lifeSMART

Support small Municipalities towARds energy Transition

Co-funded by the European Union

D3.3 Country Reports

Task 3.3 – Strategy definition

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INTRODUCTION

Task 3.3 is part of WP3 “IMTSs at work”, which includes a set of activities where the IMTSs – the inter-municipal technical support teams – work with local municipalities to initiate the implementation of a local energy transition strategy.

Following Task 3.2, which produced an inter-municipal vision and a set of potential joint actions, this task requires each territory to **select and deepen one priority action**, preparing the groundwork for actual implementation in Task 3.4.

The approach is decentralized, and **each project beneficiary operates autonomously** within their local context, in line with local regulations and agreements with municipalities, supported by external experts (IMTSs), who play a key role in technical assistance and coordination.

T.3.3 Strategy definition (COO 1-Anatoliki + APs, BEN 2-AREANATEJO+APs, BEN 3-CCI_NCA +APs, BEN 4- CMRC+APs, BEN 5-FAMP + APs, BEN 6-US, BEN 7-Cras)

This task aims to go into depth on a single priority action, selected among those included in the documents resulting from T.3.2, in order to prepare the ground for its implementation through national financing schemes, for instance under the NRRP or ERDF regional programmes.

According to the priorities agreed, each SMART team will identify one or two measures referred to its target area and will develop the related implementation strategy (T.3.2). Such strategies will take the shape of a master plan or a feasibility study, and should detail aspects related to current energy consumptions, technical characteristics and requirements of the main works, expected savings/RE production, investment and maintenance costs, funding opportunities, stakeholders to involve and related roles, etc. At the moment, beneficiaries are oriented as follows (the topics may vary):

- *the Greek team will develop a strategy on the energy upgrading of municipal building and public lighting.*
- *the Portuguese team will develop a strategy for PV plant on public roofs and for the implementation of NZEB code.*
- *the French team will develop a strategy on the assessment of energy performance of the existing building stock,*
- *o the Italian team will develop a strategy for the activation of a local REC and the realization of an electric vehicles recharging infrastructure.*

PART 1 – GUIDELINES FOR TASK IMPLEMENTATION

1. Expected activities, outputs and impacts

The task was scheduled between **M19 (April 2025)** and **M27 (December 2025).**

According to the project budget, expected expenditures under this task regards personnel costs, besides a share of the subcontracting cost attributed to the involvement of the IMTS external experts, which should play a significant role in this task, especially enabling the cooperation between the municipalities in the target area and providing technical support to the local staff.

The main objectives of the task are :

- Select **one priority action** among those identified in Task 3.2
- Develop a **detailed implementation strategy**
- Prepare the action for future **funding and execution** (e.g., national recovery plans, European Regional Development Fund, local schemes) in the task 3.4

Given its goals, the key activities to be undertaken under this task by beneficiary staff, in collaboration with both internal and external IMTS members, could be :

1. A preliminary comparative analysis of potential actions including assess costs, funding potential, impact, and elementary study of feasibility.
2. Priorization workshops or meetings organized with the external expert and local municipalities. Different tools could be used such as Priority Matrix (see Figure 1). The outcome is a clear and shared choice of one priority action.
3. Development of an implementation strategy, in the form of a **master plan or feasibility study,** including:
    - Current energy consumption data
    - Technical specifications and regulatory requirements
    - Estimated energy savings and RES production
    - Investment and maintenance costs
    - Funding opportunities (local, national, EU)
    - Roles of stakeholders and governance
    - Provisional implementation timeline

