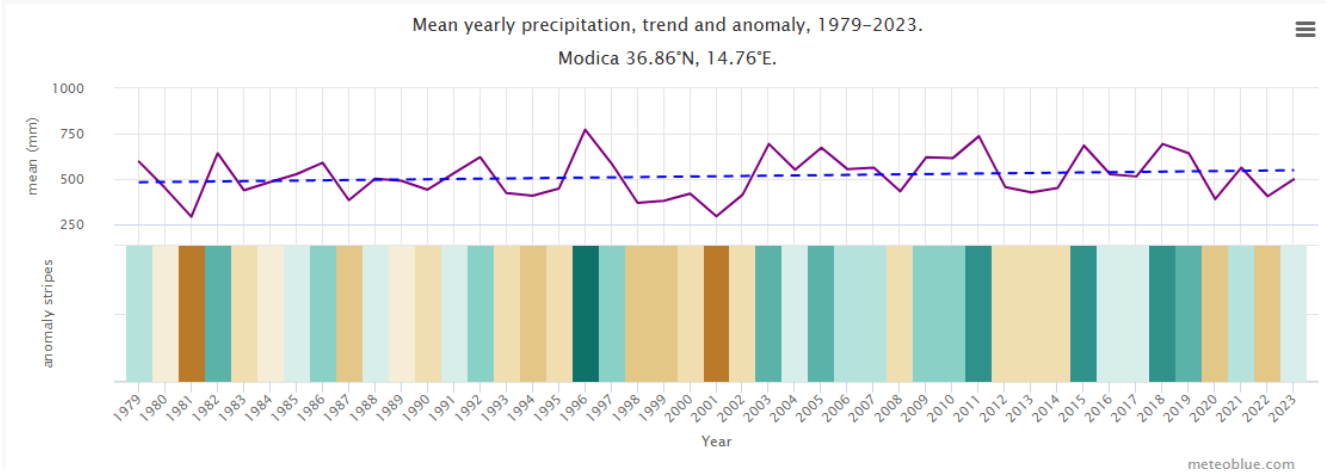
The Climate Framework

Modica has a Mediterranean climate characterised by hot, dry summers and mild, wet winters. The average annual temperature is around 16.6 °C, with summer highs averaging 29 °C and winter lows hovering around 5-6 °C.

The increase in average summer temperatures recorded in recent years represents a growing criticality, these are referred to as heat waves. In the Modica area, as shown in the graph below, 2022 was the year in which temperatures exceeded the average of 1.2°C, which leads to an increase in energy requirements for cooling .



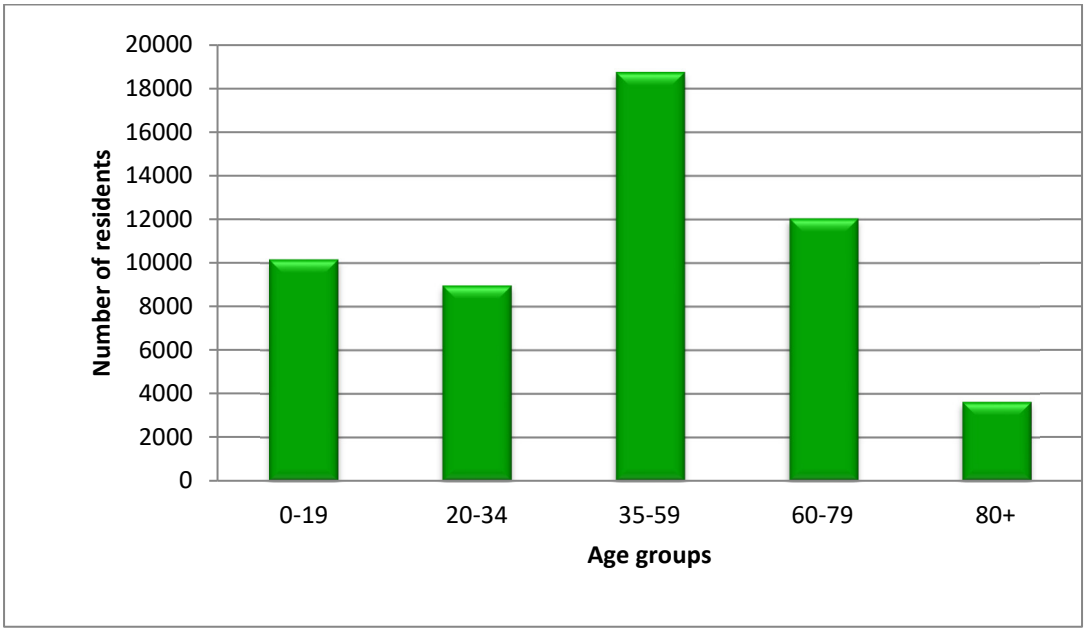
The territory is exposed to extreme weather events, such as torrential rains and long periods of drought, which put significant strain on water resources; the rainfall trend is shown in the figure.

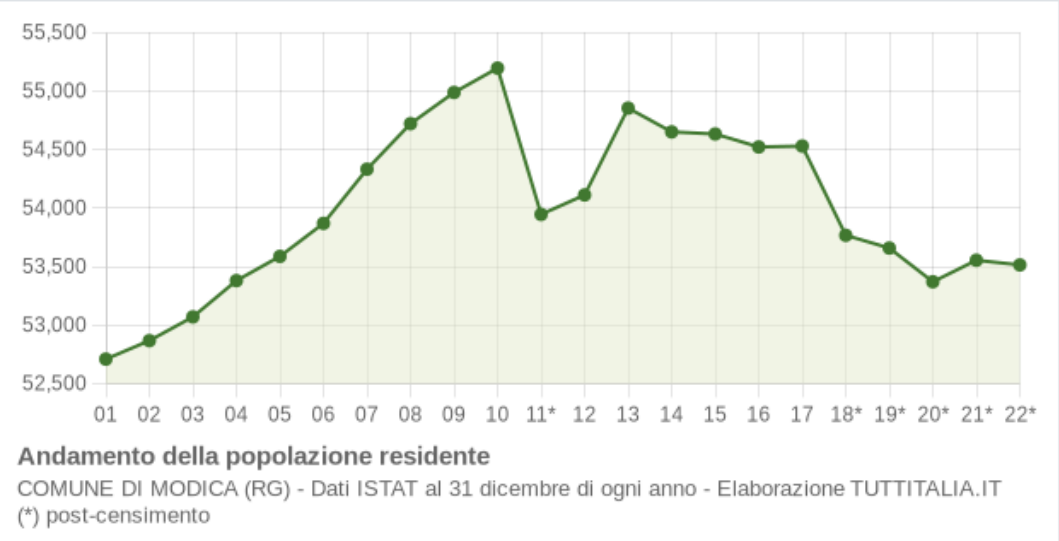


At the bottom, the graph shows so-called precipitation stripes. Each coloured stripe represents the total precipitation for a year - green for the wettest years and brown for the driest. Again, the year 2022 was a particularly hot year.

The Socio-Economic Framework

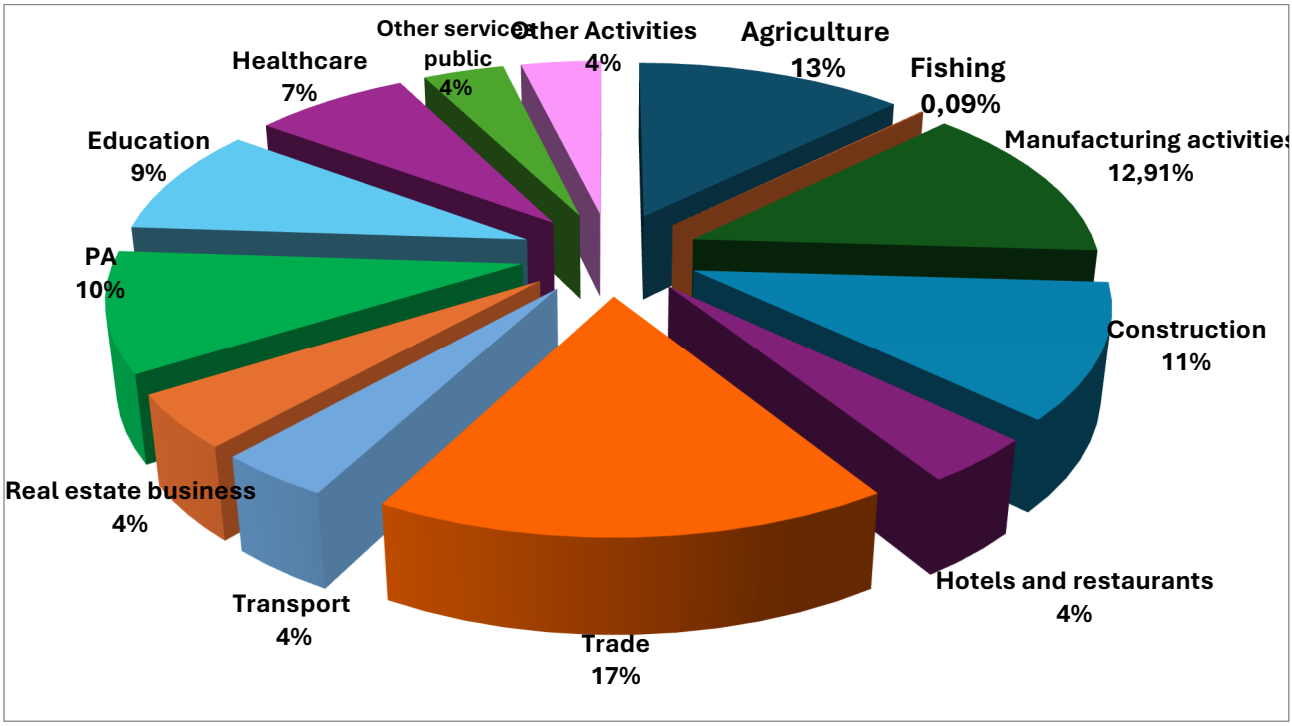
As of 1st January 2024, the municipality of Modica, according to ISTAT data, had 53,485 inhabitants, broken down as follows: 19% young people aged 0-19 years, 17% aged 20-34 years, 35% aged 35-59 years, 22% aged 60-79 years and 7% aged over 80 years.





The traditional economy is linked to agriculture, with the production of olives, carob, pulses and cereals, as well as the breeding of the Modican cattle breed. In recent decades, the tertiary sector has acquired a predominant role, driven by cultural and gastronomic tourism, thanks to UNESCO recognition and the fame of Modican chocolate. The manufacturing sector is present, but to a lesser extent than in the past, while handicrafts and local trade remain fundamental to the economic fabric.

Below is the graph of the percentage distribution of employed working-age residents by sector of activity (source: Istat).



2. The local reference policy and strategic context

At the local level, the Municipality of Modica has already undertaken several initiatives and strategies for environmental sustainability and energy transition:

- SEAP/SECAP (Sustainable Energy and Climate Action Plan): Modica in 2016 approved the SEAP to reduce CO_2 emissions through targeted interventions in the building sector, sustainable mobility and renewable energy. Adhering to the new Covenant of Mayors, which aims to reduce emissions by at least 40 per cent by 2030 and increase resilience to climate change, the municipality of Modica therefore undertook the updating of the SEAP into SECAP, assessing the main climate risks to which the territory is subject. The new document therefore sets out new actions to increase the reduction of emissions by 44.26% compared to the base year (2011) and adaptation actions aimed at countering the territory's climate risks.
- Urban and town planning: Local building regulations encourage the adoption of high-efficiency technologies and the use of renewable energy in public and private buildings.

Local Energy Strategies and Existing Action Plans

The Municipality of Modica adopted a strategic approach to energy sustainability through the Sustainable Energy Action Plan (SEAP), later updated to SECAP (Sustainable Energy and Climate Action Plan), as part of the Covenant of Mayors.

- SEAP 2015 - 20% reduction of CO_2 emissions - 20% increase of renewables in the local mix, partially implemented, ongoing update with SECAP.
  Energy efficiency in public and private buildings, sustainable mobility, renewable energy, energy requalification of public buildings, promotion of solar thermal and photovoltaic energy, sustainable mobility measures.
- SECAP 2023 - Emission reduction of at least 40%. Under implementation.
  Climate change adaptation, energy transition, urban resilience. Mitigation measures for heat waves; improvement of efficiency in H&C installations; incentivisation of RES for cooling; climate risk reduction; enhancement of the H&C sector with sustainable solutions.

H&C Supply and Demand Plan Scenarios

H&C demand. Cooling demand significantly exceeds heating demand, especially during the summer months due to high temperatures and increasingly frequent heat waves. Residential and commercial buildings represent the main sector for H&C energy demand.

H&C offer. Most cooling systems still use traditional systems powered by electricity from non-renewable sources. The plan scenarios aim to increase the adoption of technologies based on renewable sources (solar thermal, heat pumps and biomass).

Current scenario - future goal

- Low efficiency of conventional H&C systems; expected 20% increase in energy efficiency through innovative technologies such as:
  1. **Low Emission Heating and Cooling Systems**
     - **High-efficiency heat pumps**: Installation of air-water and geothermal heat pumps, powered by renewable energy.
  2. **Integration of Renewable Energies**

- **Photovoltaic systems with storage**: Solar energy production systems combined with state-of-the-art batteries to optimise self-consumption.
- **Advanced solar thermal:** Installation of solar thermal panels for domestic hot water production, reducing the use of fossil fuels.

3. **Smart Technologies for Energy Efficiency**
   - **IoT sensors**: Implementation of real-time monitoring and control systems to optimise the efficiency of heating and cooling systems.
   - **Smart thermostats**: Introduction of smart devices that allow optimal management of climate control, based on collected data.
4. **Waste Heat Recovery**
   - Systems for recovering heat from industrial processes or electrical distribution networks, to be reintegrated into urban heating/cooling networks.
5. **Innovative Insulation Materials and Techniques**
   - Use of environmentally sustainable insulation materials (e.g. natural fibres or nanomaterials) to improve the energy efficiency of buildings.
   - Implementation of ventilated walls and dynamic insulation systems.
6. **Supporting Sustainable Mobility**
   - Integration of charging stations for electric vehicles powered by renewable energy.
   - Development of solutions for sharing energy between homes and vehicles (vehicle-to-grid).
7. **Renewable Energy Communities (RECs)**
   - Promotion of energy communities to share the energy produced by condominiums or urban photovoltaic systems.
   - Use of digital platforms for the management of CERs.
8. **Reducing Energy Losses**
   - Replacing and upgrading obsolete energy infrastructure with minimum-loss distribution systems.
   - Use of inefficiency and leakage detection technologies.

- RES marginally integrated in heating systems; planned increase of RES share to 30% in the energy mix for H&C
- Insufficient resilience of plants to extreme weather events; planned development of resilient and optimised infrastructure to manage demand

To address this issue, the project envisages **the development of resilient infrastructures** designed to meet the challenges posed by extreme weather events. Key actions include:

- **Optimisation of existing plants**: Through the adoption of advanced technologies to improve the physical and operational resilience of plants.

- **Implementation of intelligent demand management systems**: Use of IoT sensors and digital platforms to monitor consumption in real time and distribute energy efficiently, even during emergency situations.

- **Use of distributed energy sources**: Promotion of microgrids and decentralised plants that reduce dependence on a single central infrastructure, ensuring business continuity in the event of breakdown or malfunctioning due to extreme weather conditions.

These strategies aim to create a local energy system that not only reduces vulnerability to climate impacts, but also improves overall efficiency, contributing to the transition to a more sustainable and robust energy model.

Actions and Plan Instruments

- Promotion of renewable energy sources - Incentives for the installation of solar thermal panels for domestic water heating; implementation of heat pumps for sustainable cooling.
- Improvement of energy efficiency - Renovation of public and private buildings to reduce heat loss; introduction of intelligent control systems for energy management in buildings.

- Strengthening urban resilience - Creation of green spaces and urban forestation to mitigate the heat island effect; design of buildings with passive cooling solutions.

Settore/ambito di intervento	tipo di azione	Riduzione consumi (MWh/a)	Produzione da FER (MWh/a)	Riduzione emissioni di CO2 (t/a)
Edifici comunali, strutture pubbliche	PU01L-Riqualificazione energetica degli edifici comunali e uso razionale dell'energia	669,66		235,78
	PU03B Efficientamento delle stazioni di sollevamento	4483,75		1930,85
:tore terziario	TE01L Promuovere l'efficientamento, il risparmio energetico e l'uso razionale dell'energia nel settore terziario	18007,88		7754,81
Settore residenziale	RE01B Allegato Energetico – Ambientale" al regolamento edilizio comunale	38646,27		12827,16
	RE03C Gruppi di Acquisto Energia Rinnovabile	12882,09		4275,72
	RE04B Riqualificazione energetica degli edifici residenziali tramite incentivo fiscale Superbonus 110	19323,14		6413,58
ıminazione pubblica				
lustria				
sporti - mezzi comunali	TR01L Razionalizzazione, gestione centralizzata e ammodernamento dei veicoli del parco auto Comunale			67,6
sporto pubblico locale				
Trasporto privato e commerciale	TR02L Rinnovamento del parco mezzi di trasporto privato con passaggio ad auto e motocicli a basse emissioni tramite nuovi	258,72		25456,06
	TR03B Campagna di sensibilizzazione all'utilizzo razionale dell'automobile e all'applicazione di tecniche di Ecodrive	97797,81		15273,63
ricoltura	AG01B Promuovere l'uso razionale dell'energia in Agricoltura	17169,25		5475,6
Produzione locale di energia elettrica	PU02M installazione d'impianti FV su edifici comunali		1079,72	464,48
	PU04B installazione di impianti fotovoltaici per stazioni di sollevamento		750	255,97
›duzione locale di calore/freddo				
ro (specificare)	SA03B "Casella di posta energia" e pagina web sul sito istituzionale	18884,72		6860,66
ro (specificare)				
ro (specificare)				

PU01L Energy requalification of municipal buildings and rational use of energy. In the context of a global approach for the reduction of polluting emissions, the Municipality of Modica intends to undertake a profound energy requalification of municipal buildings that will allow a net reduction of thermal and electrical consumption. It is therefore envisaged to carry out interventions to improve the performance of the envelopes, to make the heating systems more efficient, and to renew the electrical systems, with the modernisation of the internal lighting systems. To maximise the benefits resulting from these interventions, training will also be provided to those responsible for the facilities on the correct use of the systems and the application of good practices. The interventions will be financed through participation in public tenders and/or internal resources. The possibility of using Esco or Project Financing is also envisaged.

PU02M Installation of photovoltaic systems on municipal buildings Installation of photovoltaic systems for the production of electricity on the roofs of buildings owned by the municipality for a capacity of 583 kWp. Steps for achieving the action:

- Feasibility study with reconnaissance of suitable buildings
- Preparation of preliminary projects with cost and time estimates
- Drawing up executive projects
- Entrustment and Implementation

The interventions will be financed through participation in public tenders and/or internal resources. The possibility of using Esco or Project Financing is also envisaged.

PU04B Installation of photovoltaic systems for lifting stations: Installation of photovoltaic systems for the production of electricity necessary for the inverter motors used by the lifting stations for a total of 405 kWp. The interventions will be financed through participation in public tenders and/or internal resources. The possibility of using Esco or Project Financing is also envisaged.

SA03B "Energy mailbox" and web page on institutional website: The project envisages the opening of an "Energy mailbox" and a web page on the institutional website on energy and environmental issues. The structure would be managed, on a non-profit basis, by staff of one or more environmental associations, competent to provide technical information, updates on:

- Energy saving in homes and offices;
- lifestyles and sustainable mobility;
- green procurement;
- regulatory obligations and advantages of Energy Certification;
- environmental initiatives promoted by the municipality;
- promotion of best practices through individual counselling of citizens.

The project envisages the creation of a web page dedicated to the Covenant of Mayors and energy saving issues on the Municipality's institutional website, an easy-to-consult space that will contribute to citizens' awareness of these issues, where all the events and activities implemented will be publicised. The realisation of the web page will be financed through internal resources and participation in public tenders. In addition, the involvement of external parties who could sponsor the intervention is conceivable.

RE01B "Energy-Environmental Annex" to the Municipal Building Regulation Drafting of the "Energy-Environmental Annex" to the Municipal Building Regulation with compulsory and voluntary contents related to the energy efficiency of buildings (envelope and systems) and to the integration of renewable energy sources. Transposition of national/regional regulations on energy and environmental sustainability as well as the objectives indicated in the current European Directives on the subject, which envisage all new buildings to be nearly zero energy by 31 December 2020. Definition of energy and environmental standards, with a 5% increase where quantitative requirements are made explicit and the provision of incentives for virtuous actions. The working group for drafting the annex will be financed through resources from the municipal budget.