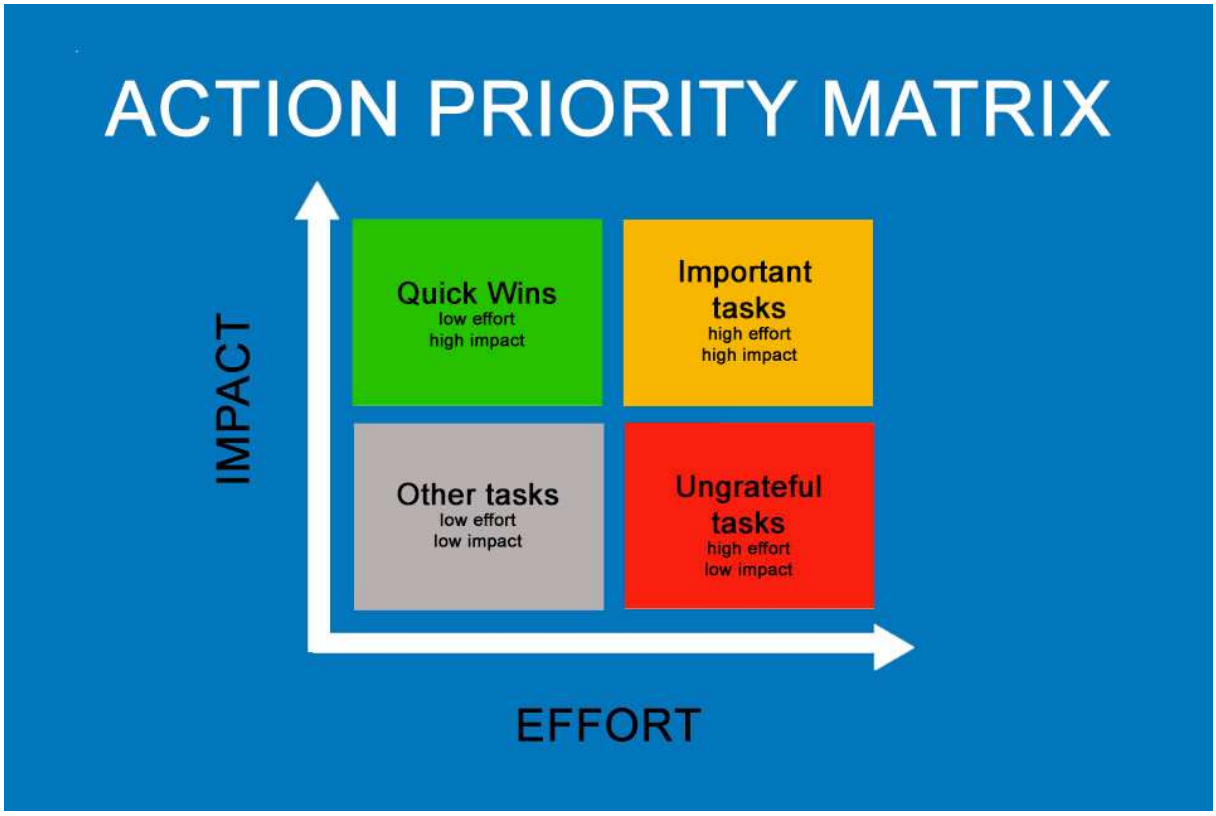


Figure 1 : Action Priority Matrix

The IMTS role is to provide technical advice, to coordinate stakeholders, and validate technical aspects.

The main output will be a well-prepared strategy ready for the implementation of the action in the Task 3.4.

2. Reporting template

Each beneficiary is required to submit a structured report (approx. 10 pages) with supporting annexes by **end of November 2025**. The report should follow the template below:

A. Selection of the Priority Action

Please describe the process, tools used to select the priority action (e.g., evaluation grids, priority matrix), and criteria applied.

Demonstrate how municipalities and local actors were involved.

***Annexes**:*

- *Tools used (matrices, evaluation documents)*
- *Photos from meetings or workshops*

B. Implementation Strategy

Please detail the key elements and structure of the developed strategy.

Describe the methodology used (e.g., energy audits, stakeholder mapping, financial modelling).

Identify any challenges faced during the process and how they were addressed.

Annexes:

- *Feasibility study or master plan*
- *Technical notes, calculations, or diagrams*

3. Structure of Deliverable “D3.3 Country reports”

The deliverable “D3.3 Country reports”, will be drafted once concluded the task 3.3 to summarize the activities implemented and the results achieved in each country. It is expected to be structured in 3 different parts:

Part 1 – Current Guidelines (prepared by CCI NCA)

Part 2 – National Reports (to be submitted by October 2025):

- Greece – by Anatoliki
- Portugal – by Areanatejo
- France – by CCI NCA
- Spain – by FAMP + USpace
- Italy – by CMCR + Cras

Part 3 – Comparative analysis and recommendations (CCI NCA will draft this section after collecting all national reports, by December 2025)

PART II : COUNTRY REPORTS ON STRATEGY DEFINITION

1. Greek target area (by Anatoliki)

Abbreviations - acronyms

CRES	Center For Renewable Energy Source
EED	Energy Efficiency Directive
EEEF	European Energy Efficiency Fund
ELENA	European Local Energy Assistance
EPBD	Energy Performance of Buildings Directive
EPC	Energy Performance Certificate
EPPB	Energy Performance Plan for Buildings
ERDF	European Regional Development Fund
IPMVP	International Performance Measurement and Verification Protocol
HVAC	Heating Ventilating Air-Conditioning
JESSICA	Joint European Support for Sustainable Investment in City Areas
JMD	Joint Ministerial Decision
KENAK	Greek Regulation on the Energy Performance of Buildings
LTRS	Long-Term Renovation Strategy
MERP	Municipal Emission Reduction Plan
MEPS	Minimum Energy Performance Standards
NECP	National Energy & Climate Plan
NZEB	Near Zero Energy Building
NRRP	National Recovery and Resilience Plan
NSRF	New National Strategic Reference Framework (2021 – 2027)
PPC	Public Power Corporation

1.1 Context and objectives

The Municipalities of Volvi and Aristotelis, both located in Central Macedonia, face challenges typical of small and medium-sized Greek municipalities, including aging building stock, limited technical capacity, and high operational energy costs. The strategic objective is to modernize public infrastructure, contribute to national decarbonization goals, and improve the quality of public services. Both Municipalities have developed municipal energy performance action plans for their building stock, supporting Greece's National Energy and Climate Plan (NECP) in accordance with National and EU legislations. These plans emphasize the leading role of the public sector in the energy transition.

The current deliverable aims to examine in depth a single priority action per Municipality, in order to prepare the ground for its implementation through national financing schemes, such as the NRRP or ERDF regional programmes. It aligns with the LIFE SMART project's objective to empower small municipalities with replicable, investment-ready strategies for the energy transition

The main objectives are:

- Selection of one priority action per Municipality.
- Development of a detailed implementation strategy.
- Preparation of each action for future funding (e.g., national recovery plans, European Regional Development Fund, local schemes) and subsequent implementation under Task 3.4 "Preparation for the implementation of local initiatives".

Within this framework, the legal context and the obligation for the preparation and submission of Energy Performance Plans for municipal buildings are presented in Chapters 2 and 3, while Chapter 4 provides an overview of the building stock of both Municipalities. Chapter 5 analyses in depth the methodology and criteria used for energy performance evaluation and the prioritization of buildings for energy upgrades in each Municipality.

The municipal buildings selected as priority actions are described in Chapter 6. These buildings will be energy-audited and certified according to the existing Energy Efficiency of Buildings Regulation, and feasibility studies will be conducted within Task 3.4 of the LIFE SMART project. The objective is to prepare and deliver to both Municipalities Energy Performance Certificates, along with mature energy and financial feasibility studies (one building per Municipality), ready for submission to relevant national funding programmes, as described in Chapter 8.

Thus, the current plan, aligned with the Municipalities' EPPBs, provides a robust, investment-ready framework to improve energy performance, reduce emissions, and demonstrate public leadership in the energy transition. By implementing the identified priority actions, both Municipalities will demonstrate their capacity to deliver replicable, investment-ready energy upgrade projects, gaining valuable know-how and experience, and thereby advancing their energy transition efforts.

In the long term, both Municipalities aim to achieve significant cost savings and environmental benefits while fostering local employment and skills development. The current plan is ready for transition to Task 3.4 "Preparation for the implementation of local initiatives".

1.2 Legal framework and obligations

The current Chapter includes an overview of the **legal obligations** for energy efficiency of municipal (and public) buildings in Greece deriving from the **National Energy & Climate Plan (NECP)**, the **Energy Performance of Buildings Directive (EPBD)**, and related **Greek laws**. It focuses on what municipal buildings must, or are to, comply with — as opposed to voluntary or best-practice measures.

Key EU/legal framework

1. **EPBD (Directive 2010/31/EU + amendments, and the revised EPBD 2024/1275 on energy performance of buildings)**
   - Sets requirements for minimum energy performance of new buildings and major renovations.
   - Requires all new public sector buildings from 1 January 2019 in Greece to be *Nearly Zero-Energy Buildings (NZEBs)*; for all new buildings (public and private), NZEB requirement applies from 1 January 2021.
   - Obligations for Energy Performance Certificates (EPCs) for buildings when constructed, sold, rented, or after major renovation. Also for public buildings. The EPC must express the energy class, and minimum energy performance criteria for building elements & systems (envelope, HVAC, lighting, etc.).
   - Under the revised EPBD, new stricter targets are being introduced: zero-emission buildings for public buildings by 1 January 2028, new energy performance standards (MEPS), solar-readiness, etc.
2. **Energy Efficiency Directive (EED) / Greece's transposition laws (e.g. Law 4342/2015, amendments)**
   - Obliges public bodies to lead by example. In particular, tasks like renovating a certain share of publicly owned buildings each year to meet minimum performance requirements.
   - Requires energy management and energy efficiency plans by regional and local authorities, and a strategy for energy savings.
3. **NECP (National Energy & Climate Plan) (latest Greece version, including updates)**
   - Sets national targets for energy efficiency, emissions, renewable energy, etc., including in the building sector.
   - Specific obligations for public bodies to reduce final energy consumption by a certain % per year, and renovate a percentage of floor area of heated/cooled public buildings annually.
   - Emphasis on exemplary role of public sector, accelerating depth and pace of renovations, facilitating financing, energy management.

The national laws/regulations that transpose the abovementioned EU obligations, or add national requirements are described at **Annex I: Greek National Laws & Regulations Relevant to Municipal Buildings**.

Specific Obligations for Municipal / Public Buildings

Putting together the above, here are **key legal obligations** that municipal/public buildings in Greece must comply with (or will be required to comply with):

1. **NZEB requirement** for new public buildings from 2019, and for all new buildings from 2021. Municipal buildings built after those dates must meet NZEB standards.
2. **Minimum energy performance requirements**: For new buildings and for major renovations, minimum standards for building envelope, HVAC systems, lighting, etc., as set by the Regulation on the Energy Performance of Buildings (KENAK). All public buildings are subject to these.
3. **EPC (Energy Performance Certificate) obligations**:
   - Must be issued for buildings when built, sold, rented, or renovated significantly. Municipal buildings are included.
   - EPCs must show energy class and energy index. Also, some laws require valid EPC for contracts involving public bodies (e.g. purchase or lease).
   - EPCs must be posted in visible areas of public buildings, proving information related to the their energy class and efficiency.
4. **Annual renovation targets for public buildings:**
   - Under EED-transposed national law (Law 4342/2015, etc.), public bodies must renovate **3%** of the total floor area of heated/cooled public buildings each year to meet at least minimum energy performance requirements.
   - Also, public bodies have obligations to reduce final energy consumption by a certain % per year vs baseline (e.g. in NECP) and to lead by example.
5. **Incorporation of RES (Renewable Energy Sources):**
   - New buildings: hot water demand for new buildings must be partly covered (often minimum percentage, e.g. solar thermal or other RES).
   - In large renovations or when feasible, heating/cooling must incorporate renewable sources. Law 5037/2023, Law 5106/2024 add stricter obligations.
6. **Energy Management & Monitoring:**
   - Public buildings above certain size thresholds are or will be required to have energy management systems.

- Also, regular inspections of heating, air conditioning systems, boilers, etc., are mandatory to ensure performance.

7. **Long-Term Renovation Strategy & Minimum Energy Performance Standards (MEPS):**
   - Greece has to prepare and implement a long-term renovation strategy (as per EPBD) to decarbonize building stock by 2050.
   - Under revised EPBD, minimum energy performance standards (MEPS) will apply to non-residential (public included) buildings: e.g., a percentage of the worst performing buildings must be renovated by certain dates (16% by 2030, 26% by 2033) etc.
8. **Transparency and Display of EPCs for public buildings:**
   - For public buildings, EPCs may need to be displayed in a prominent, visible place.
   - Validity periods and audit obligations (if central government or general government is lessee/buyer) are reinforced.