RE03C Renewable Energy Purchasing Groups: The Municipality undertakes, through the services of the Energy Desk and through the organisation of specific meetings, to support the GAS (Sustainable Purchasing Groups) from the selection of the company to the study of a model contract and the identification of advantageous agreements with banks and insurance companies. The GAS will guarantee access to the system of incentives and tax deductions and the opportunity to take advantage of loans at subsidised rates with affiliated credit institutions. To achieve by 2030 an increase in local energy production from renewable sources such as to cover 10% of the energy required by the residential sector in 2011.

RE04B Energy requalification of residential buildings by means of tax incentive Superbonus 110 Decree Law no. 34 of 19 May 2020 'Urgent measures concerning health, support for work and the economy, as well as social policies related to the COVID-19 epidemic emergency', known as the 'Relaunch Decree', converted by Law no. 77 of 17 July 2020, introduced the new 110% bonus to support the building sector's recovery from the serious economic crisis caused by the COVID-19 epidemic. The legislator hooked up to the already existing 'Ecobonus' and 'Sismabonus' and introduced the 110% deduction for certain energy efficiency measures for buildings (Art.

119) and extended some tax opportunities to the tools 'Ecobonus', 'Bonus casa' and 'Bonus facciate' (Art. 121). Below is a summary table of art. 119 as amended by Law 77 on the 110% bonus.

TE01L Promoting energy efficiency, energy savings and rational use of energy in the tertiary sector: Promoting energy efficiency and energy savings in large users in the tertiary sector (large-scale retail trade, hotels, healthcare facilities, educational establishments, etc.). The involvement of these structures will serve above all to share best practices with smaller structures. The envisaged action includes:

- the involvement of key stakeholders in the selection of partners willing to be involved as pilot users;
- the awarding of an energy sustainability label to the facilities involved by the Municipality of Modica;
- the dissemination of results and the setting up of replicable schemes.

In addition, the Municipality of Modica intends to organise specific seminars addressed to all operators in the tertiary sector on possible energy requalification interventions to the application of good practices. Communication and awareness-raising activities will be financed through the use of internal resources or through sponsorship agreements.

AG01B Promoting the rational use of energy in Agriculture:The Municipality of Modica intends to carry out a series of awareness-raising meetings on energy saving issues addressed to operators in the primary sector. It is envisaged to collaborate with companies in the sector, which will present technologically advanced products and equipment that can significantly reduce consumption and emissions. With a view to spreading a new, more sustainable lifestyle, it is also intended to set aside part of these meetings for the dissemination of sustainable agriculture techniques with a low environmental impact. Communication and awareness-raising activities will be financed through the use of internal resources or through sponsorship agreements.

TR01L Rationalisation, centralised management and modernisation of municipal fleet vehicles: Rationalisation, centralised management and modernisation of municipal fleet vehicles through:

- The drafting of a plan to rationalise and optimise the use of the car fleet and internal car sharing and bike sharing policies for short-distance travel, located in the different municipal office locations.
- Centralised, computerised management where all data on the status of the car fleet, its use and its maintenance are brought together.
- The drafting of a multi-year modernisation programme for the car fleet with the purchase of natural gas/hybrid/electric vehicles in compliance with energy and environmental sustainability criteria.

Public funding (European, national, etc. projects), third-party funding, internal resources.

Evaluation of Urban and Territorial Plans and Regulations

The Municipality of Modica has developed a series of urban planning and regulatory tools that integrate energy sustainability principles and aim at the transition to carbon neutrality.

General Regulatory Plan (PRG)

The PRG of Modica, updated with the General Variant drafted in April 2018, regulates land use and buildings, promoting:

- Land zoning - Identification of specific areas for residential, industrial and agricultural development, with the aim of optimising land use and reducing environmental impact.
- Areas for equipment and services - Allocation of space for public infrastructure, parks and collective services, promoting balanced urban development.

The PRG encourages the integration of sustainable energy technologies, such as the installation of solar thermal and photovoltaic systems, and the adoption of high-efficiency heating and cooling systems.

Local Building Regulations

The Modica Rules establish criteria for the design and construction of buildings, emphasising:

- Energy efficiency - Promotion of thermal insulation, the use of sustainable materials and the adoption of energy-saving technologies, making use of national and European funds, such as PNRR, POFSER (Fsc Sicilia 21-27 resources).
- Renewable Sources - Incentivisation of the integration of renewable energy systems in buildings, in line with regional and national regulations. Over the past two years, the municipality has participated in the call for tenders for the contribution to the implementation of Renewable and Solidarity Energy Communities, assuming the realisation of No. 4 CERs in different areas of the territory.

Building Redevelopment Plans

Modica has initiated urban regeneration programmes that aim to reduce CO_2 emissions and improve residents' quality of life and are focused on:

- Rehabilitation of the historic building heritage - Interventions to improve the energy efficiency of historic buildings while preserving their cultural value.
- Regeneration of degraded areas - Projects to transform declining urban areas into sustainable neighbourhoods with modern energy infrastructure.

Authorisation Procedures

The municipality simplified the procedures for the installation of renewable energy systems, facilitating the adoption of sustainable technologies by citizens and businesses.

Urban Adaptation Strategies and Measures

Modica has implemented strategies to adapt to climate change that interact with mitigation strategies, reducing energy demand for cooling and improving urban resilience, including:

- Emergency plans for heat waves - Measures to protect vulnerable sections of the population during periods of extreme temperatures. In 2024, the President of the Sicilian Region signed an ordinance stipulating that throughout the Sicilian territory from 12:30 to 16:00 activities would be suspended for certain sectors at risk, in order to protect the health of workers exposed to the sun)
- Urban green areas - Creation and maintenance of parks and gardens to mitigate the heat island effect and improve air quality.

In summary, Modica is integrating energy transition and carbon neutrality into its urban planning tools and urban adaptation strategies, promoting energy efficiency and the use of renewable sources in heating and cooling.

3. The local energy system

The SECAP of Modica is based on the analysis of local energy consumption referring to the base year 2011 divided among different sectors:

- Public: includes municipal-owned buildings and facilities
- Residential: accounts for a significant share of total consumption, with high demand for both winter heating and summer cooling.
- Tertiary sector: includes commercial activities and services, with significant energy consumption for lighting, heating and cooling of rooms.

- Industrial: although less predominant, it contributes to energy consumption through production processes and air conditioning needs.
- Transport: includes municipal, private and public transport.

Analysing the 2011 consumption described in the PAESC shows that the public, residential and tertiary sectors are the main contributors to energy demand for heating and cooling.

The main energy sources used in the Modica area include:
- Electricity: mainly used for summer cooling and powering electrical equipment.
- Natural Gas: mainly used for winter heating and domestic hot water production.
- Renewable Sources: growing, with the installation of photovoltaic and solar thermal systems in both the public and private sectors.

In recent years, Modica has recorded:
- Increased Demand for Cooling: Due to rising summer temperatures, an increased demand for air conditioning systems was observed.
- Growth in Energy Efficiency: through building upgrades and the adoption of more efficient technologies, a reduction in energy consumption has been achieved.
- Expansion of Renewable Energy: the installation of new photovoltaic and solar thermal plants has helped diversify the local energy mix.

Despite progress, some critical issues remain:
- Dependence on Fossil Fuels: a significant part of energy needs is still met by non-renewable sources.
- Obsolete infrastructure: some networks and facilities need modernisation to improve efficiency and reduce energy losses.
- Public Awareness: it is necessary to increase public awareness of energy-saving practices and the adoption of sustainable technologies.

In conclusion, Modica's energy system is evolving towards greater sustainability, but requires further action to overcome existing criticalities and achieve the objectives set in the PAESC.

The local energy demand

TABELLA CONSUMI ENERGETICI AL 2011

	Settori									
Vettori	Pubblico			Residenziale	Terziario	Agricoltura	Trasporti			**Totale**
	Edifici	IP	Idrico				Pubblico	Municipale	Privato	
	[MWh]	[MWh]	[MWh]	[MWh]	[MWh]	[MWh]	[MWh]	[MWh]	[MWh]	[MWh]
Energia Elettrica	1.284,04	6.189,48	11.209,36	63.575,16	60.026,30	18.158,58				160.442,92
Gas Naturale	310,56			9.492,60						9.803,16
Benzina								183,07	135.691,99	135.875,06
Gasolio	637,59			20.152,64		39.072,24	679,52	391,87	250.964,74	311.898,60
GPL				35.600,50					4.534,55	40.135,05
Totale	2.232,19	6.189,48	11.209,36	128.820,90	60.026,30	57.230,82	679,52	574,94	391.191,28	658.154,79

TABELLA EMISSIONI DI CO_2 AL 2011

	Settori									
Vettori	Pubblico			Residenziale	Terziario	Agricoltura	Trasporti			**Totale**
	Edifici	IP	Idrico				Pubblico	Municipale	Privato	
	[t CO_2]	[t CO_2]	[t CO_2]	[t CO_2]	[t CO_2]	[t CO_2]	[t CO_2]	[t CO_2]	[t CO_2]	[t CO_2]
Energia Elettrica	552,95	2.665,40	4.827,13	27.377,63	25.849,36	7.819,70				69.092,18
Gas Naturale	62,73			1.917,51						1.980,24
Benzina								45,58	33.787,31	33.832,89
Gasolio	170,24			5.380,75		10.432,29	181,43	104,63	67.007,58	83.276,93
GPL				8.081,31					1.029,34	9.110,66
Totale	785,92	2.665,40	4.827,13	42.757,20	25.849,36	18.251,99	181,43	150,21	101.824,23	197.292,89
	8.278,45			42.757,20	25.849,36	18.251,99	102.155,88			

Emissioni di CO_2 per vettore energetico e settore d'interesse all'anno 2011

Air Conditioning in Buildings

Buildings with energy class A or higher account for 5 per cent, while the majority are classified as C or lower. Modica's residential and tertiary buildings use:

- Heating - Natural gas boilers (residential); Centralised systems (public offices and schools).
- Cooling - Split-system air-conditioners, with increased use of air-to-air heat pumps.

Domestic Hot Water (DHW)

Prevalent technologies - Gas boilers, Solar thermal increasing, with more than 10% penetration in new buildings.

Industrial Processes

The industrial sector uses energy for production space heating and office air conditioning.
Common technologies: traditional boilers and heat pumps.

Evolution of Energy Demand

Cooling demand: It is expected to increase by 15-20% by 2030, due to more frequent heat waves.
Heating demand: Slight decrease due to improved building efficiency and an increasingly mild climate.

Air conditioning: Split air conditioners (70% of residential buildings); heat pumps on the rise (10% now, expected to be 30% by 2030).
DHW production: Gas boilers (80 per cent); Solar thermal (10 per cent currently, projected to 20 per cent by 2030).

Fossil fuel plants		
Building	Heating fuel	annual consumption mc/l/kWe
Town Hall	electrical	164876
Campailla Palace	electrical	79624
Former Azasi building and Giovanni XXIII School	diesel	2261
Circolo Didattico 'G. Albo' (Central Plesso)	methane	6435
Circolo Didattico 'G. Albo' (Plesso S. Scrofani)	diesel	2223

Circolo Didattico 'G. Albo' (Plesso Sacro Cuore)	methane	783,9
Circolo Didattico 'G. Albo' (Plesso Treppiedi Nord)	diesel	2397
Circolo Didattico 'G. Albo' (Plesso Trapani Rocciola)	methane	1074,9
Istituto Comprensivo 'C. Amore' (Central Plesso)	electrical	47344
Istituto Comprensivo 'C. Amore' (Plesso De Amicis)	diesel	6374
Istituto Comprensivo 'C. Amore' (Plesso S. Teresa)	diesel	6206
Istituto Comprensivo 'C. Amore' (Plesso Delegesso. Frigintini)	diesel	1720
Istituto Comprensivo 'C. Amore' (Plesso Torre)	electrical	5525
Istituto Comprensivo 'C. Amore' (Gianforma Elementare)	diesel	973
Istituto Comprensivo 'C. Amore' (Plesso Cannizzara)	diesel	4868
Circolo Didattico 'Piano di Gesù' (Central Plesso)	diesel	8307
Circolo Didattico 'Piano di Gesù' (Infanzia De Amicis)	diesel	0
Istituto Comprensivo 'S. Marta' (Central Plesso)	electrical	77219
Istituto Comprensivo 'S. Marta' (Infanzia Cozzo Rotondo)	methane	1442,1
Istituto Comprensivo 'Emanuele Ciaceri' (Plesso n° 2)	electrical	24654
Istituto Comprensivo 'R. Poidomani' (Central 'G. Falcone')	diesel	9662
Istituto Comprensivo 'R. Poidomani' (Plesso Pirato)	diesel	5844
Istituto Comprensivo 'R. Poidomani' (Via Risorgimento, 112)	methane	996,33
Istituto Comprensivo 'R. Poidomani' (Via Risorgimento, 217)	diesel	1968
Istituto Comprensivo 'R. Poidomani' (Plesso Denaro Papa)	LPG	513
Istituto Comprensivo 'R. Poidomani' (Plesso R. Poidomani)	methane	657,21
Istituto Comprensivo 'R. Poidomani' (Plesso Zappulla)	electrical	10766
Istituto Comprensivo 'R. Poidomani' (Plesso Treppiedi Sud)	methane	4004,82
Istituto Comprensivo 'R. Poidomani' (Plesso Torre Cannata)	electrical	6065
Giovanni XXIII' Secondary School	diesel	1824
Nursery School	diesel	513
P. Battaglia Senior Citizens' Centre	methane	732,86
Disability Centre	methane	3973,2
St. Crispin's Senior Citizens' Centre	electrical	7766
Service Centre	electrical	83314
Garibaldi Theatre	methane	0
Palace of Culture	electrical	107918
E. Ciaceri School Institute	electrical	0
Tax Office (formerly Palaposte)	electrical	0
John XXIII School Institute (former Gensal)	methane	0
Geodetic Structure (Sports Hall)	methane	3651
Carabinieri Company Headquarters	electrical	0
Moncada Palace	methane	0
Istituto Comprensivo Santa Marta - Ciaceri	diesel	0
I.C. 'R. Poidomani' (Plesso 'R. Poidomani) - Gymnasium	methane	0

The local energy supply

The share of energy produced by RES is estimated at around 15-20% of the total consumed locally. Solar photovoltaics is the main renewable source, followed by solar thermal and biomass. Waste heat is marginally utilised, with yet untapped potential in industry.

Electricity

Generated mainly through photovoltaic installations on public, residential and industrial buildings. Installed capacity increasing over the last 5 years, with an estimated annual production of 25 GWh. About 1,200 active installations in the municipality, with an average power per installation of 5-10 kWp. Installations concentrated on public buildings (schools, town halls) and private buildings (homes, farms). The photovoltaic systems in municipal buildings as of 2024 and the type of system installed are shown below.

Renewable energy installations					
Plant type	N°	Electrical power (MW)	Thermal power (MW)	Electricity production (MWh/a)	Thermal energy production (MWh/a)
Photovoltaic Education Centre Albo (2024)	1	0,01		15,6688	
Photovoltaics - Denaro Papa School (2024)	2	0,01826		28,6112288	
Photovoltaics - Senior Centre (2024)	3	0,015		23,5032	
Photovoltaics (2011)	4	0,11		172,3568	

Photovoltaic production has grown by 30% in the last five years, thanks to national and regional incentives.

Heat

Produced by biomass-fired boilers and partly by solar thermal hot water systems. Solar thermal systems are present in about 10% of homes, with an average capacity of 4-6 m² per system. Biomass used for heating in peripheral areas, with small domestic installations. Solar thermal is growing slowly but steadily, with new installations encouraged by local programmes.

Criticalities and Opportunities

Limited centralised production capacity, with high dependence on small, distributed plants and low utilisation of waste heat, which could be a significant resource.
Promotion of incentives for the integration of solar thermal and biomass in residential and tertiary sectors.
Development of district heating/cooling networks to utilise waste heat.

4. Mapping of H&C target groups

STAKEHOLDER	TARGET GROUP	Geographical Scope
CNA - National Confederation of Artisans (Confederazione Nazionale Artigianato)	Professionale associations - productive	Provincial
ANCE - National Association of Building Contractors (Associazione Nazionale Costruttori Edili)	Professional associations - construction	Provincial
ConfCommercio - General Italian Confederation of Enterprises	Professional associations - Tertiary/trade	Provincial
FederConsumatori - Italian Consumer Association	Professional associations - consumers	Provincial
BAPS - Banca Agricola Popolare di Sicilia (Bank)	Economy and finance	Provincial
ASSISTAL - National Association of Plant Builder and Energy Services (Associazione Nazionale Costruttori di Impianti e dei Servizi di efficienza Energetica)	Professionale associations - productive	National
ASSOUTENTI	Professional associations - consumers	Provincial
CODACONS - Coordination of Associations for the Protection of the Environment and the Rights of Users and Consumer (Coordinamento delle Associazioni per la difesa dell'ambiente e dei diritti degli utenti e dei consumatori)	Professional associations - consumers	Regional
ADOC - National Association for the Protection and Guidance of Consumers (Associazione Nazionale per la Difesa e l'Orientamento dei Consumatori)	Professional associations - consumers	Regional
SiciliESCO	Energy and service companies	Regional
REGRAN - Sistema energia	Energy and service companies	Regional
Compagnia per l'Energia Rinnovabile s.r.l.	Energy and service companies	Regional
Musa Progetti s.r.l.	Energy and service companies	Provincial
Macs s.r.l.	Energy and service companies	Regional
Confagricoltura	Professional associations - agriculture	Provincial
CIA - Italian Confederation of Farmers (Confederazione Italiana Agricoltori)	Professional associations - agriculture	National
Coldiretti	Professional associations - agriculture	National
SICINDUSTRIA	Professional associations - Tertiary/trade	Provincial
Confesercenti	Professional associations - Tertiary/trade	Provincial
Confartigianato	Professional associations - Tertiary/trade	Provincial
Lega Cooperative	Cooperatives/associations	Provincial
Confcooperative	Cooperatives/associations	Provincial

ANACI - National Association of Condominium and Property Managers (Associazione Amministratori Condominiali Immobiliari)	Professional associations - construction	Provincial
Superintendency for Cultural and Environmental Heritage of Ragusa	Amministrazioni pubbliche - Enti e agenzie territoriali	Provincial
Order of Engineers Ragusa	Professional orders	Provincial
Order of Architects Ragusa	Professional orders	Provincial
Order of Geologists Sicily	Professional orders	Regional
Order of Geometers Ragusa	Professional orders	Provincial
Order of Agronomists/foresters	Professional orders	Provincial
FEDERALBERGHI	Professional associations - consumers	Provincial
National Confederation of Artisans (CNA) - Vittoria	Professional associations - Tertiary/trade	Municipal
College of Agricultural Experts	Professional orders	Provincial
College of Industrial, Electrical, and Building Experts	Professional orders	Regional
CERSU - Regional Centre for Urban Studies of Sicily (Centro Regionale Studi Urbanistici di Sicilia)	Public administrations - Territorial authorities and agencies	Regional
Province of Ragusa	Public administrations - Territorial authorities and agencies	Provincial
Zipelli Foundation	Economy and finance	Provincial
Con il Sud Foundation	Economy and finance	National
Southeastern Horticultural District	Professionale associations - productive	Provincial
Distretto SUD-EST	Professionale associations - productive	Provincial
CORFILAC - Research Consortium in the Dairy and Agro-food Supply Chain Sector of Ragusa (Consorzio di Ricerca nel settore della Filiera Latterio Casearia e Agroalimentare Ragusa)	Professionale associations - productive	Provincial
IRSAP - Regional Institute for the Development of Productive Activities (Istituto Regionale Sviluppo Attività Produttive - ex ASI)	Public administrations - Territorial authorities and agencies	Provincial
SOSVI - Società Sviluppo Ibleo	N.A.	Provincial
Local Action Group (GAL) - Valli del Golfo	N.A.	Inter-municipal
Local Action Group (GAL) - Terra Barocca	N.A.	Inter-municipal
ARPA - Regional Environmental Protection Agency (Agenzia regionale per la protezione ambientale)	Energy and service companies	Provincial

ENEA - National Agency for New Technologies, Energy and Sustainable Economic Development Agenzia nazionale per le nuove tecnologie, l'energia e lo sviluppo economico sostenibile)	Energy and service companies	Regional
Sicily Energy Manager	Public administrations - Territorial authorities and agencies	N.A.
Sicily Department of Energy and Public Utility Services.	Public administrations - Territorial authorities and agencies	Regional
Department of Energy - Sicilian Regional - Service 1.	Public administrations - Territorial authorities and agencies	Regional
IACP - Autonomous Institute of Public Housing (Istituto Autonomo Case Popolari)	Public administrations - Territorial authorities and agencies	Provincial
AOG Assocciation	Cooperatives/associations	Provincial
Ainlu Kat	Professional orders	Provincial
Co-Governance Laboratorio Civico di Sussidiarietà Politica Ragusa Association	Cooperatives/associations	Municipal
Barocco Garden Club	Cooperatives/associations	Municipal
Bureau Veritas Italia SPA	N.A.	Provincial
CNN TRE PONTI	Cooperatives/associations	Municipal
Chimetec s.r.l.	Energy and service companies	Provincial
Ocra Collective	Cooperatives/associations	Municipal
Laboratorio Verde Fare Ambiente Provinciale Ragusa	Cooperatives/associations	Provincial
Libero Professionista	Freelancer	Provincial
Libero Professionista	Freelancer	Provincial
Libero Professionista	Freelancer	Provincial
Plastic Free	Cooperatives/associations	Provincial
Guardie Ambientali Volontarie GAV Ragusa	Cooperatives/associations	Provincial
Verde Bruscé Commitee	Cooperatives/associations	Municipal
Sorella Natura Foundation	Cooperatives/associations	National

5. Summary in national language.

Modica, situata nella Sicilia sud-orientale, è una città che fonde storia e modernità, caratterizzata da un centro storico diviso in Modica Alta, di impronta medievale, e Modica Bassa, che è famosa per la sua architettura barocca, dichiarata patrimonio dell'umanità dall'UNESCO. Un altro polo importante della città è il quartiere Sacro Cuore (Sorda), che rappresenta un importante centro residenziale e commerciale. Modica è anche conosciuta per il suo cioccolato, una tradizione che supporta e alimenta l'economia locale.