1.3 Energy performance plans for buildings

According to Article 6 of Law 4843/2021 “Exemplary role of buildings belonging to the public sector” local Authorities are obliged to prepare and submit Energy Performance Plan for Buildings (EPPB) shall be prepared, in accordance with the template of the Ministry of Environment and Energy. The EPPB is a planning/strategic tool required from municipalities (and regional authorities) to identify, prioritize, and schedule energy-efficiency upgrades to their building stock. It is part of a larger set of obligations under Greek law (Law 4342/2015, Law 4936/2022) and aligns with the NECP and EU Directives (EPBD, EED). These Plans are essentially action plans specifically focused on public/municipal buildings, as a component of broader municipal emission or climate action plans and are reviewed every four (4) years.

The BEPP shall at least contain:

- Detailed presentation of the characteristics of the building stock, prioritization of the building stock with regard to the necessity of actions to improve their energy performance,
- Techno-economic analysis of building energy upgrade interventions,
- Definition of a target and a plan for achieving the energy saving target.

The Energy Efficiency Action Plans for Municipal Buildings are part of a broader web of planning instruments:

- **MERP** (Municipal Emission Reduction Plan) under Law 4936/2022 — broader than just buildings, but buildings are a major component.
- **SECAP** (Sustainable Energy & Climate Action Plan) for municipalities under Covenant of Mayors — covers energy, emissions, climate adaptation. EPPB may feed into or overlap.
- National / regional programmes and tools (subsidy schemes, technical assistance programmes) often require these plans to be in place to receive funds.

Within the aforementioned framework both Municipalities have prepared and submitted Municipal Energy Performance Plan for Buildings aiming to:

1. **Create an Inventory** of the municipal building stock including: types of buildings, floor areas, current energy performance, energy uses, status of insulation, HVAC, etc.
2. **Identify priority buildings & typologies** for retrofit, based on criteria such as high energy use, poor energy class, high occupant numbers, frequency of use, etc.
3. **Define set(s) of energy efficiency measures** for building envelope, systems (HVAC, lighting, hot water), renewables (solar roofs, PV, solar thermal), controls and monitoring (BEMS), etc.
4. **Estimate technical, energy, and economic performance** of the measures: energy savings, cost, payback, CO_2 emission reductions.
5. **Develop implementation plan / timetable**, scheduling interventions, preparing design & procurement, financing, overseeing works, etc.
6. **Monitoring, evaluation, and reporting**: setting KPIs, measurement & verification, periodic updates, ensuring compliance, checking realized savings.
7. **Linking to funding and eligibility**: many funding programmes and investment schemes require the existence of these plans; having a formally approved plan is often a condition for grant / subsidy eligibility.

1.4 Presentation of the building stock of the municipalities of aristotelis & volvi

Building stock of the Municipality of Aristotelis

This chapter includes a summary presentation—through consolidated data, tables, and charts—of the main characteristics of all buildings under the jurisdiction of the Municipality of Aristotelis. These are the buildings used by the Municipality to meet its operational needs and provide public services. It also records municipally owned buildings that are vacant or unused during the time the plan was prepared.

The Municipality of Aristotelis and its legal entities manage:

- Administrative and service buildings,
- Welfare facilities (Creative Activity Centers for Children, nurseries, elderly care centers),
- Primary and secondary education buildings,
- Water supply and sewerage installations,
- Public spaces (parks, squares, playgrounds).

To proceed with actions aimed at improving the energy efficiency of its buildings, the Municipality of Aristotelis first recorded its building stock. Priority was given to schools and municipal offices with high public use, followed by welfare and tourism-related buildings. The following data are presented below through grouped tables and diagrams:

- Age of buildings / Year of construction.
- Social function / Use of the building.
- Total floor area.
- Existence or absence of an Energy Performance Certificate (EPC) / Energy class of the building.

Analysis of Building Stock by Criteria

Building Age / Year of Construction

The age of buildings is a key factor in evaluating and planning energy efficiency improvements. According to the Municipality's Energy Performance Action Plan, most buildings were constructed between **1980–2010**, with a smaller number built **before 1980**. The following table and diagram show the breakdown:

Table 1: Building stock by year of construction

Period	Number of Buildings
Up to 1980	30
1980–2010	36
After 2010	1



Diagram 1: Building stock by year of construction

Social Function / Building Use

The function and social role of buildings influence how energy efficiency actions are organized. Most municipal buildings are used for **education**, with fewer used as **community offices** and others for **culture, sports or social welfare**.

Table 2: Building stock by use

Building Use	Number of Buildings
Industry / Manufacturing	0
Education	40
Energy / Communications / Transport	0
Public Service (Administration)	2
Public Service (Community offices)	12
Commerce	5
Residence	0
Social Welfare	1
Hotel	0
Culture / Sports	7

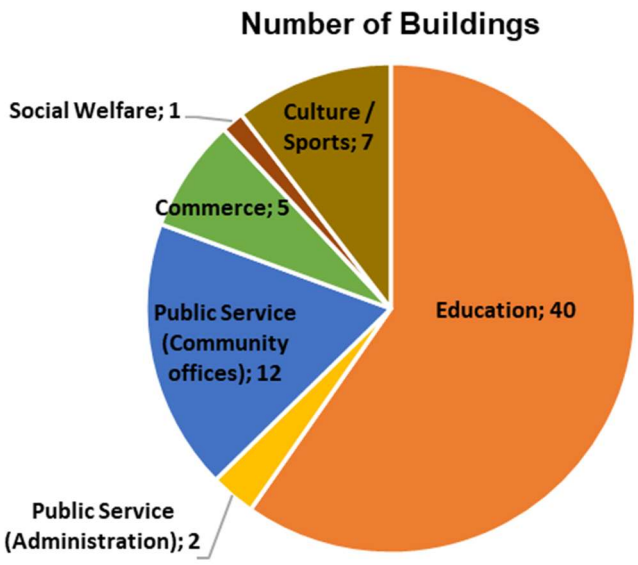


Diagram 2: Building stock by use

Total Floor Area

Another organizational criterion is total built floor area. The buildings are grouped into four size categories:

Table 3: Building stock by total floor area

Floor Area	Number of Buildings
< 250 m²	21
250–500 m²	20
500–1,000 m²	13
> 1,000 m²	13

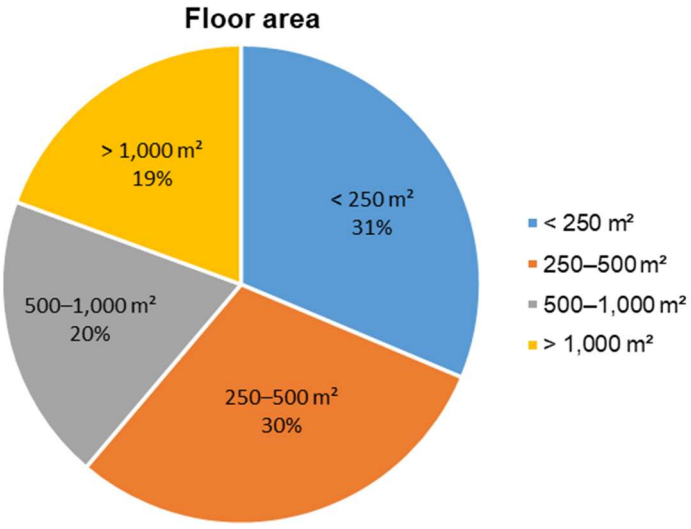


Diagram 3: Building stock by total floor area

Energy Performance Certificate (EPC) / Energy Class

The Municipality of Aristotelis has completed EPCs and energy studies for a number of its buildings, chosen according to the municipal energy management plan and each building's specific needs.

Table 4: Building stock by energy classification

Energy Class	Number of Buildings
Without EPC	55
Enegy Class A+	0
Enegy Class A	0
Enegy Class B+	1
Enegy Class B	2
Enegy Class C	1
Enegy Class D	2
Enegy Class E	3
Enegy Class F	2
Enegy Class G	1

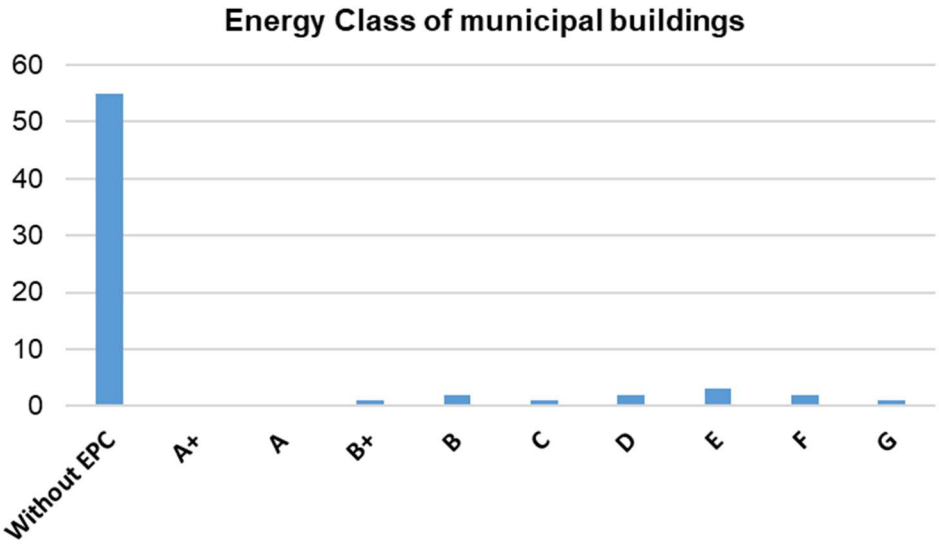


Diagram 4: Building stock by energy classification

Building stock of the Municipality of Volvi

The Municipality of Volvi owns a significant number of buildings and properties with different architectural characteristics and uses. In total, the Municipality manages **92 municipal facilities** (administrative, service, sports, and technical buildings, etc.) and **49 school units**.

Analysis of Building Stock by Criteria

Building Age / Year of Construction

The age of buildings is a key factor in evaluating and planning energy efficiency improvements. According to the Municipality's Energy Performance Action Plan, most buildings were constructed between **1980–2010**, with a smaller number built **before 1980**. The following table and diagram show the breakdown:

Table 5: Building stock by year of construction

Period	Percentage
Up to 1980	68%
1980–2010	25%
After 2010	7%

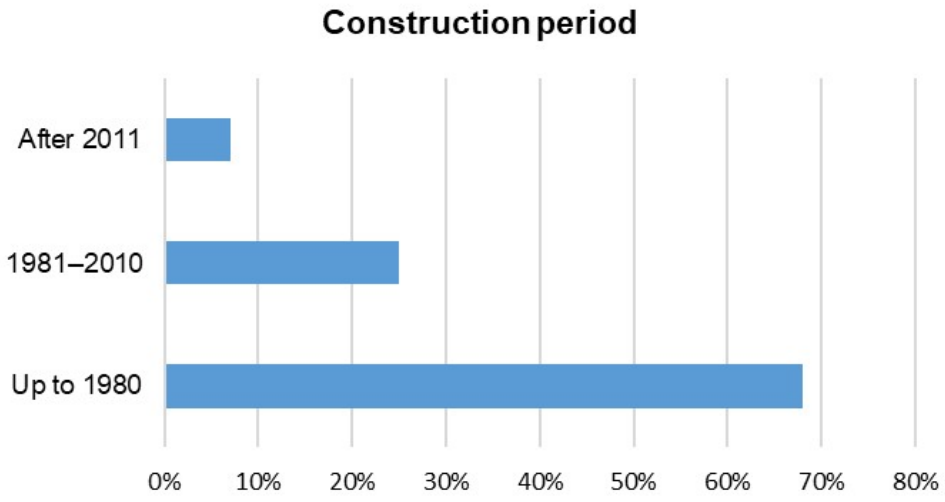


Diagram 5: Building stock by year of construction

Social Function / Building Use

The function and social role of buildings influence how energy efficiency actions are organized. Most municipal buildings are used for **education**, with fewer used as **community offices** and others for **culture, sports or social welfare**.

Table 6: Building stock by use

Building Use	Percentage

Education	35%
Public Service (Administration)	11%
Social Welfare	14%
Cultural Centres	7%
Other Uses	24%
Without Uses	9%
Total	**100%**

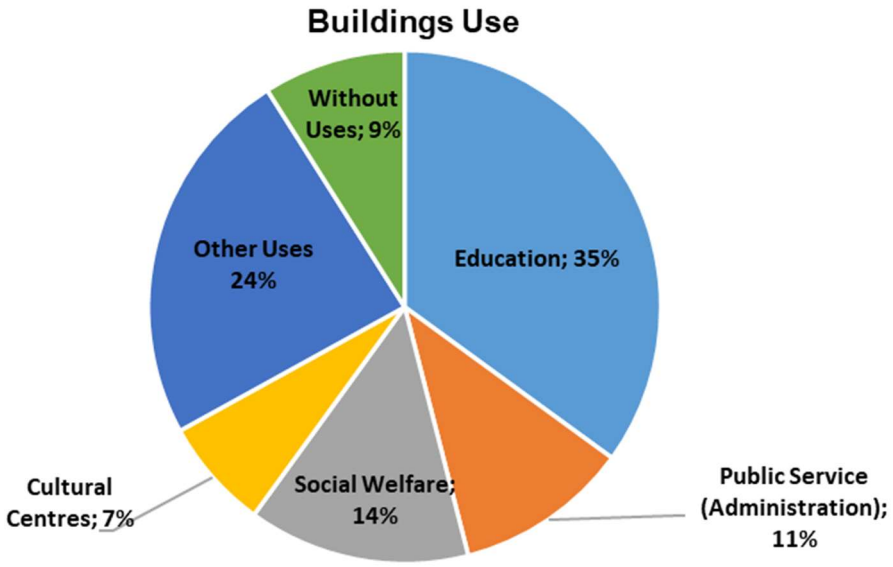


Diagram 6: Building stock by use

Total Floor Area

Another organizational criterion is total built floor area. The buildings are grouped into four size categories:

Table 7: Building stock by total floor area

Floor Area	Number of Buildings
< 250 m²	96
250–500 m²	17
500–1,000 m²	20
> 1,000 m²	8

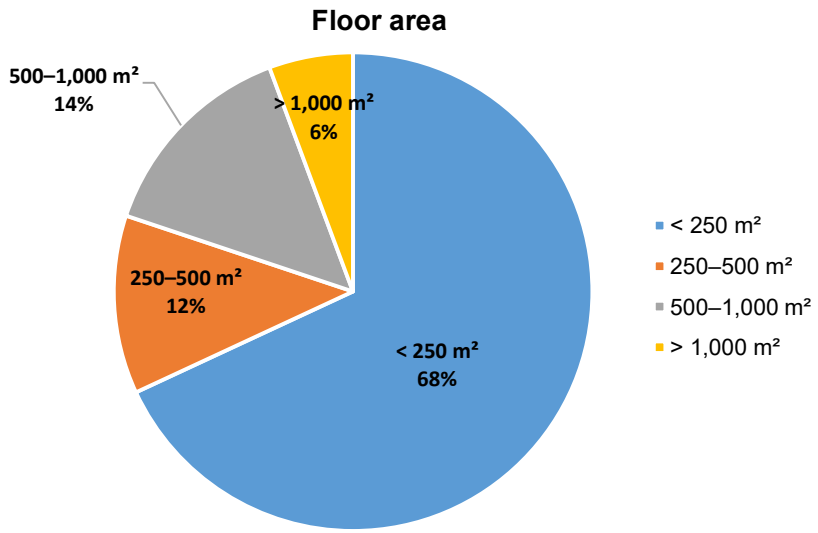


Diagram 7: Building stock by total floor area

Energy Performance Certificate (EPC) / Energy Class

The Municipality of Aristotelis has completed EPCs and energy studies for a number of its buildings, chosen according to the municipal energy management plan and each building's specific needs.