Il clima di Modica è tipicamente mediterraneo, con estati calde e secche e inverni miti. Tuttavia, negli ultimi anni, le ondate di calore sempre più frequenti hanno spinto il fabbisogno di energia per il raffrescamento, mentre la città è anche esposta a piogge torrenziali e periodi di siccità, fenomeni che pongono sfide sia per la gestione delle risorse naturali che per l'energia.

Nel 2024, la popolazione di Modica è di 53.485 abitanti. L'economia della città si basa principalmente sull'agricoltura, in particolare sulla coltivazione di olive, carrube e cereali, e sull'allevamento. Tuttavia, negli ultimi decenni, il settore terziario, soprattutto quello legato al turismo e alla produzione del cioccolato, ha prevalso, mentre l'industria manifatturiera ha subito un declino. Nonostante ciò, il commercio locale e l'artigianato sono ancora molto rilevanti per l'economia.

La Sicilia adotta strategie integrate per promuovere l'efficienza energetica, le fonti rinnovabili e l'adattamento climatico, tramite il PEARS (Piano Energetico Ambientale Regionale Siciliano), incentivi e normative edilizie. Il PEARS favorisce l'uso di energie rinnovabili e la riduzione delle emissioni di CO_2, incentivando tecnologie come pompe di calore e caldaie a biomassa. Le normative edilizie impongono l'integrazione di impianti rinnovabili negli edifici nuovi e ristrutturati, con incentivi per interventi che migliorano la sostenibilità. La strategia climatica regionale mira a ridurre le emissioni del 40% entro il 2030, promuovendo infrastrutture resilienti e comunità energetiche. I fondi POR FESR 2021-2027 finanziano progetti di efficientamento energetico, con focus sulle imprese e l'utilizzo di biomasse per produrre biogas e biometano. La Sicilia si prepara inoltre ad affrontare l'aumento della domanda di raffrescamento con soluzioni a energie rinnovabili, in linea con gli obiettivi europei.

Per affrontare le sfide legate alla sostenibilità ambientale, Modica ha intrapreso un percorso che punta alla riduzione delle emissioni di CO2 e alla promozione delle energie rinnovabili. Il piano strategico della città include sia l'adozione di tecnologie innovative che il miglioramento delle infrastrutture per rendere la città più resiliente agli effetti dei cambiamenti climatici. Il Piano d'Azione per l'Energia Sostenibile e il Clima (SEAP), approvato nel 2015, ha posto l'obiettivo di ridurre le emissioni di CO2 del 20% e di aumentare la quota di energia derivante da fonti rinnovabili. In seguito, nel 2023, il SEAP è stato aggiornato nel SECAP (Piano d'Azione per l'Energia Sostenibile e il Clima), che mira a ridurre le emissioni di CO2 del 40% entro il 2030 e a migliorare la resilienza della città agli eventi climatici estremi.

Il SECAP si concentra su misure di adattamento, come quelle per le ondate di calore, e sull'ottimizzazione dei sistemi di riscaldamento e raffrescamento, introducendo tecnologie verdi come le pompe di calore alimentate da fonti rinnovabili. Parallelamente, il Comune ha aggiornato il suo regolamento edilizio per incentivare l'integrazione delle energie rinnovabili negli edifici pubblici e privati. In particolare, sono stati previsti incentivi per l'installazione di impianti fotovoltaici, solare termico e pompe di calore sia nel settore residenziale che in quello commerciale. L'obiettivo è ridurre i consumi energetici e migliorare le prestazioni degli edifici in termini di efficienza energetica, riducendo al contempo l'impatto ambientale.

Un tema cruciale per Modica è la gestione della domanda e offerta di energia per il riscaldamento e il raffrescamento degli edifici. La città sta vivendo un cambiamento nelle necessità energetiche: a causa delle ondate di calore sempre più frequenti, la domanda di raffrescamento sta aumentando, mentre quella di riscaldamento diminuisce, grazie a miglioramenti nell'efficienza energetica e a un clima più mite. Questo

cambiamento impone una riorganizzazione delle infrastrutture energetiche, con l'introduzione di sistemi più efficienti, come le pompe di calore ad alta efficienza, che utilizzano fonti rinnovabili per soddisfare le esigenze di riscaldamento e raffrescamento.

Le tecnologie innovative sono essenziali per migliorare le prestazioni energetiche degli edifici e delle città. Modica sta investendo in soluzioni avanzate, come i sistemi di accumulo per l'energia prodotta dai pannelli fotovoltaici e tecnologie di monitoraggio tramite sensori IoT, che permettono di gestire i consumi in modo intelligente e ottimizzare l'uso dell'energia. Inoltre, l'utilizzo di materiali innovativi, come i nanomateriali per l'isolamento termico, sta contribuendo a migliorare l'efficienza energetica degli edifici.

Anche la mobilità sostenibile è un pilastro delle politiche ambientali del Comune di Modica. La città sta investendo nell'infrastruttura per veicoli elettrici, con l'installazione di colonnine di ricarica alimentate da energia rinnovabile. Inoltre, il Comune sta promuovendo l'uso di veicoli elettrici e ibridi a livello pubblico e privato, e sta sviluppando un sistema di car sharing per ridurre la dipendenza dall'auto privata e abbattere le emissioni inquinanti. Il parco auto comunale viene progressivamente razionalizzato, sostituendo i veicoli più inquinanti con modelli elettrici o a metano.

Per il settore agricolo e terziario, Modica sta sensibilizzando le imprese sull'importanza di ridurre i consumi energetici. Sono stati organizzati incontri informativi e sono previsti incentivi per l'adozione di tecnologie energetiche più efficienti. Le aziende agricole, in particolare, sono incentivate a installare impianti di riscaldamento e raffrescamento a energia solare o geotermica, con l'obiettivo di abbattere i costi energetici e migliorare la sostenibilità dei loro processi produttivi.

Modica ha anche creato uno sportello energetico e una sezione dedicata sul sito web comunale per informare i cittadini sulle soluzioni di risparmio energetico, gli incentivi per la riqualificazione edilizia e l'adozione di soluzioni di mobilità sostenibile. Inoltre, sta promuovendo il modello delle comunità energetiche rinnovabili, dove i cittadini possono condividere l'energia prodotta dai propri impianti fotovoltaici, riducendo la dipendenza dalle fonti tradizionali di energia e aumentando l'autoconsumo.

In conclusione, le azioni intraprese dal Comune di Modica per la sostenibilità energetica e la transizione ecologica si inseriscono in una visione di lungo periodo che punta a migliorare la qualità della vita dei cittadini, promuovere l'uso delle energie rinnovabili, ridurre le emissioni di CO_2 e rendere la città più resiliente agli eventi climatici. Questi sforzi si fondano su una forte collaborazione con i cittadini e le imprese, nonché sull'adozione di tecnologie avanzate, per costruire una città più verde e sostenibile nel tempo.

MUNICIPALITY OF VITTORIA

1. The local territorial context

Vittoria is a city in southern Italy, in Sicily, founded on April 24, 1607, it is the youngest city in the Free Municipal Consortium and therefore has a modern checkerboard structure with wide, straight streets. Its territory lies on the plain of Vittoria, overlooking the Sicilian Channel and bordered by two rivers: the Ippari and the Dirillo. At the south of the city is the "Pino d'Aleppo Nature Reserve," along the Ippari River .

The main economic activity is agriculture; greenhouse cultivation is widespread, where tomatoes, cherry tomatoes, eggplants, peppers, and zucchini are grown the most. Vittoria is a major center of fruit and vegetable, wine, and oil production, which continue to fuel production and trade. Famous is Cerasuolo, a typical Victorian DOCG wine. The municipality is a member of the Wine Cities Association and the Covenant of Mayors Movement. Its territory is included in the wine and food route Strada del Vino Cerasuolo di Vittoria.

Relevant is also floriculture, which feeds the special "flower market"; in which the absolute most produced flower turns out to be the carnation. In addition, as far as livestock farming is concerned, there is a fair production of sheep and cattle. Fishing is developed thanks to the fishing port of Scoglitti.

Industrial activities are mostly processing agricultural products; and metallurgy. For the disposal of local products, such as grapes, oil and vegetables, the largest fruit and vegetable market in Italy has been built in Vittoria. There are also several transportation agencies. Tourism takes advantage mainly in coastal areas, such as Scoglitti.

Vittoria is the tenth largest city on the island by population and the capital of a large agricultural district that stretches along the entire coastal strip of the province of Ragusa and neighbouring areas of the provinces of Caltanissetta and Syracuse.

The Region of Sicily is part of "Macro-region 6: Island Areas and Extreme Southern Italy." This macro-region is the warmest and driest on average, marked by the highest average temperature (16°C) and the highest number of consecutive days without rain (70 days/year). In addition, the macro-region is characterized by the lowest average summer precipitation (21 mm) and in general by extreme precipitation events that are reduced in frequency and magnitude.

The climate is Mediterranean. Its low altitude results in warmer average temperatures than those recorded in the rest of the territory of the Province Hyblean Mountains. The coldest average temperature is recorded in January while the hottest months are usually July and August.

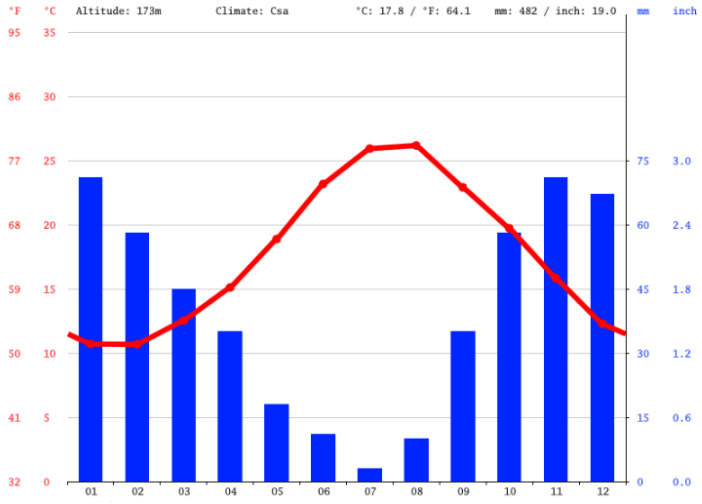
In Vittoria the hot season lasts 3 months, from 15 June to 13 September, with a daily maximum temperature of over 28 °C. The warmest month of the year in Vittoria is July, with an average maximum temperature of 30 °C and an average minimum temperature of 22 °C.

The cool season lasts 4 months, from 26 November to 25 March, with an average daily maximum temperature of less than 17 °C. The coldest month of the year in Vittoria is January, with an average minimum temperature of 7 °C and an average maximum temperature of 14 °C.

Temperature trends are in line with those defined for climate macro-region No. 6.

The chart and table (source: https://it.climate-data.org/europa/italia/sicily/vittoria-13888/) illustrate the distribution of rainfall and temperatures throughout the year. January is the rainiest month, with 71 mm of rainfall, while July is the driest, with 3 mm of rain. As for temperatures, the data show that August is the hottest

month of the year, with an average temperature of 26.2°C, while January has the lowest average temperature of 10.07°C.



	Gennaio	Febbraio	Marzo	Aprile	Maggio	Giugno	Luglio	Agosto	Settembre	Ottobre	Novembre	Dicembre
Medie Temperatura (°C)	10.7	10.7	12.5	15.1	18.9	23.2	25.9	26.2	22.9	19.7	15.8	12.3
Temperatura minima (°C)	8.1	7.8	9.3	11.6	14.9	18.8	21.4	22	19.6	16.8	13.3	9.8
Temperatura massima (°C)	13.5	13.6	15.9	18.6	22.6	27.1	29.9	30.2	26.3	22.9	18.5	14.9
Precipitazioni (mm)	71	58	45	35	18	11	3	10	35	58	71	67
Umidità(%)	79%	76%	76%	72%	66%	62%	61%	64%	72%	78%	78%	78%
Giorni di pioggia (g.)	7	6	5	5	3	1	1	1	4	6	7	7
Ore di sole (ore)	6.7	7.3	8.8	10.3	12.0	12.8	12.8	11.9	10.0	8.3	7.1	6.6

The annual solar radiation (GHI) in the municipality of VITTORIA is 1,814 kilowatt-hours per year. (https://globalsolaratlas.info 2023)

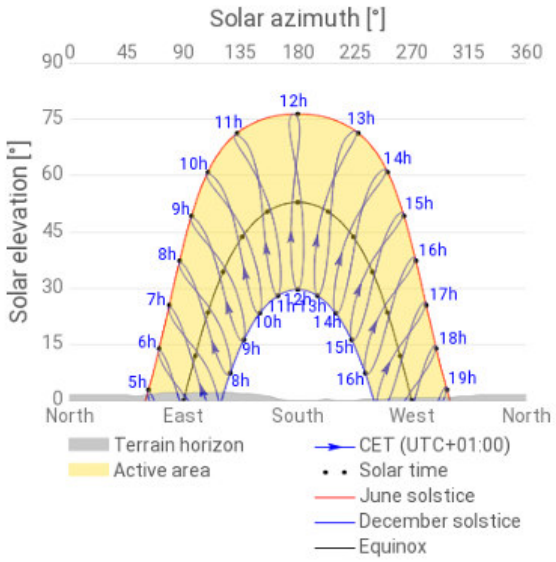
Deliverable D2.1 – Annex 1

SITE INFO

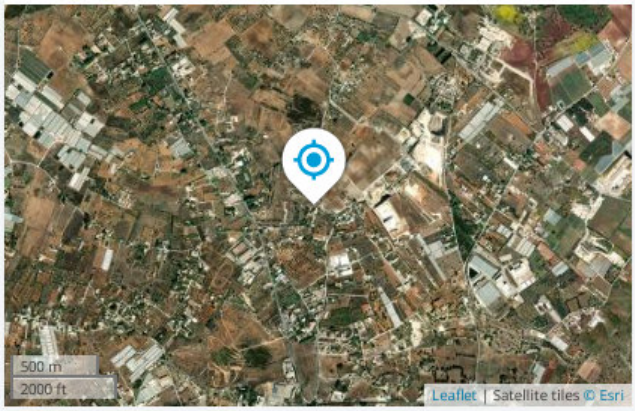
Map data

		Per year	
Specific photovoltaic power output	PVOUT specific	**1674.4**	kWh/kWp
Direct normal irradiation	DNI	**1922.1**	kWh/m²
Global horizontal irradiation	GHI	**1814.1**	kWh/m²
Diffuse horizontal irradiation	DIF	**643.8**	kWh/m²
Global tilted irradiation at optimum angle	GTI opta	**2065.8**	kWh/m²
Optimum tilt of PV modules	OPTA	**32 / 180**	°
Air temperature	TEMP	**17.5**	°C
Terrain elevation	ELE	**198**	m

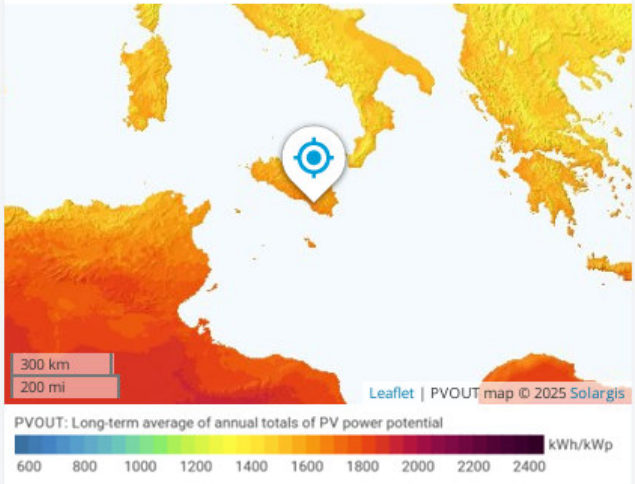
Horizon and sunpath



Map



PVOUT map



2. The local reference policy and strategic context

The municipality of Vittoria adhered to the Covenant of Mayors with City Council resolution no. 101 of 27/10/2011 committing itself, as a consequence, to reduce territorial emissions by at least 20%.

Sector/filed of intervention	Action (SEAP 2011)	Energy savings (MWh/a)	RES production (MWh/a)	CO2 reduction (t/a)
Municipal buildings, equipment/facilities	Energy saving interventions on municipal buildings	1732,46	0	464,46
Municipal buildings, equipment/facilities	Energy Management System	745,93	0	339,25
Municipal buildings, equipment/facilities	Implementation of photovoltaic systems on municipal buildings	18,89	0	9,12
Municipal buildings, equipment/facilities	Construction of a plant for the production of biogas	4792	0	2314,54
Tertiary	Reduction of thermal consumption for heating in the tertiary sector	5746,76	0	1693,86
Residential buildings	Reduction of thermal consumption for heating in the residential sector	13368,28	0	3940,3
Residential buildings	Replacement of traditional boilers with condensing boilers in the residential sector	2019,02	0	595,11
Residential buildings	Reducing electricity consumption for lighting in the residential sector	5268,1	0	2544,49
Residential buildings	Realisation of private photovoltaic plants	37044,94	0	17892,7
Residential buildings	Realisation of solar thermal systems on private buildings	16335,93	0	7890,25
Public lighting	Efficiency enhancement of the lighting system public lighting	2433,45	0	1175,36
Industry	Reduction of electricity and heat consumption in the production sector	4941,6	0	2719,17
Municipal fleet	Reducing emissions from the car fleet municipal	324,8	0	91,47

Actions highlighted in yellow that promote increased efficiency and deployment of renewables in the H&C sector. In particular:

- Energy saving interventions on municipal buildings. The action envisages the implementation of several efficiency measures in public buildings. The cost incurred for implementation depends on the type of project solution adopted. The cost will in any case be borne by the Administration and amounts to € 670,000.00.
- Energy Management System. The implementation of voluntary management systems has always had the main purpose of improving organisations through the optimisation and definition of standardised processes, thus giving added value to any type of organisation, whether it produces a good or provides a service. The Administration, in light of the energy policy of which the following Plan is an expression, intends to adopt an Energy Management System that complies with the provisions of the regulations in force. The cost incurred for the implementation of the action amounts to € 15.000. The cost will be borne by the Municipal Administration.
- Implementation of photovoltaic systems on municipal buildings. Another municipal plant is planned. The photovoltaic plant that will be realised at the Lombardo Radice middle school, as it is still under construction, contributes, even if to a modest extent, to increasing the share of renewable energy produced in the municipality.
- Construction of a plant for the production of biogas. The private company AB Group Società Agricola Srl has started the construction of an anaerobic digestion plant for the production of biogas. This plant, located within the administrative boundaries of the municipality of Vittoria, has an electrical capacity of 599 kW. The introduction of a matrix into the digester, which will presumably consist of production waste from the fruit and vegetable sector, will lead to the production of biogas as a product of the

anaerobic digestion process. The output biogas will be used as a vector for the production of electrical and thermal energy in cogeneration. Leaving aside the benefits resulting from the possible recovery of the thermal energy produced, the incidence from the production of electrical energy alone was evaluated. The cost was borne by a private company and can be estimated at approximately €2,000,000.00.

- Reduction of thermal consumption for heating in the tertiary sector. Starting with an analysis of the existing building stock and the building types found throughout the territory, and with the help of studies and consolidated statistics, the potential for reducing consumption resulting from the implementation of measures to upgrade private buildings for commercial use was assessed. The positive outcome of the action is only possible if the Administration, in addition to monitoring the consumption parameters of the tertiary sector, establishes the modalities, in support and synergy with what is foreseen for the residential sector, of training for professionals operating in the area and dissemination activities for citizens. The funds needed to implement the action will be borne by the citizenship and are estimated at €13,005,000.00. Financial instruments of reference are tax breaks and incentive mechanisms provided at national level.
- Reduction of thermal consumption for heating in the residential sector. The objective of the action is to reduce thermal energy consumption attributable to the residential sector. Interventions on buildings are limited by the considerable economic commitment required for their realisation. Moreover, the fragmentation of real estate ownership represents a seemingly insurmountable obstacle to the redevelopment of large building complexes from the 1960s, 1970s and 1980s. The exception are perhaps the portions of the housing stock built from the late 1990s onwards belonging to the shared ownership housing, which may constitute an interesting area for intervention.

Starting with an analysis of the existing quite critical residential heritage and the building types widespread in the area, together with the help of studies and consolidated statistics and on the basis of the qualified report received from the CNA, National Confederation of Craftsmen and Small and Medium Enterprises –and the Territorial Headquarters of Vittoria, the potential for reducing thermal consumption derives from the implementation of retraining interventions in private buildings. Given the multiplicity of interventions, applicable solutions, the different characteristics of the building and the fluctuating market prices, the cost estimated is € 28,741,000.00. The municipal administration plans to take on a share of 2% of this sum (amounting to €574,820.00), as a contribution to the redevelopment of buildings owned by needy families. The funds required to implement the action will be borne by the citizens. Financial instruments of reference are the tax concessions and incentive mechanisms provided at national level.

- Replacement of traditional boilers with condensing boilers in the residential sector. The objective of the action is to assess the reduction of methane consumption required for space heating and/or domestic hot water production in the residential sector through the replacement of obsolete heat generators and the replacement of condensing boilers. The funds needed to implement the action will be borne by the citizens and are estimated at €5,065,000.00. Financial instruments of reference are the tax breaks and incentive mechanisms provided at national level.
- Realisation of private photovoltaic plants. From the analysis of the best technologies available on the market, given the landscape conformation, the climatic characteristics of the area, and the real possibility linked to decentralised design solutions, it is possible to state that photovoltaics is, to date, the technology for the production of energy from renewable sources that has become more widespread in the municipality of Vittoria than others. The action contemplates different solutions, adopted

according to the choices of the individuals who have decided/decide to install a photovoltaic system; the estimated cost of the photovoltaic plant is € 11,000,000.00.

- Realisation of solar thermal systems on private buildings. The objective of the action is to increase the number of solar thermal systems in residential buildings. From the analysis of the best technologies available on the market, given the landscape conformation and the real possibility linked to decentralised design solutions, it is possible to affirm that solar thermal is, as of today, one of the technologies that can spread the most in the Vittoria territory. The positive outcome of the action is only possible if the Administration, in addition to monitoring the increased parameters of energy production, establishes, in support and synergy with the other actions, the modalities of citizen involvement. The cost of implementing the action is difficult to estimate, given the variety of project solutions and the strong fluctuation of prices over the years, which vitiate the calculation to determine an average expenditure figure; it can however be estimated at € 1,702,340.00.
- Reduction of electricity and heat consumption in the production sector. Starting from the analysis of the incentive mechanisms for energy efficiency, the most recent reference legislation and the degree of diffusion of the best performing technologies, it is possible to hope for a reduction in consumption which, given the complexity and differentiation of the sector and of the solutions, has been evaluated on a lump-sum basis with respect to consumption in the reference year. The funds required to implement the action will be borne by the citizens and are estimated at € 4,238,000.00.

PRG - Building Regulations

The building regulation of the PRG of the municipality of Vittoria (revised in 2003) only mentions general indications regarding heating. In particular, Article 49 recites, verbatim: “where accommodation is equipped with heating systems, the design temperature of the indoor area must be between 18° C and 20° C and must be the same in all inhabited rooms and in the services, excluding storage rooms. Under the conditions of occupancy and use of the dwellings, the interior surfaces must not show signs of permanent condensation. All constructions must also comply with current legislation on insulation and energy consumption”.

3. The local energy system

SEAP SOURCE

The consumption of the different sectors is the following:

- public (municipal buildings and equipment and public lighting);
- civil residential: 100.430, 67 MWh/year
- civil tertiary: 69.939,48 MWh/year
- agriculture: 33407,08 MWh/year
- Urban Transportation: 280.374,72 MWh/year
- industry: 67.333,21 MWh/pear

Deliverable D2.1 – Annex 1

The local energy demand

Sector	FINAL ENERGY CONSUMPTION (MWh) - 2011 (SEAP)																
	Electricity	Heat/cold	Fossil fuels								Renewable Energy						Total
			Natural gas	GPL	Heating oil	Diesel	Gasoline	Lignite	Coal	Other fossil fuel	Plant oil	Biofuel	Other biomass	Solar Thermal	Geothermal	Other	
Municipal buildings, equipment/facilities	6574	/	251,12	67	/	642	/	/	/	/	/	/	/	/	/	/	7534,12
Tertiary	56830,75	/	10648,86	1598,99	196,63	629,98	/	/	/		/	/	29,64	/	/	4,63	69939,48
Residential buildings	75489,08	/	13217,8	7131,19	/	95,3	/	/	/	/	/	/	4494,17		/	3,14	100430,68
Public lighting	5459	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	5459
Industry	49416,01	/	9111,85	2317,09	4721,73	1677,86	/	/	/	/	/	/	58,41	/	/	30,26	67333,21
Municipal fleet	/	/	225	/	/	195,87	275,77	/	/	/	/	42	/	/	/	/	738,64
Pubblic transport	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	0
Private and commercial transport	/	/	/	6364,19	/	200511,92	73498,61	/	/	/	/	/	/	/	/	/	280374,72
Agriculture, Forestry, Fisheries	26833,02	/	145,1	194,29	/	6174,27	60,39	/	/	/	/	/	/	/	/	/	33407,07
Other	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	0
Total	220601,86	0	33599,73	17672,75	4918,36	209927,2	73834,77	0	0	0	0	42	4582,22	0	0	38,03	565216,92

Since 2013 Vittoria joined the Covenant of Major voluntary agreement and therefore adopted a SEAP that forecasted a GHG reduction goal of 20% by 2020. Nowadays Vittoria is going to apply for the implementation of SECAP with more ambitious GHG reduction objectives, with different scenarios, but still the monitoring of the previous target needs to be done.

The energy strategy proposed in the SEAP concentrate efforts on two macro sectors: the civil sector and transports.

In the civil sectors (residential and tertiary) interventions are proposed to reduce the heat demand in existing buildings (refurbishment of buildings envelop and renewal of thermal plants) and also to support the use of thermal RES (thermal solar and biomasses).

Specific action also concerns energy efficiency in the industrial sector, focusing both on electric and thermal consumptions for the production processes.

The City of Vittoria collaborates with other local institutions to implement integrated and complementary actions of the SEAP, that was joined with City Council resolution no. 101 of 27/10/2011 committing, consequently, to reduce territorial emissions by at least 20%.

In 2022 the City of Vittoria promoted a public tender for improving local Renewable Energy Communities (REC) and analysing technical feasibility. In fact, Italian government has decided to anticipate in some extent the transposition of two UE Directives that treat those arguments in depth. Since then, the administration has worked on that considering it a reality with high social, ethical and economic value, whose development could contribute to achieving the development of a fair model of sustainable mobility and to the fight against energy poverty present in the area.

All citizens, small enterprises, local authorities and in general any social or economic actor would benefit of the new scenario of becoming, in cooperation with each other, collective energy prosumers. The incentive system available at this stage can lead to a win-win performance in implementing these schemes.

With this commitment the first three Italian agricultural energy communities were born in Vittoria with the aim of involving agricultural businesses in the area to virtually share their energy consumption produced by photovoltaic panels, obtaining twenty-year state incentives to be redistributed for the benefit of the members of the energy community. All with economic and environmental benefits for the entire territory.

In 2022 Vittoria also participated in a public call of the "Horizon Europe" program, with a project for the total decarbonization of cities for research and innovation for the period 2021-2027.

In 2023, another important field of action for energy transition is about energy efficiency of public lighting service (LED retrofits) with installation of a new public lighting system in the city of Vittoria which involves the replacement of 12,000 light points all characterized by LED lighting and therefore aimed at energy saving.

The local energy supply

RES plant					
plants	N°	Electric power (MW)	Thermal power (MW)	Electricity production (MWh/a)	Thermal energy production (MWh/a)
PHOTOVOLTAIC	11	0,125	/	197,39	/

4. Mapping of H&C target groups

STAKEHOLDER	TARGET GROUP	Geographical Scope
CNA - National Confederation of Artisans (Confederazione Nazionale Artigianato)	Professionale associations - productive	Provincial
ANCE - National Association of Building Contractors (Associazione Nazionale Costruttori Edili)	Professional associations - construction	Provincial
ConfCommercio - General Italian Confederation of Enterprises	Professional associations - Tertiary/trade	Provincial
FederConsumatori - Italian Consumer Association	Professional associations - consumers	Provincial
BAPS - Banca Agricola Popolare di Sicilia (Bank)	Economy and finance	Provincial
ASSISTAL - National Association of Plant Builder and Energy Services (Associazione Nazionale Costruttori di Impianti e dei Servizi di efficienza Energetica)	Professionale associations - productive	National
ASSOUTENTI	Professional associations - consumers	Provincial
CODACONS - Coordination of Associations for the Protection of the Environment and the Rights of Users and Consumer (Coordinamento delle Associazioni per la difesa dell'ambiente e dei diritti degli utenti e dei consumatori)	Professional associations - consumers	Regional
ADOC - National Association for the Protection and Guidance of Consumers (Associazione Nazionale per la Difesa e l'Orientamento dei Consumatori)	Professional associations - consumers	Regional
SiciliESCO	Energy and service companies	Regional
REGRAN - Sistema energia	Energy and service companies	Regional
Compagnia per l'Energia Rinnovabile s.r.l.	Energy and service companies	Regional
Musa Progetti s.r.l.	Energy and service companies	Provincial

Macs s.r.l.	Energy and service companies	Regional
Confagricoltura	Professional associations - agriculture	Provincial
CIA - Italian Confederation of Farmers (Confederazione Italiana Agricoltori)	Professional associations - agriculture	National
Coldiretti	Professional associations - agriculture	National
SICINDUSTRIA	Professional associations - Tertiary/trade	Provincial
Confesercenti	Professional associations - Tertiary/trade	Provincial
Confartigianato	Professional associations - Tertiary/trade	Provincial
Lega Cooperative	Cooperatives/associations	Provincial
Confcooperative	Cooperatives/associations	Provincial
ANACI - National Association of Condominium and Property Managers (Associazione Amministratori Condominiali Immobiliari)	Professional associations - construction	Provincial
Superintendency for Cultural and Environmental Heritage of Ragusa	Amministrazioni pubbliche - Enti e agenzie territoriali	Provincial
Order of Engineers Ragusa	Professional orders	Provincial
Order of Architects Ragusa	Professional orders	Provincial
Order of Geologists Sicily	Professional orders	Regional
Order of Geometers Ragusa	Professional orders	Provincial
Order of Agronomists/foresters	Professional orders	Provincial
FEDERALBERGHI	Professional associations - consumers	Provincial
National Confederation of Artisans (CNA) - Vittoria	Professional associations - Tertiary/trade	Municipal
College of Agricultural Experts	Professional orders	Provincial
College of Industrial, Electrical, and Building Experts	Professional orders	Regional
CERSU - Regional Centre for Urban Studies of Sicily (Centro Regionale Studi Urbanistici di Sicilia)	Public administrations - Territorial authorities and agencies	Regional
Province of Ragusa	Public administrations - Territorial authorities and agencies	Provincial
Zipelli Foundation	Economy and finance	Provincial
Con il Sud Foundation	Economy and finance	National
Southeastern Horticultural District	Professionale associations - productive	Provincial
Distretto SUD-EST	Professionale associations - productive	Provincial
CORFILAC - Research Consortium in the Dairy and Agro-food Supply Chain Sector of Ragusa (Consorzio di Ricerca nel settore della Filiera Latterio Casearia e Agroalimentare Ragusa)	Professionale associations - productive	Provincial

IRSAP - Regional Institute for the Development of Productive Activities (Istituto Regionale Sviluppo Attività Produttive - ex ASI)	Public administrations - Territorial authorities and agencies	Provincial
SOSVI - Società Sviluppo Ibleo	N.A.	Provincial
Local Action Group (GAL) - Valli del Golfo	N.A.	Inter-municipal
Local Action Group (GAL) - Terra Barocca	N.A.	Inter-municipal
ARPA - Regional Environmental Protection Agency (Agenzia regionale per la protezione ambientale)	Energy and service companies	Provincial
ENEA - National Agency for New Technologies, Energy and Sustainable Economic Development Agenzia nazionale per le nuove tecnologie, l'energia e lo sviluppo economico sostenibile)	Energy and service companies	Regional
Sicily Energy Manager	Public administrations - Territorial authorities and agencies	N.A.
Sicily Department of Energy and Public Utility Services.	Public administrations - Territorial authorities and agencies	Regional
Department of Energy - Sicilian Regional - Service 1.	Public administrations - Territorial authorities and agencies	Regional
IACP - Autonomous Institute of Public Housing (Istituto Autonomo Case Popolari)	Public administrations - Territorial authorities and agencies	Provincial
AOG Assocciation	Cooperatives/associations	Provincial
Ainlu Kat	Professional orders	Provincial
Co-Governance Laboratorio Civico di Sussidiarietà Politica Ragusa Association	Cooperatives/associations	Municipal
Barocco Garden Club	Cooperatives/associations	Municipal
Bureau Veritas Italia SPA	N.A.	Provincial
CNN TRE PONTI	Cooperatives/associations	Municipal
Chimetec s.r.l.	Energy and service companies	Provincial
Ocra Collective	Cooperatives/associations	Municipal
Laboratorio Verde Fare Ambiente Provinciale Ragusa	Cooperatives/associations	Provincial
Libero Professionista	Freelancer	Provincial
Libero Professionista	Freelancer	Provincial
Libero Professionista	Freelancer	Provincial
Plastic Free	Cooperatives/associations	Provincial
Guardie Ambientali Volontarie GAV Ragusa	Cooperatives/associations	Provincial
Verde Bruscé Commitee	Cooperatives/associations	Municipal
Sorella Natura Foundation	Cooperatives/associations	National

5. Summary in national language

Vittoria, è una vivace città della Sicilia meridionale. La sua struttura moderna, caratterizzata da strade ampie e dritte disposte a scacchiera, riflette le sue origini relativamente recenti. Situata nella piana di Vittoria, la città è delimitata dai fiumi Ippari e Dirillo, con la "Riserva Naturale del Pino d'Aleppo" che si estende lungo il fiume Ippari fino alla costa. Vittoria gode di un clima mediterraneo, con estati calde e inverni miti, rientrando nella Macro-regione 6, caratterizzata da temperature elevate e un ambiente arido. L'agricoltura rappresenta il pilastro dell'economia locale, con una vasta coltivazione in serra di ortaggi come pomodori, peperoni e zucchine. La città è rinomata per la produzione del Cerasuolo di Vittoria, un prestigioso vino DOCG, ed è riconosciuta come un centro importante per la produzione di vino, frutta e ortaggi. Ospita il più grande mercato ortofrutticolo d'Italia e vanta un fiorente settore florovivaistico, con i garofani come fiore principale. Anche la pesca, sostenuta dal porto di Scoglitti, e l'allevamento contribuiscono significativamente all'economia locale.

Vittoria è attivamente impegnata nell'affrontare le sfide climatiche e nel promuovere la sostenibilità. Come firmataria del Patto dei Sindaci dal 2011, la città si è impegnata a ridurre le emissioni di gas serra di almeno il 20%. Questo impegno si allinea con le più ampie strategie energetiche della Sicilia delineate nel Piano Energetico e Ambientale Regionale (PEARS), che enfatizza l'efficienza energetica, l'adozione di energie rinnovabili e la decarbonizzazione attraverso iniziative come la promozione di sistemi energetici rinnovabili, tra cui solare e biomasse, il sostegno alle tecnologie efficienti dal punto di vista energetico negli edifici pubblici e privati, e la creazione di comunità energetiche per migliorare la produzione e la distribuzione locale di energia pulita. Le strategie climatiche della Sicilia mirano a mitigare l'aumento delle temperature, le ondate di calore prolungate e la scarsità d'acqua attraverso misure come il miglioramento dell'efficienza energetica degli edifici, l'integrazione di sistemi rinnovabili nelle costruzioni e l'adozione di pratiche sostenibili di sviluppo urbano. A Vittoria, queste misure sono fondamentali per bilanciare la vitalità economica della città con la necessità di resilienza climatica. Con il suo dinamico settore agricolo e un forte impegno per la sostenibilità, Vittoria svolge un ruolo significativo nel percorso della Sicilia verso un futuro più verde ed efficiente dal punto di vista energetico.

La città di Vittoria ha avviato numerosi progetti per migliorare l'efficienza energetica e promuovere l'utilizzo di energie rinnovabili, puntando a una significativa riduzione delle emissioni di gas serra e a uno sviluppo sostenibile del territorio. Tra gli interventi principali, l'efficientamento energetico degli edifici pubblici, con un investimento di €670.000, prevede l'adozione di misure volte a ridurre i consumi, come l'installazione di impianti fotovoltaici in strutture come la scuola media Lombardo Radice. Questi progetti mirano ad aumentare la quota di energia rinnovabile prodotta localmente, seppur con contributi inizialmente modesti.

Un altro passo importante è rappresentato dall'introduzione di un sistema di gestione energetica conforme agli standard normativi, volto a ottimizzare processi e risorse. Questo intervento, dal costo di €15.000, mira a migliorare l'efficienza organizzativa e a promuovere una gestione energetica più responsabile. Parallelamente, il settore privato contribuisce alla transizione energetica, come dimostra la realizzazione di un impianto di digestione anaerobica per la produzione di biogas, avviato da AB Società Agricola Srl con un investimento di

circa €2.000.000. Questo impianto, alimentato da scarti agricoli, produce biogas che viene utilizzato per generare energia elettrica e termica in cogenerazione.

Nel settore residenziale e terziario, sono state pianificate azioni per ridurre i consumi termici attraverso la riqualificazione energetica degli edifici. Tali interventi includono il miglioramento dell'isolamento e la sostituzione degli impianti di riscaldamento obsoleti con caldaie a condensazione. Un'altra priorità è l'installazione di impianti fotovoltaici e solari termici su edifici privati. Il fotovoltaico, già ampiamente diffuso nel territorio di Vittoria, continua a rappresentare una tecnologia chiave per la produzione di energia rinnovabile.

Per quanto riguarda il settore pubblico, l'amministrazione ha implementato interventi di riqualificazione dell'illuminazione urbana, sostituendo 12.000 punti luce con sistemi LED a basso consumo, con significativi risparmi energetici. Inoltre, la città ha promosso la creazione di Comunità Energetiche Rinnovabili (REC), coinvolgendo cittadini, imprese e istituzioni locali nella condivisione dell'energia prodotta da impianti fotovoltaici. Questo modello innovativo non solo favorisce la lotta contro la povertà energetica, ma genera benefici economici e ambientali diffusi. Le prime tre comunità energetiche agricole italiane sono nate proprio a Vittoria, dimostrando l'importanza di coinvolgere le aziende agricole nella transizione energetica.

A livello strategico, Vittoria ha aderito nel 2011 al Patto dei Sindaci, impegnandosi a ridurre del 20% le emissioni entro il 2020. Oggi, attraverso il Piano d'Azione per l'Energia Sostenibile e il Clima (SECAP), punta a obiettivi ancora più ambiziosi. In questo contesto, la città ha partecipato a iniziative come il programma europeo "Horizon Europe" presentando un progetto dedicato alla decarbonizzazione della città.

In sintesi, le azioni intraprese da Vittoria evidenziano una strategia integrata che coinvolge settore pubblico, privato e cittadini, con l'obiettivo di promuovere un modello energetico sostenibile e inclusivo, garantendo benefici economici, sociali e ambientali per tutta la comunità.