Table 8: Building stock by energy classification

Energy Class	Number of Buildings
Without EPC	132
Enegy Class A+	0
Enegy Class A	0
Enegy Class B+	1
Enegy Class B	0
Enegy Class C	0
Enegy Class D	5
Enegy Class E	3
Enegy Class F	1
Enegy Class G	0

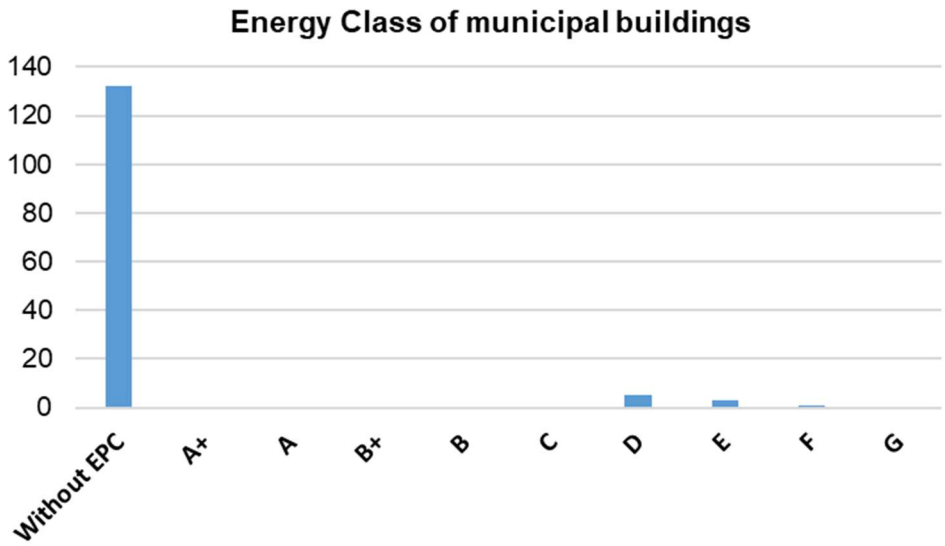


Diagram 8: Building stock by year of construction

1.5 Priority actions – methodological approach and criteria applied

The selection of the priority action per Municipality and the subsequent preparation of the groundwork for actual implementation (Task 3.4) was achieved taking into consideration the preparatory work already done via the analysis of each Municipality's building stock and the respective Energy Performance Plan for Buildings, and more specifically the prioritization process based on the energy and other predefined characteristics of each municipal building.

The methodological approach for prioritizing the buildings of each Municipality was based on the guidelines of the Directorate of Energy Policies and Energy Efficiency of the General Secretariat for Energy and Mineral Raw Materials of the Ministry of Environment and Energy.

Higher-scoring buildings are prioritized for energy improvement measures. Since the process is comparative across buildings, normalization of values (e.g., for annual energy consumption or EPC category) was required. The assessment process of the municipal building stock is dynamic and updated periodically, each time the municipal building registry is enriched with new energy data—whether this concern energy consumption or the technical characteristics and Energy The prioritization process involved ranking the buildings according to the need for actions to improve their energy performance.

The classification of buildings was carried out based on a combination of energy-related and non-energy-related criteria, as detailed below.

- **Energy Criteria:**
  - Energy Performance Certificates (EPCs) of the buildings.
  - Energy performance category of the building (from EPC).
  - Specific energy consumption (kWh/m^2).
  - Quality of buildings' shell (insulation, openings).
- **Non-Energy Criteria:**
  - Age of the building.
  - Social function or use of the building.
  - Total floor area.
  - Number of users

Because the prioritization and scoring process is comparative among the assessed buildings, normalization of the values of the abovementioned was required. Thus, each of them was assigned a common scoring scale, on which a weighting factor was applied to calculate a weighted score for each criterion and a total prioritization score for each building ($\mathbf{S_{total}}$). The weighting of each criterion was determined according to the specific requirements of the Municipality.

Let p_1, p_2, …, p_n be the coefficients indicating the importance (weight) of each evaluation criterion, and n_1, n_2, …. n_n normalised value per criterion, the weighting score per building was calculated according the following formula: $\mathbf{S_{total} = p_1 \, x \, n_1 + p_2 \, x \, n_2 + \ldots + p_n \, x \, n_n}$

The building's score reflects the importance of taking action. Therefore, buildings with higher scores indicate higher priority for energy upgrade. The normalised values per criterion and the respective weighting factors used per Municipality are presented in the following tables.

Criteria applied by the Municipalities of Aristotelis and Volvis

The evaluation criteria applied by the Municipality of Aristotelis are summarised in the following Tables

Table 9: Criterion MAr-1: Energy Performance of Building (EPC)

Energy Class	No. of Buildings	Normalized value
Without EPC	55	1
Energy Class A+	0	2
Energy Class A	0	3
Energy Class B+	1	4
Energy Class B	2	5
Energy Class C	1	6
Energy Class D	2	7
Energy Class E	3	8
Energy Class F	2	9
Energy Class G	1	10

Table 10: Criterion MAr-2: Building's total area

Floor Area (m²)	No. of Buildings	Normalized value
No data	0	0
< 250 m²	21	0
250–500 m²	20	1
500–1000 m²	13	2
> 1000 m²	13	3

Table 11: Criterion MAr-3: Building's Age

Year of Construction	No. of Buildings	Normalized value
No data / after 2010	1	0
1980–2010	36	1
Up to 1980	30	2

Table 12: Criterion MAr-4: Building's social character/ Use

Use	No. of Buildings	Normalized value

Industry / Manufacturing	0	0
Education	40	3
Energy – Communications – Transport	0	0
Public Service (Administration)	2	2
Public Service (Community offices)	12	1
Commerce	5	0
Residence	0	0
Social Welfare	1	3
Hotel	0	0
Culture – Sports – Catering	7	3

Table 13: Evaluation criteria's weighting factors – Municipality of Aristotelis

Coding	Criterion	Factor (%)
MAr-1	Energy Performance of Building (EPC)	20%
MAr-2	Building's total area	30%
MAr-3	Building's Age	20%
MAr-4	Building's social character/ Use	30%
Total		**100%**

The Municipality of Volvi used a slightly different approach prioritising only the buildings that were issued Energy Performance Certificates and available energy data were available. The criteria used are presented below.