D2.1

LOCAL CONTEXT TO DEVELOP SLHCPS

GREECE

MUNICIPALITY OF AMPELOKIPI – MENEMENI AND MUNICIPALITY OF THERMI

1. The local territorial context

In the region of Central Macedonia, the SLHCP will be developed for the municipalities of Thermi and Ampelokipi-Menemeni. Both are located in the metropolitan area of Thessaloniki. The Municipality of Thermi, which is a suburb of Thessaloniki, is situated southeast of the city, while Ampelokipoi-Menemeni, belongs to the territory of the city of Thessaloniki and it is located northwest of the city center.

Ampelokipi-Menemeni is one of the most densely populated municipalities in the urban complex of Thessaloniki with 50,143 inhabitants and covers a relatively small area of approximately 7.45 km². The municipality is primarily urban and residential, with some commercial and industrial activities. It serves as a densely populated area with numerous small businesses and light industries. It also has historical and cultural significance, and public services are key employers in the area. In addition to the Ampelokipoi-Menemeni, municipality of Thermi covers an area of approximately 382.106 km² and its population is around 55,358. Thermi is characterized by a mix of residential, agricultural, and light industrial activities, with key sectors being agriculture, trade, education, and tourism. The area also houses research institutes and educational facilities.

According to the 2021 census of the Greek Statistical Authority - ELSTAT, buildings constructed before 1980 are 15.8% for the municipality of Thermi, while for the municipality of Ampelokipoi – Menemeni, this percentage is 62.1%. This date is a milestone for the adoption of the first insulation ordinance in Greece. In the municipality of Thermi, 38% are single-family houses, in contrast to the other municipality where 91.8% are multi-family buildings. As for the buildings, in the municipality of Ampelokipoi - Menemeni, 8.7% of the dwellings do not have a heating system.

We understand that there is a developing area - a municipality in the east of Thessaloniki, with relatively new buildings, where new houses are increasingly being built in line with the latest energy and environmental standards, and a densely populated municipality on the west side of Thessaloniki, which, as mentioned, is one of the oldest areas of the city, with an old and low-energy-efficiency building stock.

Also, high unemployment rates are observed in the municipality of Ambelokipi-Menemeni, equal to 23%, while the pensioners of the two areas amount to 17.8% and 20.2% respectively. As for the educational level, it is observed that those who have not received any level of education, and those who have received only that of basic education are 23.5% for Thermi and 27.9% for Ampelokipoi – Menemeni.

Table 49: Municipalities of Thermi and Ampelokipoi - Menemeni

2021 Census of the Greek Statistical Authority - ELSTAT

	Municipality of Thermi	Municipality of Ampelokipoi - Menemeni
Buildings built before 1980	15.8%	62.1%
Single-family houses |Block of Flats	38% | 43%	3.2% | 91.8%
dwellings without heating	3.5%	8.7%
Unemployment	12.1%	23%
Pensioners	17.8%	20.2%
Illiteracy and primary education	23.5%	27.9%

It should be noted, that the municipality of Ampelokipoi Menemeni was selected by the Energy Poverty Advisory Hub (EPAH), to receive technical assistance to diagnose and tackle the phenomenon of energy poverty. Indicatively, the survey conducted in the municipality, showed among others:

- 41.2% did not heat their entire house
- 36.3% of the households faced problems with humidity – mold inside their residents
- 59.1% were beneficiaries of the social tariff
- 36.9% were not consistent in paying their energy bills

As for the climate conditions, both municipalities belong to the complex of Thessaloniki, which means that they have the same climate characteristics. According to the Technical Directive for the climate data published by the Technical Chamber of Greece in 2014; Thessaloniki is a territory with 2795 cooling DH and 1677 heating DD. The average daily temperature for the winter's months is 6.9, 5.3 and 6.8 ^{o}C for December, January and February, while the average daily temperature for the summer's months (Jun-Jul-Aug) is 24.5, 26.8 and 26.2^{o}C. The average temperature of the municipality of Thermi during the period 1986-2005 was 13.97 while for Ampelokipi-Menemeni was 14.27 for the same period. This gap is possibly attributed to the suburban area of Thermi. It has to be mentioned, that these data were published in 2014 and the Technical Chamber of Greece is preparing the newest technical guidance with the updated climate data. It is estimated that the average daily temperature for all the months and the cooling DH will be increased significantly. The next Table presents the monthly Temperature for the city of Thessaloniki, according to the Hellenic National Meteorological Service for 2022.

Table 50: Average Temperature per Month in Thessaloniki.

Month	Jun	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Tmax (^{o}C)	10,6	13,9	13,7	21,0	26,9	31,7	33,5	33,5	27,5	24,2	19,0	14,5
Average Tmin (^{o}C)	3,3	6,0	4,8	11,0	16,5	21,6	23,7	23,4	18,5	14,3	11,9	9,0
Average T (^{o}C)	6,9	9,6	8,9	15,7	21,6	26,4	28,6	28,1	22,9	18,9	15,4	11,6

To conclude, on the one hand there is a municipality with dense construction, an aging building stock with low energy efficiency, high unemployment rates and low income households. On the other hand, there is a municipality that has experienced strong growth in recent years, with households of some economic well-being.

2. The reference policy and strategic context

The regional context

The Regional Climate Change Adaptation Plan (PESPKA) for Central Macedonia, published in February 2023, outlines several key actions and measures aimed at reducing energy consumption, particularly in the context of heating and cooling (H&C) demand, and fostering adaptation to climate change.

Action 10.1 addresses horizontal coordination actions concerning energy demand for cooling, targeting areas with high energy demand, such as residential, industrial, tourism, and service sectors. The goal is to reduce energy consumption and implement best available practices for energy efficiency. This action includes several key measures containing:

- Providing incentives for energy savings, aligning with tourism sector measures and the built environment.
- Developing bioclimatic infrastructures in both public and private buildings, such as the use of green materials in new constructions and renovations, and the creation of green roofs and vertical gardens.
- Enhancing the energy performance of public buildings, including thermal insulation, window replacements, and the upgrading of HVAC (Heating, Ventilation, and Air Conditioning) systems.
- Running awareness campaigns to inform the public, government bodies, and businesses on energy-saving practices.

Action 10.2 focuses on research and development, particularly in smart grids and demand management to mitigate the impact of increased electricity demand due to rising temperatures. In particular, it promotes the application of smart grid technologies in first-priority areas, major municipalities, and summer tourism zones during the peak summer months.

Additionally, according to a 2021 report by Greek Transmission System Operator (ADMIE), the energy landscape in Central Macedonia includes a gas-fired combined-cycle power plant with an installed capacity of 430 MW, located in Thessaloniki. The region has an installed capacity of 331.7 MW from wind and solar power, and 138.2 MW from biomass, biogas, small hydroelectric plants (MYHS), and Combined Heat and Power (CHP) systems. This capacity is likely higher today due to the growing trend of new photovoltaic system installations, particularly in urban settings such as residential buildings, businesses, and public sectors' facilities. Today, Central Macedonia has an installed capacity of 1484.53 MW of renewable sources including CHP plants, producing 2,125.36 GWh in 2024 and saving 531.34 ktn of carbon, according to the new "Production of Electricity from Renewable Energy Sources" data base of the Hellenic Electricity Distribution Network Operator (DEDIE).

These actions and energy developments reflect the regional commitment to addressing climate change through energy transition, focusing on reducing energy consumption, expanding renewable energy capacity, and adapting to the increasing challenges posed by rising temperatures. The Heating and Cooling (H&C) sector plays a significant role in the adaptation strategies, particularly in reducing energy demand for cooling during hot summer months and enhancing energy efficiency in buildings.

Regarding the available incentives, supporting mechanisms, and financial tools for energy transition and decarbonizing the H&C sector, the region has several measures in place. The incentives primarily focus on energy savings, the installation of renewable energy systems, and energy-efficient renovations. These include financial support for bioclimatic building infrastructure, energy upgrades in public buildings, and the promotion of smart grids and demand management tools. Financial tools may include subsidies, tax incentives, and other mechanisms that facilitate the adoption of green technologies in both the private and public sectors. The region of Central Macedonia provides 94.7M euros for energy efficiency and decarbonisation measures through the regional operational programme "Kentriki Makedonia 2021-2027" for the seven years programming period. From this amount, 69.7M is dedicated to energy efficiency and decarbonisation measures of public buildings.

In conclusion, the current climate and energy strategies at the regional level in Central Macedonia are designed to foster energy efficiency, encourage the use of renewable energy, and promote adaptation to climate change, with a clear focus on the H&C demand and supply scenarios, particularly in relation to cooling. The incentives and financial tools available play a crucial role in supporting the decarbonization of the H&C sector and the broader energy transition.

The local context

The Municipality of Thermi, as part of the Covenant of Mayors, implemented the development of a Sustainable Energy and Climate Action Plan (SECAP) for the city in 2013. Therefore, the data presented is not up-to-date. According to the municipality's plan, eight different actions were carried out that contributed to energy savings and a reduction in CO_2 emissions.

Regarding local electricity generation, a significant number of private individuals have installed photovoltaic systems connected to the grid. The municipality also created a municipal photovoltaic park, as outlined in the action plan, with a capacity of 1 MW and a value of 1.2 million euros. Photovoltaic systems were installed on the roofs of schools, and at the same time, the municipality proceeded with the installation of a combined heat and power (CHP) plant, using waste cooking oil collected from local households.

Table 51: Action for reducing energy consumption and CO_2 emissions.

Actions	Energy Saving (MWh)	Emission Reduction (tn CO_2)	Cost (€)
Replacement oil boilers with NG boilers	462.5	231.2	151,700
Replacement old boilers with new ones	83.65	22.7	23,690
Replacement old windows and doors with new ones	109.1	36.3	594,288
Installation of temperature control valves	234	59.7	42,232.5
Installation of Solar Panels for the production of hot water	140.7	38	27,200
Installation of floodlights in football pitches	14.73	24	45,000
Improvement of existing structures	325.4	373.9	1,500,000
Energy saving measures in municipal street lighting	965.395	1109	N/A
Total	**2335.5**	**1895**	**2.384.110,5**

Municipality of Ampelokipoi-Menemeni has managed to implement different actions to increase its energy efficiency and decline its carbon emissions. As for the local plans, the latest SECAP was published in December 2023, while the Building Energy Performance Plan (SEAK) was published in July 2024. SEAK aims to present an improvement plan for all the public buildings, in order to enhance their energy efficiency. As for the energy consumption and the CO_2 emission of the municipality, it has been calculated including activities and energy use of the Building Sector & Infrastructures, Road lighting and transports.

According to those plans, only 2 of the 42 public buildings have an EPC while Municipality aims to renovate 5% of its building surface annually. As for the CO_2 emissions, they have set 40% reduction of their emission until 2028 as a goal, and they are able to achieve a 45.2% reduction according to the Best Case Scenario of its action plan, compared to the reporting year, 2019. The actions and measures through which the CO_2 reduction target is to be met are described in the municipality's plan and include: installation of insulation, double-glazing windows, shades, new air conditioning systems and high energy efficiency electrical appliances at the public buildings. It also includes the replacement of old lighting lamps with new LED lamps and the replacement of oil boilers with heat pumps or high energy efficiency natural gas boilers. Lastly, it includes the maintenance of the existing boilers, the application of "cool colors" on ceilings and the installation of solar thermal systems for the production of hot water in sports facilities buildings and other public buildings with hot water demand.

It should be noted that according to Regional Climate Change Adaptation Plan (PESPKA) that referred and previously, the whole region will face an increase of the average temperature by 4 degrees at least the period 2080-2100, according to the Worst Case Scenario, and the days that the temperature will be over 35 oC will be increased by 30 days. In the medium and short term period, there will be slight variations. Lastly, Municipality of Ampelokipi-Menemeni belongs to the vulnerable and the most exposed to the climate change municipalities of the Region of Central Macedonia.

3. The local energy system

The local energy demand

It is also worth noting that natural gas is the most popular heating choice in the area. Specifically, the western part of Thessaloniki, which includes the municipality of Ampelokipi-Menemeni, is characterized by dense urban development with many apartment buildings closely located together, facilitating the development of a natural gas network in the area.

Table 4 and Table 5 present the energy consumption and the CO_2 emissions of the Municipality of Ampelokipi-Menemeni for 2019.

Table 52: Energy Consumption and CO_2 emissions for the year 2019 including only the public sector.

	Energy Consumption (kWh)	CO_2 emissions (tn CO_2)	Percentage (%)
Electricity Consumption	6,534,559.0	3,946.9	67%
Natural Gas Consumption	2,988,073.6	603.6	10.2%
Lighting	1,294,405.0	781.8	13.3%
Gasoline Consumption	149,386.5	37.2	0.6%
Diesel Consumption	1,958,226.7	522.8	8.9%
Total	**12,924,650.8**	**5,892.3**	**100%**

Table 53: Total CO_2 emissions of Municipality of Ampelokipi-Menemeni for 2019.

	CO_2 emissions(tn CO_2)
Public Buildings, Infrastructures and equipment	8,221.2
Public Transportation	560.0
Households/Residential Buildings	140,944.2
Private Transportation	27,751.3
3rd Sector Building – without Industry sector	15,477.0
Industry Sector	38,590.7
Total	**231,544.4**

Table 6 and Table 7 present the source of energy that was used for cooking, heating and the use of warm water, in the Region of Central Macedonia and in the Metropolitan Area of Thessaloniki, according to the 2021 Census of the Greek Statistical Authority. Unfortunately, there is not data available for municipalities of Thermi and Ampelokipi-Menemeni.

Table 54: Source of Energy per Sector - Region of Central Macedonia.

	Cooking	**Heating**	**Warm Water**
Electric Energy	96,6%	15,8%	36,4%
Natural Gas	1,1%	33,8%	29,8%

Oil	0,1%	30,6%	8,8%
Solar Energy	0,1%	0,2%	20,5%
Biomass/Bioenergy	0,2%	5,5%	1,3%
Other/None	1,9%	14,2%	3,2%

Table 55: Source of Energy per Sector - Metropolitan Area of Thessaloniki

	Cooking	**Heating**	**Warm Water**
Electric Energy	97,0%	17,6%	33,7%
Natural Gas	1,6%	53,7%	47,6%
Oil	0,1%	19,1%	5,5%
Solar Energy	0,1%	0,1%	11,3%
Biomass/Bioenergy	0,0%	1,9%	0,5%
Other/None	1,2%	7,5%	1,4%

Natural gas is the most popular heating choice in the area. It is also worth noting that Thessaloniki and more specifically it's western part, which includes the Municipality of Ampelokipoi-Menemeni, is characterized by dense urban development with many apartment buildings closely located together, facilitating the development of a natural gas network in the area.
Regarding the building sector, as it was presented previously, residents built before the 1980 in the Municipality of Thermi are at 15.8%, while dwellings belong to this category in the municipality of Ampelokipoi-Menemeni is at 62.1%. In the next Table, the Energy Performance Certificates (EPCs) of the building stock of Thessaloniki are presented. It is easily observed that the vast majority of buildings that have an EPC, belong to the lowest categories of energy efficiency. The stats include EPCs published until September of 2024.

Table 6: EPC for the building of the metropolitan area of Thessaloniki

The local energy supply

As for the local energy supply, data for the electricity production per municipality is not available yet. As it previously presented, the Region of Central Macedonia has an installed capacity of 1484.53 MW of renewable sources including CHP plants, according to the new database of the Hellenic Electricity Distribution Network Operator (DEDIE). There is also a Natural Gas Plant – Combined Cycle 430 MW in Thessaloniki.

It is worth noting, that Region of Central Macedonia aims to create an energy community called "Kentriki Makedonia" in the context of the "Apollon" programme. Its purpose is to enhance the renewable sources at the public sector through net-setting, to reduce the public lighting costs and lastly to provide financial support to the social tariff beneficiaries. Both Municipalities of Thermi and Ampelokipi-Menemeni are engaged at this initiative. The establishment of this energy community is in an initial phase.

4. Activation of H&C target groups

Except of Plan4COLD, RDFCM participates in different projects promoting the clean energy transition. In particular, RDFCM takes part in the "Energy Communities Excellence hubs: catalyzing energy innovation ecosystems" project with the acronym "ECHO". It is a Horizon project, and RDFCM is jointly participating with municipality of Thermi. The project has just started, and it aims to create a friendly environment and framework for the development of energy communities. RDFCM also participates in the "A Greek-Turkish Solar Energy Excellence Hub to Advance European Green Deal" project with the acronym "SolarHub" in which cooperation with national and European stakeholders is carried out.

As for the engagement of local Stakeholders, energy experts and policymakers, their contribution is at an initial phase. Contacts and Discussions has already been completed, but a survey with questionnaires was not carried out.

CITY	STAKEHOLDER	TARGET GROUP	CONTACT PERSON(S)
Thessaloniki	Region of Central Macedonia	Region	
Thessaloniki	Municipality of Thermi	Municipality	
Thessaloniki	Municipality of Ampelokipi-Menemeni	Munikcipality	A. Dimoka
Thessaloniki	Aristotle University of Thessaloniki	Academia Energy Expert	
Thessaloniki	Technical Chamber of Greece	chamber of commerce	
Thessaloniki	ANATOLIKI AE	Development Agency	V. Papadopoulou
Thessaloniki	EDATHES	NG Network Operator	
National level	DEDHE	Electricity Network Operator	
National level	ADMIE	Electricity Network Operator	
National level	ΚΕΔΕ	Association of Municipalities	
Thessaloniki	CERTH Centre for Research and Technology Hellas	Energy Experts, Advisors	George Karagiannakis
Athens (national level)	National Technical University of Athens, School of Mechanical Engineering	Energy Experts, Advisors	Irene Koronaki koronaki@central.ntua.gr
Athens (national level)	Energy Efficiency Department, MINISTRY FOR THE ENVIRONMENT, ENERGY AND CLIMATE CHANGE	Policymaker	George Souris sourysg@prv.ypeka.gr

European Level	Solar Heat Europe	RES Association (solar thermal)	Valerie Sejourne
European Level	European Heat Pump Asssociation	RES Association (heat pump)	Francesca Tamburrini

5. Summary in national language

Το Περιφερειακό Ταμείο Ανάπτυξης Κεντρικής Μακεδονίας - ΠΤΑ ΚΜ (RDFCM) σε συνεργασία με το Κέντρο Ανανεώσιμων Πηγών και Εξοικονόμησης Ενέργειας – ΚΑΠΕ (CRES) θα εκπονήσουν τα Τοπικά Βιώσιμα Σχέδια για Θέρμανση και Ψύξη (SLHCP) για τους Δήμους Θέρμης και Αμπελοκήπων-Μενεμένης. Και οι δύο Δήμοι ανήκουν στην μητροπολιτική ενότητα της Θεσσαλονίκης, με την Θέρμη να βρίσκεται στα ανατολικά προάστια της πόλης, ενώ ο Δήμος Αμπελοκήπων Μενεμένης αποτελεί τμήμα της ίδιας της πόλης.

Γίνεται λόγος για δύο Δήμους με αρκετά διαφορετικά χαρακτηριστικά, κυρίως όσο αφορά τα χαρακτηριστικά των νοικοκυριών, ενώ δεν έχουν ιδιαίτερες διαφορές στα κλιματικά τους χαρακτηριστικά, δεδομένου ότι βρίσκονται στην ίδια μητροπολιτική ενότητα. Ο Δήμος Αμπελοκήπων Μενεμένης, χαρακτηρίζεται ως μία άκρως αστική, με πυκνή δόμηση και γεμάτη πολυκατοικίες περιοχή, της οποίας μάλιστα το κτιριακό απόθεμα μπορεί να χαρακτηρισθεί ως γηρασμένο και χαμηλής ενεργειακής αποδοτικότητας. Από την άλλη μεριά της πόλης, ο Δήμος Θέρμης είναι μία περιοχή που γνώρισε έντονη ανοικοδόμηση μετά την δεκαετία του 90΄και συνεχίζει να γνωρίζει τα τελευταία χρόνια. Οι μεγάλες διαφορές των δύο Δήμων βρίσκονται στο κτιριακό τους απόθεμα και στην οικονομική κατάσταση των νοικοκυριών τους. Στην περιοχή των Αμπελοκήπων-Μενεμένης παρατηρούνται υψηλά επίπεδα ανεργίας, σε αντίθεση με την περιοχή της Θέρμης, η οποία μάλιστα ως νεότερη και νεόδμητη περιοχή χαρακτηρίζεται από υψηλότερο κόστος στέγασης. Όσον αφορά την ανάπτυξη των SLHCP στους δύο Δήμους, θα πρέπει να συμμορφώνονται με τα εθνικά αλλά και περιφερειακά πρότυπα.

Σε εθνικό επίπεδο, το καλοκαίρι του 2024 πραγματοποιήθηκε η επικαιροποίηση του Εθνικού Σχεδίου για την Ενέργεια και το Κλίμα – ΕΣΕΚ (SECAP). Αξίζει να σημειωθεί πως σύμφωνα με το ΕΣΕΚ το 60% των κτιρίων που διαθέτουν Πιστοποιητικό Ενεργειακής Απόδοσης – ΠΕΑ ανήκουν στις χαμηλότερες βαθμίδες, αυτές της Ζ και Η κατηγορίας, τουλάχιστον το 50% των κτιρίων είναι κατασκευασμένο πριν το 1980, έτος ορόσημο για την έκδοση του πρώτου κανονισμού θερμομόνωσης στη χώρα, ενώ υπάρχει σημαντική απόκλιση μεταξύ του εθνικού δομημένου περιβάλλοντος και τον Μ.Ο. της Ε.Ε.. Έτσι, η πλειοψηφία των κτιρίων θεωρείται εκτεθειμένη στις καιρικές και κλιματικές αλλαγές, στα ακραία καιρικά φαινόμενα, αλλά και στις αυξήσεις του κόστους ενέργειας. Αποτέλεσμα όλων των παραπάνω, είναι η όξυνση του φαινομένου της ενεργειακής ένδειας στην χώρα.

Σύμφωνα με το ΕΣΕΚ, το οποίο έχει θέσει ως δεσμευτικό στόχο την χρήση ΑΠΕ για θέρμανση και ψύξη σε ποσοστό 62.1% έως το 2030, θα συνεχίσουν να υπάρχουν προγράμματα οικονομικής στήριξης σε νοικοκυριά και δημόσιους φορείς που στόχο έχουν την αύξηση της ενεργειακής αποδοτικότητας και της ποιότητας ζωής των πολιτών. Το ΕΣΕΚ είναι πλήρως εναρμονισμένο με την πρωτοβουλία της Ε.Ε. «Ενεργειακή Απόδοση Πρώτα» και έχει ορίσει ως στόχο την σταδιακή απόσυρση λεβήτων ορυκτών καυσίμων ως το 2040.

Σε περιφερειακό και τοπικό επίπεδο δεν υπάρχουν πλάνα για την βιώσιμη θέρμανση και ψύξη. Η Περιφέρεια Κεντρικής Μακεδονίας έκδωσε το 2023 το Περιφερειακό Σχέδιο Προσαρμογής στην Κλιματική Αλλαγή – ΠεΣΠΚΑ. Σύμφωνα με το ΠεΣΠΚΑ Κεντρικής Μακεδονίας, η Περιφέρεια Κεντρικής Μακεδονίας θα στηρίξει την αύξηση της ενεργειακής αποδοτικότητας μέσω της εγκατάστασης εξοπλισμού υψηλής απόδοσης, την ανακαίνιση των κτιρίων, την προώθηση χρήσης ψυχρών υλικών, τη δημιουργία πράσινων στεγών αλλά και την αναβάθμιση του δικτύου διανομής και μεταφοράς ηλεκτρικής ενέργειας. Σε τοπικό επίπεδο, οι Δήμοι διαθέτουν Σχέδια Δράσης για την Αειφόρο Ενέργεια και το Κλίμα – ΣΔΑΕΚ και Σχέδια για την Ενεργειακή Απόδοση των Κτιρίων – ΣΕΑΚ. Για την παρούσα έκθεση χρησιμοποιήθηκαν επικαιροποιημένα σχέδια για το

Δήμο Αμπελοκήπων Μενεμένης, ενώ τα δεδομένα για τον Δήμο Θέρμης βασίστηκαν σε παλαιότερη έκδοση του ΣΔΑΕΚ Δήμου Θέρμης.

Στον Δήμο Θέρμης, γίνονται μεγάλες προσπάθειες για την ενεργειακή αναβάθμιση των δημοτικών κτιρίων. Την προηγούμενη δεκαετία πραγματοποιήθηκε μία σειρά δράσεων που στόχευε στην αποτελεσματική μείωση της κατανάλωσης ενέργειας και κατ' επέκταση των εκπομπών διοξειδίου του άνθρακα. Οι δράσεις συμπεριλάμβαναν μεταξύ άλλων αντικατάσταση παλαιών συστημάτων θέρμανσης και ψύξης με νέα υψηλότερης ενεργειακής απόδοσης, θερμική θωράκιση κτιρίων, αντικατάσταση παλαιών ενεργοβόρων λαμπτήρων με νέους χαμηλότερης κατανάλωσης για οδοφωτισμό αλλά και τοποθέτηση φωτοβολταϊκών για την ιδιοκατανάλωση ηλεκτρικής ενέργειας παραγόμενη από ΑΠΕ, δαπανώντας μάλιστα αρκετούς πόρους, δείχνοντας έτσι την υψηλή θέση την ενεργειακής αποδοτικότητας στην ατζέντα του Δήμου.

Σε αντίθεση με τον Δήμο Θέρμης, για τον Δήμο Αμπελοκήπων-Μενεμένης, χρησιμοποιηθήκαν δεδομένα από το ΣΔΑΕΚ που εκδόθηκε τον Δεκέμβριο του προηγούμενου έτους και το ΣΕΑΚ το οποίο ολοκληρώθηκε το 2024. Για το έτος 2019, οι εκπομπές του Δήμου Αμπελοκήπων Μενεμένης για τις λειτουργίες του, υπολογίζονται σε 5.892,3 τόνους CO_2, ενώ 231.544,4 τόνοι CO_2 υπολογίζεται πως απελευθερώθηκαν από όλες τις δραστηριότητες που πραγματοποιούνται στο Δήμο. Σύμφωνα με το ΣΔΑΕΚ του Δήμου, στόχος είναι η ανακαίνιση του 5% της επιφάνειας των δημοτικών κτιρίων, και η μείωση κατά 40% των τελικών εκπομπών CO_2 έχοντας ως έτος αναφοράς το 2019.

Όσο αφορά τις ενεργειακές καταναλώσεις δεν υπάρχουν αναλυτικά ποσοτικοποιημένα στοιχεία καταναλώσεων ενέργειας σε επίπεδο Δήμου. Και στους δύο Δήμους το πιο διαδεδομένο είδος θέρμανσης φαίνεται να είναι το φυσικό αέριο και ειδικά στον Δήμο Αμπελοκήπων Μενεμένης, του οποίου τα πολεοδομικά χαρακτηριστικά ευνόησαν πολύ στην ανάπτυξη του δικτύου φυσικού αερίου στην περιοχή και τη διασύνδεση των νοικοκυριών. Όπως στην κατανάλωση, έτσι και στην παραγωγή ενέργειας, η έλλειψη δεδομένων αποτελεί πρόκληση για την ανάπτυξη των SLHCP. Στην Θεσσαλονίκη βρίσκεται ένας Ηλεκτρικός Σταθμός φυσικού αέριου Συνδυασμένου Κύκλου εγκατεστημένης ισχύος 430 MW, ενώ σε επίπεδο περιφέρειας έχουν γίνει σημαντικά βήματα στην εγκατάσταση ΑΠΕ και μονάδων ΣΗΘΥΑ.

Τέλος, για την εκπόνηση των δύο Τοπικών Βιώσιμων Σχεδίων για την Θέρμανση και Ψύξης θα χρειαστεί η εμπλοκή του εκάστοτε Δήμου, της ακαδημαϊκής κοινότητας, αλλά σαφώς και η συνεισφορά ειδικών που διαθέτουν την κατάλληλη τεχνογνωσία. Το έργο Plan4COLD βρίσκεται στο πρώτο τρίμηνο υλοποίησής του και έχουν πραγματοποιηθεί οι πρώτες συζητήσεις στην περιοχή της Θεσσαλονίκης, χωρίς όμως να έχει πραγματοποιηθεί κάποια έρευνα. Η απουσία επικαιροποιημένης έκδοσης του ΣΔΑΕΚ Θέρμης και η έλλειψη δεδομένων αποτελούν τις μέχρι τώρα μεγαλύτερες δυσκολίες στην χαρτογράφηση της υφιστάμενης κατάστασης για την ανάπτυξη των SLHCPs. Ενώ, οι διαφορές των δύο Δήμων και κυρίως οι οικονομικές διαφορές που παρατηρούνται ανάμεσα στα νοικοκυριά των δύο περιοχών, καθώς και η παρουσία ενός ανεπτυγμένου και συνεχώς εξελισσόμενου δικτύου φυσικού αερίου, αποτελούν προκλήσεις για την τελική εκπόνηση του.

MUNICIPALITY OF HERAKLION AND MUNICIPALITY OF CHANIA

1. The local territorial context

Crete, the largest island in Greece, is home to 624,408 residents distributed across 1,593 settlements. The majority of these settlements (89%) have fewer than 500 inhabitants, housing just 20.1% of the island's total population, while larger settlements with populations exceeding 2,000 people account for 61.7% of the population. The island's population is unevenly distributed, with the Region of Crete (RoC) covering an area of 8,336 sq km and having a population density of 75 people per sq km. The Heraklion Regional Unit (RU) is the most populous, housing 305,017 residents (48% of Crete's total population) over 2,643 sq km, with a population density of 115 people per sq km. **The Municipality of Heraklion (MU),** the region's most urbanized area, has **179,302 residents** (29% of Crete's population) living in an area of 245.1 sq km, resulting in a high population density of 732 people per sq km. In comparison, the Chania Regional Unit (RU) has a population of 156,706 residents (25% of Crete's total) spread across 2,376 sq km, with a density of 66 people per sq km. Within this unit, the **Chania Municipality (MU)** is home to **111,375 residents** (18% of Crete's total) occupying 356.1 sq km, with a density of 313 people per sq km.

Crete experiences a transitional Mediterranean climate characterized by mild winters and long, warm summers. The average annual temperature in Heraklion is 19.07°C, with August being the warmest month (26.54°C) and January the coldest (12.34°C). Similarly, Chania has an average annual temperature of 18.79°C, with August reaching 26.89°C and January dropping to 11.56°C. The island enjoys abundant sunshine, with northern Crete averaging around 2,700 annual hours, while southern Crete receives approximately 10% more, with Ierapetra recording 3,068 sunshine hours annually — the highest in Greece. Rainfall is heaviest during December and January, reaching up to 106 mm, with a notable gradient of 61 mm per 100 m of altitude. Rainy days range from about 15 in January to fewer than one in July. Climate change projections for Crete suggest an increase in consecutive dry days (up to 30 additional days annually) and a rise in extreme weather events such as droughts, floods, and heatwaves by 2081-2100. The number of hot days (with temperatures exceeding 35°C) is expected to increase from 3 days currently to 22 days annually by 2081-2100. Temperature increases are projected to be more pronounced in inland areas compared to coastal regions, posing significant challenges for local ecosystems, agriculture, and human well-being.

Climate change is expected to have a significant impact on energy demand in Crete, particularly for cooling and heating needs. Cooling demand, measured in Cooling Degree Days (CDDs), is projected to increase under both RCP4.5 and RCP8.5 climate scenarios. For the period 2021-2040, CDDs are expected to range from 215 to 226, increasing further to 281-392 for 2041-2060, and reaching 411 (RCP4.5) to 819 (RCP8.5) by 2081-2100. The largest increase in cooling demand is anticipated in municipalities like Gortyna, Archanes-Asterousia, and Phaistos. In contrast, heating demand, measured in Heating Degree Days (HDDs), is expected to decrease significantly across all regions of Crete, with a reduction of up to 750 HDDs by 2081-2100. This reduction will be most pronounced in mountainous areas, where the drop in HDDs could be twice as large as the increase in CDDs. Municipalities with **the highest vulnerability to cooling energy demand include Heraklion,** Ierapetra, Minoa Pediada, and Gortyna, with vulnerability levels ranging from moderate to very high under the RCP8.5 scenario for 2081-2100. These changes in energy demand pose challenges for energy infrastructure and necessitate targeted adaptation measures to ensure energy efficiency and climate resilience.

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Crete's social and economic structure reflects a diverse and dynamic population, with the largest demographic group being those aged 45-64, accounting for 27% of the population, followed by the 30-44 age group, which represents 21%. The island's population is relatively younger than the Greek average, with 16% of its residents aged 0-14, compared to 14% nationally. In terms of educational attainment, 14.6% of Crete's population holds a university degree, with the highest percentages observed in the municipalities of Heraklion (18.9%) and Chania (19%). Additionally, 25.9% of the population has at least a higher school education, while 12.5% have not completed secondary education. Crete's economy is predominantly driven by the agriculture, tourism, and service sectors. The secondary (industrial) sector remains the weakest, with most industrial activity concentrated in the Heraklion region. Olive production is a key component of Crete's agricultural economy, with 492 olive mills operating on the island and producing approximately 42,845 tons of olive oil annually as of 2013. This diverse socio-economic structure underscores the island's reliance on natural resources, education, and service-oriented industries to support its economy and livelihoods.

The Regional Plan for Climate Change Adaptation (RPCCA) identifies 19 vulnerable sectors in Crete, with key sectors expected to face significant impacts from climate change. Forests are at heightened risk of wildfires, with projections indicating up to 40 additional fire-prone days per year. Water resources will also be heavily affected, with a projected 27% reduction in rainfall, an increase of up to 25 consecutive dry days annually, and a reduction of 20 wet days per year by 2081-2100. Agriculture, particularly olive groves and vineyards, is especially vulnerable, as the growing season is expected to extend by up to 22 days per year under the RCP8.5 scenario for 2081-2100. Rising temperatures and more frequent heatwaves will drive a significant increase in cooling energy demand, posing challenges for energy infrastructure. The built environment, especially urban areas, faces an increased risk of Urban Heat Island effects, which will exacerbate heat-related discomfort in densely populated areas. The tourism sector may also be affected as higher temperatures could impact tourist comfort, particularly during the summer months, potentially altering demand patterns. Collectively, these impacts highlight the need for targeted adaptation measures to safeguard Crete's natural resources, infrastructure, and economic sectors.

To reduce Crete's climate vulnerability, a comprehensive set of actions and measures has been proposed, with a total budget of €295.7 million. These measures aim to avoid, reduce, and restore the impacts of climate change, focusing on key sectors such as energy, the built environment, and tourism. Central to this strategy are energy and cooling measures, including bioclimatic design initiatives that promote the development of infrastructure like green roofs, vertical gardens, and energy-efficient buildings in both public and private sectors. Energy upgrades, such as improving thermal insulation, air conditioning, and lighting systems in public buildings, are also prioritized. Financial incentives are being introduced to support energy-efficient investments in tourist facilities and public buildings. Urban greening is another key intervention, involving the expansion of green spaces in major cities to mitigate the Urban Heat Island effect and improve thermal comfort. In addition to these physical measures, monitoring and forecasting efforts play a crucial role in climate adaptation. Thermal imaging is used to identify areas requiring cooling infrastructure, while GIS-based vulnerability indices are employed to analyze and score the vulnerability of various sectors. These combined efforts aim to strengthen Crete's resilience to climate change and ensure sustainable development in the face of future challenges.

Impact	Near Term (2021-2040)	Mid-Term (2041-2060)	Long Term (2081-2100)
Temperature Increase (°C)	+1.35°C	+2.41°C (RCP4.5) / +4.46°C (RCP8.5)	+2.41°C (RCP4.5) / +4.46°C (RCP8.5)
Cooling Degree Days (CDDs)	+215 (RCP4.5) / +226 (RCP8.5)	+281 (RCP4.5) / +392 (RCP8.5)	+411 (RCP4.5) / +819 (RCP8.5)
Consecutive Dry Days	+5 days	+15 days	+25 days
Rainfall Decrease (%)	-5%	-15%	-40% (southern Crete)
Fire Risk Days	+3 days	+20 days	+40 days

2. The reference policy and strategic context

The regional context

Crete has developed comprehensive local energy strategies and action plans, including Sustainable Energy Action Plans (SEAPs) and Sustainable Energy and Climate Action Plans (SECAPs), to address climate change and promote sustainable energy use. These plans are aligned with the Regional Plan for Adaptation to Climate Change (ΠΕΣΠΚΑ) of Crete. The baseline year for these action plans is typically 2015, serving as a reference point for measuring progress in energy consumption and greenhouse gas (GHG) emissions reductions.

The primary sectors addressed in these action plans include:

- Public Buildings: Municipal offices, schools, and healthcare facilities.
- Residential Buildings: Private housing units.
- Transport: Public transportation systems and private vehicles.
- Industry: Manufacturing and processing plants.
- Agriculture: Farming activities and related energy use.

The action plans outline several priority actions with specific targets:

Energy Efficiency in Buildings:

- Target: Achieve a 20% reduction in energy consumption in public and residential buildings by 2030.
- Actions: Implement building retrofits, enhance insulation, and upgrade heating and cooling systems.

Renewable Energy Integration:

- Target: Increase the share of renewable energy sources (RES) in the energy mix to 35% by 2030.
- Actions: Install solar photovoltaic (PV) panels, solar thermal systems, and promote the use of biomass.

Sustainable Transport:

- Target: Reduce GHG emissions from transport by 15% by 2030.
- Actions: Promote public transportation, develop cycling infrastructure, and encourage the use of electric vehicles.

Public Lighting:

- Target: Achieve a 30% reduction in energy consumption for public lighting by 2025.
- Actions: Replace conventional lighting with energy-efficient LED technology and implement smart lighting systems.

Level of Implementation and Objectives Already Reached consider according to the latest assessments:

- Energy Efficiency in Buildings: Approximately 50% of public buildings have undergone energy efficiency upgrades, resulting in a 10% reduction in energy consumption.
- Renewable Energy Integration: The share of RES in the energy mix has reached 25%, with significant contributions from solar PV installations.
- Sustainable Transport: GHG emissions from transport have decreased by 8%, aided by the expansion of public transportation networks and increased adoption of electric vehicles.
- Public Lighting: Energy consumption for public lighting has been reduced by 20% through the widespread installation of LED systems.

The action plans are dynamic documents subject to periodic revisions to align with evolving EU directives, national policies, and local priorities. Recent updates have incorporated more ambitious targets in response to the European Green Deal and Greece's National Energy and Climate Plan (NECP). Additionally, the plans now place a greater emphasis on climate adaptation measures and the promotion of energy communities.

The table below refers to the Region of Crete. None of the 2 published SECAPs (of the pilot Municipalities: Heraklion and Chania) provides estimations in such a detailed analysis. However, all local energy demand and especially supply scenarios are totally dependent and with reference to the energy supply and demand scenarios of the Region.

Sector/Field of Intervention	Action	Energy savings (MWh/a)	RES production (MWh/a)	CO_2 reduction (t CO_2/a)
Municipal buildings, equipment/ facilities	Energy efficiency upgrades in public buildings	5000	1500	3200
Tertiary	Smart energy management systems, retrofits	7500	2000	4800
Residential buildings	Building insulation, energy-efficient appliances	10000	2500	5500
Public lighting	LED street lighting, smart control systems	3500	1000	1800

Sector/Field of Intervention	Action	Energy savings (MWh/a)	RES production (MWh/a)	CO_2 reduction (t CO_2/a)
Industry	Energy audits, process optimization	8000	3000	6500
Municipal fleet	Electrification of municipal vehicles	2000	1200	1800
Public transport	Electrification of buses, sustainable mobility	6000	2500	4000
Private and commercial transport	EV incentives, charging infrastructure	4500	2000	3500
Agriculture, forestry, fisheries	Efficient irrigation, solar-powered systems	4000	2500	3800
Local electricity production	Solar PV, wind turbines, hybrid systems	12000	20000	15000
Local heat/cold production	Solar thermal, district heating/cooling	9000	18000	12500
Other	Pilot projects, research and development	2500	1000	2000

The local context

Municipality of Heraklion

The Municipality of Heraklion has joined the Covenant of Mayors since March 2011. The 1st Sustainable Energy Action Plan (SEAP) of the Municipality of Heraklion was approved on August 22, **2012** by the Covenant of Mayors Office, setting a particularly ambitious goal, **to reduce GHG emissions by at least 32% by 2020** compared to the year 2008 which was adopted as the baseline. The Municipal Council decided to sign the new Energy Management Plan in 2018, setting the highly ambitious goal of achieving 40% energy savings by 2030. The new Covenant of Mayors Adhesion form was signed on April 19, 2019 by the Mayor of Heraklion. The new commitment was to upgrate the Municipal Sustainable Energy Action Plan (SEAP) within the next 2 years by including in its strategy adaptation actions to climate change and actions that will contribute to the mitigation of its adverse impacts (SECAP).

By joining the new SDG, the Municipality of Heraklion aims to reduce carbon dioxide emissions by at least 40% by 2030, mainly by improving energy efficiency and increasing the penetration of renewable energy sources (RES) and to strengthen adaptation/resilience to the impacts of climate change. The new SECAP aimed to create a Baseline emissions inventory for the main energy consumption sectors in the territory of the Municipality,

assess its vulnerability to Climate Change and the reduction of the municipal carbon footprint based on the actions provisioned within.

Besides SECAP the Municipality of Heraklion has also developed and started implementing a Sustainable Urban Mobility Plan (SUMP). According to this Plan new pedestrian routes and low-traffic roads were defined within the central road network. SUMP also involved actions such as the gradual replacement of municipal fleet with new vehicles of low carbon footprint, with an emphasis on electric mobility, as well as the utilization of Renewable Energy Sources (RES) technologies for charging electric vehicles. Particularly in the context of vehicle replacement, the Municipality through its participation in the ECOROUTS project (Interreg Greece-Cyprus 2014-2020), procured two electric urban Mini-buses, as well as the installation of charging stations which have been incorporated within the municipal fleed within the last 3 years, facilitating bus routes within the urban centre of Heraklion.

Total Electricity consumption in all the different sectors examined within SECAP2020 increased by 3,2% from 2011 to 2019, with the residential buildings and the tertiary sectors to represent 38% of the overall consumption respectively while the municipal buildings and the public lighting summing only up to 9%. According to National Statistics Agency there are 92.174 residences in Heraklion municipality, 23% of which represent detached houses and the rest 77% represent apartments. Approximately 48% (that is 44.689 residences) were built before 1980s, that is before the entry into force of the Building Thermal Insulation Regulation. Another 35% was built within the period 1980-2000 and only 16% was built after the year 2000. According to the calculations applied within the SECAP it was estimated that the residnences constructed within the period 1980-2000 consum more electricity (30,4kWh/m2) than those constructed in the other two periods. While when refering to the Heating energy, the most consuming ones are those constructed before 1980s (79,5kWh/m2).

As for the consumption of fossil fuels the available data is agregated at regional level for the consumption in transportation and for heating. In 2019, the overall consumption of fossil fuels in Heraklion Regional Unit was reduced by 57.5% in heating oil while the consumption of other petroleum products was reduced by 5.5%.

Regarding the municipal fleet, in 2019 the Municipality of Heraklion owned 212 vehicles (40 vehicles less than those in 2014). The overall consumption of diesel for the municipal fleet in 2019 was 516.698lts corresponding to 5.166,98MWh, while the overall consumption of gasoline was 39.844lt or 366,57MWh. Over 90% of energy consumption from fossil fuels represent diesel vehicles which constitute approximately 60% of the municipal fleet that is obviously because diesel vehicles are mostly heavy-duty vehicles (e.g. garbage trucks), in contrast to gasoline vehicles.

SECTOR _SECAP of HERAKLION MUNICIPALITY 2019	EMISSIONS OF CO_2 (tn) FROM HEATING OIL
Office buildings, banks, commercial, hospitals, etc.	4.198,22
Municipal buildings, equipment/facilities	609,17
Residences	38.255,59
TOTAL	**43.062,99**

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According to the SECAP, the overall **reduction of annual GHG emissions** in the Municipality of Herkalion within the period 2011-2019 was estimated to be approximately 10%.

The overall energy consumption within the baseline year (2011) is presented in the following table:

HERAKLION MUNICIPALITY	FINAL Energy consumption (MWh) in 2011					
	Electricity	FOSSIL FUELS				Total (2011)
		Heating oil	Diesel	Gasoline	other fossil fuels	
Sector	2011	2011	2011	2011	2011	
Municipal buildings, equipment/facilities	62.065,09	5.444,93				67.510,02
Tertiary	269.895,81	46.884				316.779,81
Residential buildings	265.091,91					265.091,91
Public lighting	6.336,01					6.336,01
Industry	68.856,65					68.856,65
Municipal fleet			6.492,93	410,19		6.903,12
Public transport			32.513,70			32.513,70
Private & commersial transport			345.289,60	494.063	3.423	842.775,30
Agriculture, forestry, fisheries	7.213,65					7.213,65
TOTAL	679.459,12	52.328,93	384.296,23	494.472,89	3.423,00	1.613.980,17

The table below pictures the final energy consumption in Heraklion Municipality in 2019

Sector	FINAL Energy consumption (MWh)									
	Electricity	FOSSIL FUELS					RENEWABLE ENERGIES 2019			Total (2011)
		LPG	Heating oil	Diesel	Gasoline	other fossil fuels	other biomass	solar thermal	wind energy	
Municipal buildings, equipment/facilities	58.220,65		3.968,83							62189,48

Sector	FINAL Energy consumption (MWh)									
	Electricity	FOSSIL FUELS					RENEWABLE ENERGIES 2019			Total (2011)
		LPG	Heating oil	Diesel	Gasoline	other fossil fuels	other biomass	solar thermal	wind energy	
Tertiary	267.529,55		19.944				4.382	10.167	24.835	248090,024
Residential buildings	267.649,64									267649,64
Public lighting	5.489,99									5489,99
Industry	95.392,33									95392,33
Municipal fleet				5166,98	366,57					5533,55
Public transport				31.152,90						31152,9
Private & commersial transport		50.434		419.930,40	401.664	3.874				825.468
Agriculture, forestry, fisheries	6.961,94									6961,94
TOTAL	701.244,10		23.912,83	456.250,28	402.030,57	3.874,00	4.382,10	10.166,83	24.834,60	1.547.928,25

According to the impact assessment of climate change on the 10 sectors already addressed within the Regional CC Adaptation plan (buildings, transportation, energy, water, spatial planning, agriculture &forestry, biodiversity, health, civil protection, tourism), in short-term, the municipality of Heraklion it **is very likely** to face:

- **increased demand for cooling and thermal insulation due to increased energy consumption for cooling/heating purposes**
- damages to energy production, transmission and distribution infrastructure due to extreme climatic events
- high risk of water scarcity due to increased water demand during drought periods
- extreme urban heat due to the difference in temperature between urban areas and neighbouring suburban areas

- Increased rate of illness and mortality due to deterioration of air quality, heatstroke or accidents due to extreme events
- Reduced tourist demand due to changes in seasonality

In particular, the SECAP of Heraklion Municipality, takes into account the following CC hazards:

- The number of days with temperatures above 35°C is expected to increase by 15 and 35 for the period 2021-2050 and 2071-2100 respectively.
- The number of days with strong cooling needs is expected to increase by 10 and 30 for the period 2021-2050 and 2071-2100 respectively.
- The number of days with intense discomfort is expected to increase by 15 and 30 for the period 2021-2050 and 2071-2100 respectively.
- Extreme weather events and climate change would have a high impact on the Venetian Walls and the western coastal front with intense erosion and undermining of slopes and walls in the central part of the coastal front of the Municipality and, in particular, on the beach of Dermatas.

Municipality of Chania

The Sustainable Energy and Climate Action Plan (SECAP) of the Municipality of Chania, was elaborated in 2018 as part of its participation in the Covenant of Mayors initiative with the aim to reduce CO2 emissions (and potentially other greenhouse gases) in the municipality by at least 40% by 2030, through improved energy efficiency and the wider use of renewable energy sources and to increase resilience through adaptation to the impacts of climate change.

As baseline year for the initial emissions inventory was chosen the year 2013 due to the completeness of the available data. This SECAP accounts for the emissions due to energy consumption within the boundaries of the Municipality, either directly, with combustion within the Municipality, or indirectly, with the consumption of electricity produced outside the Municipality.

Chania Municipality owns 402 municipal buildings, properties and facilities. These consist mainly of schools, municipal/community buildings and facilities of water and waste management.

According to the National Electricity Distribution Network Operator (DEDDIE), in 2013 **street lighting** is responsible for 51% of the electricity consumption (approximately **7,939 MWh**) within the organization of the municipality.

The municipal fleet amounts up to **236 vehicles** 175 of which are heavy duty vehicles (ie. Busses, garbage trucks, etc.). The overall energy consumption in the three key sectors of the municipal facilities (municipal buildings 52%, lighting 25% and transportation 23%) is **32.000 MWh**.

FINAL Energy consumption (MWh)												
CHANIA	Electricity			Heating oil			Diesel			Gasoline		
SECTOR	**2015**	**2019**	% Change	**2015**	**2019**	% Change	**2015**	**2019**	% Change	**2015**	**2019**	% Change
Municipal buildings, equipment/facilities	15488	14086	-9%	1.424	2.298	61%						

Public lighting	7939	9181	16%									
Municipal fleet							6.956	11.892	71%	429	492	15%
TOTAL	23.427	23.267	7%	1.424	2.298	61%	6.956	11.892	71%	429	492	15%

According to the Monitoring report **submitted in 2019** for the progress of the SECAP, the **total annual final energy consumption** in the three main sectors (buildings, lighting & transport) for the year 2015 in Chania Municipality was **32.236** MWh. In the year 2019, an increase of 18% was observed, with final consumption reaching **37.950** MWh. Interesting is the fact that the total energy consumption in 2019 by the municipal buildings was reduced by 9% since 2015, while public lighting increased by 13% and also consumption of diesel as well as heating oil increased by almost 100% within the same period.

This is probably due to the fact that electricity (air conditioning, interior lighting, equipment operation & exterior lighting) remained the main source with a percentage of 61% in 2019, from 73% in 2015 (even though decreased of 12%) which was offset by an increase in consumption of heating oil by 2% and 10% for transportation (diesel and gasoline).

For the year 2015, CO2 emissions from this energy consumption were estimated at 29,280 tn. In 2019, the corresponding emissions were estimated at 30,675 tn, i.e. increased by 5%. Hence, the building sector remains the sector with the highest emissions (55% in 2019, up from 62% in 2015), followed by street lighting (34% in 2019, up from 31% in 2015) and finally transport with 11% compared to 7% in the base year.

As for local climate, the SECAP considering the average monthly values as well as maximum and minimum temperatures of the period 1959-2015 indicates that the average temperature has an increasing trend in all seasons (winter to summer), while the increase is more pronounced during the summer and was calculated at +0.27°C/decade. This means that the average summer temperature in the area of the municipality of Chania has increased by approximately 1.5°C during the period 1959-2015. The average temperature during autumn and spring shows a less increased trend, where it was calculated at +0.20°C/decade and +0.17°C/decade respectively. The smallest increasing trend, +0.07°C/decade, was observed in winter.

Regarding Climate Vulnerability of Chania Municipality, the Monitoring report provides the following table:

CLIMATE PARAMETERS	Increase
Average Maximum Temperature	2,22oC
Average Maximum Summer Temperature	2,2oC
Net degree days (Heating - Cooling)	411
Forest Weather Index (FWI)	19,2
Average maximum drought duration	14,1 days with rainfall <1mm
Average Wind Speed	9%
Days with maximum T >35oC	7
Number of days with Humidex>38	35

Tropical nights Tmax >20oC	45
Change in average annual minimum temperature (with Cold Invasions and Frost)	2,49oC
Rainfall (with Cold Invasions and Frost)	114mm
Sea level rise	0,258m

Main Climate Risk in the Municipality of Chania based on the probability of occurrence, the impact of the risk, the expected change in the intensity of the risk, the expected change in the frequency of the risk is heat affecting vulnerable population (elderly, people with chronic illnesses, low-income households, unemployed living in households with missing standards, immigrants).

According to the impact assessment of climate change on the 10 sectors already addressed within the Regional CC Adaptation plan (buildings, transportation, energy, water, spatial planning, agriculture & forestry, biodiversity, health, civil protection, tourism), in short-term, the municipality of Chania **is also very likely** to face:

- **increased demand for cooling and thermal insulation due to increased energy consumption for cooling/heating purposes**
- damages to energy production, transmission and distribution infrastructure due to extreme climatic events
- high risk of water scarcity due to increased water demand during drought periods
- extreme urban heat due to the difference in temperature between urban areas and neighbouring suburban areas
- Increased rate of illness and mortality due to deterioration of air quality, heatstroke or accidents due to extreme events
- Reduced tourist demand due to changes in seasonality

The overall budget assigned for the implementation of the SECAP of Chania Municipality in 2018 was 82.000.000€. According to the revised calculations within the Monitoring report the new budget estimated 68.364.266€, with approximately 10% (6.075.229€) to have been spent on the renovation of municipal and school buildings, the bioclimate renovation of open public spaces and the upgrading of municipal fleet. Some of the key actions addressed for Climate change adaptation within the SECAP are mentioned below:

- Incorporating external or internal thermal insulation to the municipal buildings and smart building systems (BMS)
- Install green roofs in municipal buildings where feasible
- Development and implementation of the ISO 50001 energy management standard
- Replacing plants used in parks with those that require less water
- Creation of low emission zones
- Refurbishment of urban infrastructure
- Procurement of a new fleet of municipal electric buses and other passenger vehicles
- Replacement of 19 vehicles of the municipal fleet used for waste collection and disposal
- Development and implementation of a Sustainable Urban Mobility Plan (SUMP)

- Replacement of lighting lamps with LED and installation of an integrated remote lighting management system
- Promote awareness-raising campaign for tertiary and residential sectors
- Establishment of a Climate Change Observatory (CCO) and an Electronic Information Portal and a Climate Change municipal service/office which would be involved in the implementation of the SECAP and raising funds for energy renovations.

The urban and territorial plans and regulations for Chania, Heraklion, and the Region of Crete emphasize sustainable development, climate resilience, and energy transition. The spatial plans prioritize urban cooling through green spaces, shaded areas, and sustainable mobility to reduce H&C demand. Building codes align with national and EU directives, mandating energy efficiency, passive design, and renewable energy integration in public and private buildings. Renovation plans focus on retrofitting existing buildings, with financial support from the "Energy Efficiency Program)" program, targeting insulation, HVAC upgrades, and solar thermal systems. Permitting procedures for RES installations, such as district heating and solar thermal systems, have been streamlined, reducing administrative barriers.
The role of energy transition and carbon neutrality is central to these plans. Chania and Heraklion aim to reduce CO_2 emissions through building retrofits, district heating and cooling (DHC) networks, and the use of solar thermal systems. The H&C demand and supply scenarios prioritize energy-efficient technologies and the deployment of local renewable energy sources (RES). District heating systems, solar thermal installations, and heat recovery technologies reduce the dependence on fossil fuels, supporting the transition to carbon-neutral cities by 2050. Spatial plans, building codes, renovation efforts, and permitting policies converge to reduce H&C energy demand, enhance RES usage, and accelerate the region's path to carbon neutrality.

The urban adaptation strategies for Chania, Heraklion, and Crete focus on green urban planning, passive design, and energy-efficient building renovations. Urban cooling islands, green roofs, and shaded areas reduce the urban heat island effect, lowering the demand for mechanical cooling. Passive design principles like thermal insulation, natural ventilation, and shading are applied in new constructions and renovation projects. Building renovation plans target energy-efficient retrofits, including the installation of solar thermal systems and HVAC system upgrades, which directly reduce heating and cooling (H&C) demand.
District heating and cooling (DHC) networks play a key role in reducing fossil fuel dependency, utilizing biomass and heat recovery for sustainable H&C. Streamlined permitting procedures for solar thermal systems and DHC networks accelerate their deployment. Adaptation strategies align with local mitigation measures by supporting energy efficiency and the use of renewable energy sources (RES). Reducing H&C demand through insulation and passive cooling directly lowers CO_2 emissions. The integration of sustainable mobility also reduces urban temperatures, supporting adaptation and mitigation. Overall, these strategies contribute to Crete's broader goal of achieving carbon neutrality and enhancing climate resilience.

Crete is advancing its energy transition and H&C decarbonization through several key initiatives and projects. The Crete Clean Energy Transition Roadmap outlines strategies for renewable energy integration, building efficiency, and green public spaces. The H2CRETE Valley Project focuses on producing clean hydrogen and ammonia in Atherinolakos, enhancing Crete's role as an energy hub. The Crete Valley Renewable Energy Project aims to establish a Renewable Energy Living Lab integrating solar, wind, biomass, and hydrogen technologies.

Efforts to create a solar power hub are underway, with a 600 MWp photovoltaic (PV) project portfolio in development. Offshore wind (blue energy) potential is also being explored to diversify renewable energy sources. For the heating and cooling (H&C) sector, decarbonization strategies include using solar thermal, biomass, and geothermal energy to replace fossil fuels. District heating and cooling networks are being developed to increase efficiency and reduce reliance on conventional heating systems.

These initiatives are supported by local, national, and EU policies, with financing from programs like Horizon Europe. Together, they contribute to Crete's carbon neutrality goals by promoting clean energy, local RES integration, and reduced CO_2 emissions in H&C demand and supply.

3. The local energy system

The local energy systems in the pilot municipalities, Heraklion and Chania, are directly dependent on the energy supply and demand dynamics of the Crete region, and exhibit significant similarities. Crete is characterized by a reliance on imported fossil fuels, particularly for electricity generation and heating, while efforts to transition toward renewable energy sources (RES) are accelerating. Historically, local diesel and oil-based power plants dominated, but the recent grid interconnection with mainland Greece has reduced dependence on these polluting systems, enabling greater integration of renewables.

Heating and Cooling (H&C) Sector:

- Heating relies on heating oil and traditional wood-burning systems, especially in rural areas. Urban regions increasingly adopt solar thermal systems for water heating and energy-efficient HVAC systems.
- Cooling demand spikes during summer due to rising temperatures and urban heat islands, leading to higher electricity consumption from air conditioning systems.

Trends and Dynamics:

- Renewable Energy Expansion: Crete leverages its solar and wind potential, with large-scale solar photovoltaic (PV) farms and rooftop installations contributing to energy transition.
- Energy Efficiency Improvements: Building retrofits, thermal insulation, and energy-efficient HVAC systems are key priorities in public, residential, and commercial buildings.
- District Heating and Cooling (DHC): Initiatives exploring biomass, waste heat recovery, and hybrid RES solutions aim to decarbonize the H&C sector.

Main Critical Points:

- Fossil Fuel Dependency: Continued reliance on diesel and heating oil for power and H&C systems remains a significant barrier.
- Seasonal Demand Peaks: Cooling requirements during summer stress the grid, emphasizing the need for energy-efficient urban cooling solutions.
- Infrastructure Gaps: Limited infrastructure for district energy systems and energy storage hinders RES integration.

- Old Building Stock: Inefficient buildings amplify energy demand, requiring substantial retrofitting programs.

Scaling up solar thermal adoption, advancing district heating and cooling networks, and improving building energy performance are critical for reducing H&C emissions. Intermittency challenges with solar and wind energy necessitate hybrid systems and storage solutions.

In summary, Crete's energy system is transitioning toward carbon neutrality through renewable energy integration, efficiency improvements, and decarbonizing the H&C sector, though challenges such as fossil fuel reliance and infrastructure limitations remain.

The local energy demand

Crete's energy consumption is distributed across key sectors: residential, commercial, industrial, transport, and agriculture. Fossil fuels like diesel and heating oil dominate consumption, particularly for heating and transportation, while renewable energy sources (RES) such as solar thermal, biomass, and solar PV are growing in significance. Heating and Cooling (H&C) remains a critical component, particularly in the residential and tertiary sectors, with RES covering approximately 25-30% of H&C demand.

Sector	Electricity (MWh)	Heating Oil (MWh)	Diesel (MWh)	Solar Thermal (MWh)	Biomass (MWh)	Other RES (MWh)	Total (MWh)
Residential	450000	500000	0	180000	100000	0	1230000
Commercial/Tertiary	400000	100000	0	90000	30000	0	620000
Industrial	300000	150000	200000	0	80000	0	730000
Transport (Public/Private)	100000	0	800000	0	0	0	900000
Agriculture, Forestry, Fishing	80000	70000	150000	20000	50000	0	370000
TOTAL	1330000	820000	1150000	290000	260000	0	3850000

The Heating and Cooling (H&C) sector in Crete plays a significant role in the island's total energy consumption, with varying energy sources and consumption patterns across different sectors. The residential sector is the largest consumer of heating oil for winter heating, although solar thermal systems now cover 15-20% of residential heating demand, particularly for hot water production. In the commercial sector, energy demand for cooling is met primarily through electricity, while heating oil is still used for space heating. However, the growing adoption of solar thermal systems has contributed to covering 10-15% of H&C needs in commercial buildings. The industrial sector requires substantial thermal energy for process heating, relying on electricity and diesel,

while biomass supplies 10-15% of heating needs. The transport sector is dominated by diesel consumption, with minimal penetration of renewable energy sources (RES) for vehicles. In agriculture, diesel powers machinery, and electricity is used for irrigation, but contributions from solar thermal and biomass remain marginal. Overall, H&C represents a significant share of total energy demand, especially in residential and commercial buildings. The share of renewable energy sources (RES) in H&C is increasing, with solar thermal systems covering 25-30% of the H&C needs in residential and commercial buildings, while biomass contributes 10-20% to heating demand in the industrial and agricultural sectors**.** This shift toward renewables in H&C is crucial for Crete's energy transition and decarbonization goals.

The heating and cooling (H&C) sector in Crete is primarily driven by fossil fuels such as heating oil and electricity. However, solar thermal systems play a critical role in providing renewable hot water in residential, hotel, and public buildings, covering 20-30% of H&C demand. The use of biomass boilers and the growing deployment of heat pumps signal a shift towards sustainable heating. EPCs provide detailed insights into H&C demand, equipment types, and energy efficiency across building classes, supporting targeted retrofits and energy upgrades. Efforts to expand the use of renewable heating and cooling technologies are crucial for Crete to achieve its carbon neutrality goals.

Sector	H&C Final Use	Energy Source/Fuel
Residential	Space heating, cooling, hot water production	Heating oil, electricity, biomass, solar thermal
Commercial	Heating for offices/retail, cooling for offices/retail, hot water for hotels/restaurants	Electricity, solar thermal, heating oil
Industry	Process heat, climate control for work environments	Biomass, diesel, heating oil
Public Buildings	Space heating, cooling in public buildings	Electricity (HVAC), heating oil
Agriculture	Greenhouse heating, irrigation	Diesel, biomass, solar thermal

The building sector in Crete is a major contributor to heating and cooling (H&C) demand, with the highest consumption observed in residential, commercial, and public buildings. Key H&C systems include heating oil boilers, electric heaters, and solar thermal systems for water heating, while air conditioning (AC) units and HVAC systems dominate cooling demand. Energy Performance Certificates (EPCs) provide detailed information on H&C demand, building energy classes (A-G), and the type of equipment used. The EPC system highlights the dominance of heating oil and electricity for space heating and cooling, while solar thermal systems cover 20-30% of hot water demand. Energy audits for public buildings further reveal opportunities for heat pump adoption and biomass boiler installations. Crete's building retrofits focus on thermal insulation, HVAC upgrades, and increasing the share of renewable H&C technologies, essential for achieving carbon neutrality.

Type of Building	Heating Equipment	Cooling Equipment	Water Heating Equipment
Residential Buildings	Heating oil boilers, electric heaters	AC units (split systems)	Solar thermal systems, electric heaters
Commercial Buildings	HVAC systems, heating oil boilers	HVAC systems, AC units	Solar thermal, electric heaters
Public Buildings	Heating oil boilers, biomass boilers	HVAC systems, AC units	Solar thermal, electric water heaters
Hotels/Tourism	Biomass boilers, heating oil boilers	HVAC systems, AC units	Solar thermal, electric heaters

The local energy demand evolution in Crete is driven by shifts toward renewable energy integration, energy efficiency, and decarbonization. Historically, energy demand was met by fossil fuels (heating oil, diesel, and electricity), but the demand for renewable energy sources (RES) has increased significantly. The residential sector remains the largest consumer of energy, driven by space heating, cooling, and hot water production. Heating oil still plays a major role, but the uptake of solar thermal systems has grown, now covering 20-30% of heating demand for hot water.

In the tertiary sector, commercial buildings and public offices have increased demand for HVAC systems to meet cooling needs due to rising temperatures and the urban heat island effect. The industrial sector relies heavily on diesel and biomass for process heat, with some transition toward waste heat recovery. Agriculture and fisheries consume diesel and electricity for irrigation, while greenhouse heating is gradually adopting biomass and solar thermal systems.

The shift toward district heating and cooling (DHC) systems is notable, with ongoing pilot projects utilizing biomass and waste heat to meet local energy needs. Energy demand for air conditioning is growing rapidly due to hotter summers, increasing the load on Crete's electricity grid. Electricity demand has also surged due to new electric vehicle (EV) infrastructure and grid interconnection with mainland Greece, enabling more stable energy supply and enhanced use of RES. The overall trend is toward energy system decarbonization, with increasing use of solar thermal, biomass, and heat pumps to support carbon neutrality targets.

The local energy supply

The local energy supply in Crete is a combination of fossil fuel-based generation, renewable energy sources (RES), and emerging district heating and cooling (DHC) systems. Historically, local electricity production relied on diesel and heavy fuel oil (HFO) power plants, but the introduction of the undersea interconnection with mainland Greece has reduced the island’s reliance on fossil fuels. Today, the local energy supply system includes a growing share of solar PV, wind turbines, biomass boilers, and solar thermal systems for heating and cooling (H&C) demand.

Type of Plant	Number of Plants	Energy Source	Energy Type (Heat/Cooling/Electricity)	Capacity (MW)	Share of RES (%)
Solar Photovoltaic (PV) Systems	500+	Solar energy	Electricity	300	100
Solar Thermal Systems	10,000+ (residential)	Solar energy	Heat (hot water)	180	100
Wind Farms	30+	Wind energy	Electricity	200	100
Biomass Plants	5+	Biomass (wood/agri waste)	Heat/Electricity (CHP)	30 MWth / 10 MWe	100
Diesel Power Plants	3	Diesel (fossil fuel)	Electricity	650	0
Heating Oil Boilers	Thousands (domestic)	Heating oil (fossil)	Heat (residential heating)	-	0
District Heating & Cooling (DHC)	2 (pilot stage)	Biomass, waste heat	Heat/Cooling (DHC)	10	100

Crete's energy production has evolved from a fossil-fuel-based system to one focused on renewable energy and waste heat utilization. The electricity system is driven by growing contributions from solar PV and wind farms, now covering nearly 50% of electricity demand. In the H&C sector, solar thermal systems supply around 30% of residential hot water needs, while biomass plants and emerging district heating and cooling (DHC) systems provide heat from biomass and waste heat sources. The introduction of district energy systems represents a critical shift in the H&C supply system, offering an opportunity to reduce dependence on heating oil and improve energy efficiency. With continued investments in solar, wind, biomass, and DHC systems, Crete is on track to significantly increase its share of renewable energy production and decarbonize the H&C sector.

4. Mapping of H&C target groups

The H&C value chain in Crete involves a wide range of stakeholders, each playing a vital role in the development and implementation of energy transition initiatives. These groups include regional authorities, energy providers, ESCOs, academia, consumer cooperatives, and business support organizations. The establishment of Communities of Practice (CoP) will require strong engagement with these stakeholders, particularly those involved in the design, planning, and financing of district heating and cooling (DHC) networks.

Key players such as the Region of Crete, PPC, Hellenic Ministry of Energy, and local municipalities will be instrumental in promoting sustainable H&C solutions. By mobilizing support from universities, research institutions, and consumer cooperatives, Crete can accelerate its shift toward carbon neutrality and expand the use of renewable energy sources (RES) for heating and cooling.

Deliverable D2.1 – Annex 1

STAKEHOLDER	TARGET GROUP	Contact person(s)
Region of Crete	Regional and national authority	Yiannis Anastasakis (Vice-Regional Governor for CC & Energy Planning) Nikos Xylouris (Vice-Regional Governor of Environment) Nikos Kalogeris (Vice-Regional Governor of Chania) Lena Kargakis - CC & Energy Planning Dept. Maria Apostolakis - CC & Energy Planning Dept.
Decentalized Region of Crete	Regional and national authority	Kozyraki maria (Director) Angeliki Martinou (Directorate of Water division)
Municipality of Heraklion	Regional and local authority	Tsakmopoulos Panagiotis (Dept. of European Programs) Ahladianaki Sofia (Dept. of Maintenance of Primary & School Buildings) Vasarmidaki Despoina (Directorate of Environment, Agricultural Development & Trade) Fotakis Emmanouel (Dept. of Environment) Koutoulakis Georgios (Dept. of Studies & Maintenance of urban Green) Papadaki Evangelia (Dept. of Electromechanical Projects, Energy Management & Permitting) Manousakis Emanuel (Directorate of Technical Projects & Studies)
Municipality of Chania	Regional and local authority	Panagiotis Simandirakis (Mayor) Giorgos Efthymiou (Director of Technical Service) Vangelis Pasipoularidis (Technical Service - Energy Manager) Nikiforos Andreadakis (Technical Service)
Regional Energy Agency of Crete	Energy agency	Nikolaos Sofronas (Director) George Pantelakis (Dept. of EU projects)
Public Power Corporation (PPC) - DEI	Energy provider, utility	Public Relations Office (info@dei.gr)
Hellenic Electricity Distribution Network Operator S.A. (HEDNO S.A.)- DEDIE	Operation, maintenance and development of the power distribution network in Greece	Helen Marolachaki (Officer Sub-Division of Procedures & Customer Service Systems - Users Network), Loukos Georgios (Director of Research & Innovation) Rogakos Vassilios (Director of Network Metering)
Hellenic Meditteranean University	Academia, research organization	Dimitris Katsamprakakis (Dept of Mechanical Engineering)
Technical University of Crete	Academia, research organization	Tsoutos Teocharis (TUC sustainabillity team)
Centre for Renewable Energy Sources and Saving (CRES)	Research organization, technical advisory body	(info@cres.gr)

Heraklion Chamber of Commerce and Industry	Business support and trade association	Maria Sideris-Symeonidou- (*EU Projects Coordinator)*
Chania Chamber of Commerce and Industry	Business support and trade association	Antonios Rokakis (Tourism Dept.)
Green Fund	Financing body, public funding institution	Green Fund Support Line (info@prasinotameio.gr)
Minoan Energy Community	Energy cooperative, citizen-led initiative	Energy Community of Crete Charalampos Gianopoulos (President) Ermioni Gyaliti (Vice President) Public Contact https://minoanenergy.com
Greenpeace Greece	Environmental NGO	Greenpeace Greece (info@greenpeace.gr)
WWF Greece	Environmental NGO	WWF Greece (info@wwf.gr)
Municipal Water and Sewerage Services of Heraklion (DEYACH)	Public service provider, infrastructure manager	Emmanouel Kosmadakis (General Director) Zavlakis Popi (Director of Technical Service)
Municipal Water and Sewerage Services of Chania (DEYACH)	Public service provider, infrastructure manager	Mr. Konos Stergiannis (General Director) Nikolaos Gulielmos (Civil Engineer) Stefanos Paraskakis (Mechanical Engineer)
ORGANIZATION FOR THE DEVELOPMENT OF CRETE S.A.	Public service provider, infrastructure manager	Basdanis Georgios (Research associate)
Hotel Owners Associations	heraklion-hotels.gr allchaniahotels.gr	Association of Hotel Owners - Heraklion info@heraklion-hotels.gr Association of Hotel Owners - Chania info@haniahotels.gr
Pancretan Bank of Crete (Green Banking Division)	Financing Institution, Public Bank	TBA

5. Summary in national language

Σύνοψη του Τοπικού Πλαισίου για την Ανάπτυξη Σχεδίων Θέρμανσης και Ψύξης (SLHCPs) στην Κρήτη

Η Κρήτη, το μεγαλύτερο νησί της Ελλάδας, με πληθυσμό 624.408 κατοίκους, είναι μία περιοχή με πλούσια γεωγραφική, κλιματική και κοινωνική πολυμορφία. Το νησί αποτελείται από 1.593 οικισμούς, με την πλειονότητα των κατοίκων να διαμένει στα αστικά κέντρα, κυρίως στο Ηράκλειο και στα Χανιά. Το κλίμα της Κρήτης είναι μεσογειακό, με ήπιους χειμώνες και ζεστά, μακρά καλοκαίρια. Ωστόσο, η κλιματική αλλαγή προκαλεί σημαντικές διαφοροποιήσεις, όπως η αύξηση της θερμοκρασίας, η μείωση των βροχοπτώσεων και η αύξηση της συχνότητας των ακραίων καιρικών φαινομένων.

Η κλιματική αλλαγή εκτιμάται ότι θα επιφέρει αύξηση της θερμοκρασίας πάνω από 2°C μέχρι το 2100, ειδικά στις ενδοχώριες περιοχές της Κρήτης. Επιπλέον, οι ημέρες καύσωνα αναμένεται να αυξηθούν από 3 σε 22 ημέρες ετησίως. Παράλληλα, η βροχόπτωση αναμένεται να σημαντικά ιδιαίτερα στις νότιες περιοχές του νησιού, με τις συνέπειες να περιλαμβάνουν μεγαλύτερα διαστήματα ξηρασίας και αυξημένο κίνδυνο δασικών πυρκαγιών.

Το ενεργειακό σύστημα της Κρήτης χαρακτηρίζεται από μετάβαση από την εξάρτηση από ορυκτά καύσιμα σε ανανεώσιμες πηγές ενέργειας (ΑΠΕ). Η πρόσφατη διασύνδεση του ηλεκτρικού δικτύου της Κρήτης με το ηπειρωτικό σύστημα της Ελλάδας ενίσχυσε τη σταθερότητα του ενεργειακού εφοδιασμού και μείωσε την εξάρτηση από πετρέλαιο.

Πηγές Ενέργειας:

- Ηλεκτρική ενέργεια: Καλύπτεται σε μεγάλο βαθμό από αιολικά και φωτοβολταϊκά πάρκα.
- Θέρμανση και Ψύξη: Χρησιμοποιούνται ηλιακά θερμικά συστήματα, βιομάζα και καυστήρες πετρελαίου για θέρμανση.
- Αυξανόμενη Χρήση ΑΠΕ: Τα φωτοβολταϊκά καλύπτουν το 50% της ζήτησης ηλεκτρικής ενέργειας, ενώ η βιομάζα χρησιμοποιείται για θέρμανση και ηλεκτροπαραγωγή.

Κατανάλωση Ενέργειας:

- Η κατανάλωση ενέργειας αφορά κυρίως την ψύξη, τη θέρμανση, τη φωταγώγηση δημόσιων και ιδιωτικών κτιρίων και την ηλεκτρική ενέργεια στη βιομηχανία και τη γεωργία.
- Η χρήση αντλιών θερμότητας και τα δίκτυα τηλεθέρμανσης και τηλεψύξης (District Heating & Cooling - DHC) αυξάνονται σταδιακά για τη μείωση της εξάρτησης από ορυκτά καύσιμα.

Η κοινωνική και οικονομική δομή της Κρήτης στηρίζεται στη γεωργία, τον τουρισμό και τις υπηρεσίες. Ο τουριστικός τομέας εξαρτάται ιδιαίτερα από το κλίμα, με τους καύσωνες και τις ακραίες θερμοκρασίες να αποτελούν απειλή για τη βιωσιμότητά του. Η γεωργία επηρεάζεται επίσης από την κλιματική αλλαγή, με μείωση της απόδοσης καλλιεργειών λόγω της έλλειψης νερού.

Η Περιφέρεια Κρήτης έχει αναπτύξει διάφορες στρατηγικές για την προσαρμογή στην κλιματική αλλαγή και τη βιώσιμη ενέργεια, όπως τα Σχέδια Δράσης για την Αειφόρο Ενέργεια και το Κλίμα (SECAPs).

Κύριες Δράσεις:

- Ανακαινίσεις κτιρίων: Ενεργειακές αναβαθμίσεις δημόσιων και ιδιωτικών κτιρίων για βελτίωση της θερμομόνωσης και αναβάθμιση των συστημάτων ψύξης και θέρμανσης.

- Προώθηση των ΑΠΕ: Αύξηση της χρήσης φωτοβολταϊκών, αιολικών πάρκων και ηλιακών θερμικών συστημάτων.
- Εφαρμογή των Δικτύων Τηλεθέρμανσης/Τηλεψύξης (DHC): Ανάπτυξη πιλοτικών έργων με χρήση βιομάζας και συστημάτων ανάκτησης θερμότητας.
- Πράσινες υποδομές: Ανάπτυξη πράσινων στεγών, κάθετων κήπων και "έξυπνων" συστημάτων αστικού φωτισμού.

Η Κρήτη και κυρίως το Ηράκλειο και τα Χανιά αντιμετωπίζουν σημαντικές προκλήσεις στον τομέα της ενεργειακής απόδοσης, κυρίως λόγω της εξάρτησής της από το πετρέλαιο για τη θέρμανση των κτιρίων. Παρά την προώθηση των ανανεώσιμων πηγών ενέργειας (ΑΠΕ), το πετρέλαιο παραμένει βασικό καύσιμο για τη θέρμανση οικιών και δημοσίων κτιρίων, γεγονός που αυξάνει τις εκπομπές διοξειδίου του άνθρακα (CO_2) και το ενεργειακό κόστος για τους πολίτες. Επιπλέον, τα παλαιά κτίρια με ελλιπή θερμομόνωση αποτελούν ένα ακόμα εμπόδιο στην επίτευξη ενεργειακής αποδοτικότητας. Πολλά από αυτά τα κτίρια δεν πληρούν τις σύγχρονες προδιαγραφές ενεργειακής απόδοσης, καθιστώντας απαραίτητες τις επενδύσεις σε ανακαινίσεις, όπως η τοποθέτηση θερμομονωτικών υλικών, η αναβάθμιση των παραθύρων και η αντικατάσταση των συστημάτων θέρμανσης. Ωστόσο, η χρηματοδότηση αυτών των επενδύσεων αποτελεί σημαντική πρόκληση, ειδικά για τους ιδιοκτήτες κατοικιών και τις δημόσιες υποδομές.

Παράλληλα, η κλιματική αλλαγή δημιουργεί πρόσθετες πιέσεις στο οικοσύστημα της Κρήτης, επηρεάζοντας κρίσιμους τομείς, όπως η γεωργία και η ύδρευση. Η μείωση της βροχόπτωσης και η αύξηση των περιόδων ξηρασίας περιορίζουν τη διαθεσιμότητα νερού, γεγονός που επηρεάζει αρνητικά τις καλλιέργειες και τη γεωργική παραγωγή. Η έλλειψη νερού αυξάνει επίσης το κόστος ύδρευσης και άρδευσης, δημιουργώντας προκλήσεις για τους αγρότες και τις τοπικές αρχές. Επιπλέον, οι καύσωνες γίνονται πιο συχνοί και έντονοι, οδηγώντας σε αύξηση της ζήτησης για ψύξη κατά τη διάρκεια των καλοκαιρινών μηνών. Η αυξημένη χρήση κλιματιστικών συστημάτων προκαλεί μεγαλύτερη πίεση στο ενεργειακό σύστημα, ειδικά τις ημέρες αιχμής, και ενισχύει το φαινόμενο της θερμικής νησίδας στις αστικές περιοχές. Οι προκλήσεις αυτές απαιτούν την άμεση ενίσχυση των υποδομών, την προώθηση ενεργειακά αποδοτικών τεχνολογιών και την ενσωμάτωση στρατηγικών προσαρμογής για την ενίσχυση της ανθεκτικότητας των τοπικών κοινωνιών και της οικονομίας.

Η Περιφέρεια Κρήτης έχει προγραμματίσει έργα και μέτρα προσαρμογής με συνολικό προϋπολογισμό 295,7 εκατομμύρια ευρώ. Οι δράσεις αυτές περιλαμβάνουν:

- Οικονομικά Κίνητρα: Παροχή οικονομικής υποστήριξης για ενεργειακές αναβαθμίσεις τουριστικών εγκαταστάσεων και δημόσιων κτιρίων.
- Υποδομές Πρασίνου: Δημιουργία περισσότερων πράσινων χώρων στις πόλεις για τη μείωση του φαινομένου της θερμικής νησίδας.
- Αναβαθμίσεις Κτιρίων: Αναβάθμιση των δημόσιων κτιρίων με στόχο την ενεργειακή αποδοτικότητα και τη μείωση των εκπομπών CO_2.

Η Κρήτη επιδιώκει την ενεργειακή της μετάβαση με βάση τη χρήση ΑΠΕ, την ενίσχυση της ενεργειακής απόδοσης και τη μείωση της εξάρτησης από τα ορυκτά καύσιμα. Η Περιφέρεια Κρήτης στοχεύει σε ένα βιώσιμο ενεργειακό σύστημα και την κλιματική ανθεκτικότητα έως το 2050, υιοθετώντας πρακτικές βιώσιμης ενέργειας, έξυπνης αστικής ανάπτυξης και περιβαλλοντικής ανθεκτικότητας. Η ενεργή συμμετοχή των τοπικών φορέων και της κοινωνίας των πολιτών αποτελεί κρίσιμο στοιχείο για την επίτευξη των στόχων αυτών.