Table 14: Evaluation criteria's weighting factors – Municipality of Volvi

Coding	Criterion	Factor (%)
MV-1	Annual energy consumption (KWh)	20%
MV-2	Annual specific energy consumption (KWh/m2)	20%
MV-3	Energy Performance of Building (EPC)	15%
MV-4	Quality of buildings' shell	15%
MV-5	Number of employees	10%
MV-6	Building's Age	10%
MV-7	Building's social character/	10%
Total		**100%**

Selection of the priority actions

The final selection of the priority actions for each Municipality was achieved through close collaboration between the Technical Departments of both Municipalities and the energy efficiency experts of ANATOLIKI, taking into account the prioritization lists developed within the Municipal Energy Performance Plan for Buildings, as well as the following factors:

- The building's use and its potential for replication. Schools and social service buildings were prioritized based on this criterion.
- The legal status of the building – absence of irregularities.
- The number and type of daily building users.

In addition, buildings that are to be included in co-funded energy-upgrade programs must have:

- A Primary Seismic Pre-Inspection Report, based on the current Greek Seismic Design Code, and must not be classified as Category A.
- Documents proving ownership status and all required legalizing documents.
- A Building/Divided Property Electronic Identity.
- An updated Energy Performance Certificate (E.P.C.).

These requirements ensure that municipalities are fully prepared to meet legislative obligations and to secure national and European funding for the proposed building energy upgrades.

Taking into consideration the above factors, the following municipal buildings were selected for energy auditing and further analysis in Task 3.4:

- The General High School of Arnea, located in the local community of Arnea in the Municipality of Aristotelis.
- The Junior High School of Stavros, located in the local community of Stavros in the Municipality of Volvi.

A more detailed presentation of the selected buildings is provided in the next chapter.

1.6 Implementation of the priority actions – buildings proposed

General Highschool (Lyceum) of Arnea

The proposed building is located in Arnea, Halkidiki (Municipality of Aristotelis) in the eastern part of the settlement on Bishop Boukoba Chrysostomou Street. The building was erected in 1975, according to the construction permit 683/1977. It is developed on three levels (ground floor – first floor – second floor) and has the use of Secondary Education school housing the General Highschool (Lyceum) of Arnea. The building is a part of a complex consisting of the following building units:

- General High School of Arnea.
- Vocational High School of Arnea.
- Indoor Sports Hall of Arnea.



Figure 1: Building location (source: Google Earth)

The total heated area of the high school is 3128,34 m^2, consisting of the following spaces:

- Ground floor: Classrooms, laboratory, gym, canteen, auxiliary spaces and WC.
- First floor: Classrooms, storage and WCs.
- Second floor: Classrooms, offices and WCs.

The building was constructed in the mid-1970s with the construction and architectural requirements of the area and the era. Therefore, and according to the information and measurements, the building is not thermally insulated, while on its main facades they have large areas of double-glazed windows with a gap of 6 mm without any film of low solar radiation permeability.



Figure 2: East Elevation Section



Figure 3: Section of the South and West façade of the building



Figure 4: Part of the North and West façade of the building

The masonry has been made of reinforced concrete and brickwork, while no type of thermal insulation has been identified. The building is roofed with a tiled roof, made of Byzantine tiles, which rests on a concrete slab which is also the roof of the second floor. The structural type of the building belongs to category OS b, i.e. it is a building with a load-bearing structure made of reinforced concrete and infill masonry consisting of brickwork without thermal insulation.

The interior masonry as well as the masonry in contact with Non-Heated Spaces are made of uninsulated running brickwork. The following Table presents the thermal transmittance coefficients of the external and internal vertical structural elements

Table 15: Thermal transmittance coefficients of external and internal structural elements

Structural Element Description	U-Value (W/m^{2}K)
T1: Uninsulated brickwork to the external environment	2,20
T2: Uninsulated reinforced concrete to external environment	3,40
E1: Internal uninsulated brickwork to Non-Heated Space	2,40
E2: Internal uninsulated reinforced concrete to Non-Heated Space	2,60
D1: Uninsulated floor to natural ground	3,10
O1: Insulated roof with reinforced concrete slab	3,05
O2: Uninsulated tiled roof on Inclined Reinforced Concrete Slab	4,70
O3: Horizontal roof under non-thermal insulated roof	3,70

Regarding the external frames, they are of a synthetic frame and have a double glazing with a gap of 6 mm without thermal break and without any low solar transmittance film. The openings are not certified and have relative high air permeability.

The building is illuminated with lighting fixtures that have T8 fluorescent lamps. These luminaires have magnetic ballast and are operated manually with light switches. Specifically, the following are observed:

- Rectangular luminaires with fluorescent strip, measuring 0.30 x 1.23 m, (2x36 Watt) in the classrooms.
- Square lamps with fluorescent strip, measuring 0.65 x 0.65 m, (4x18 Watt) in the common corridors.
- Circular lighting fixtures with fluorescent lamp in auxiliary spaces, WCs and storage rooms (10-20 Watt).

All classrooms have a sufficient number and surface area of openings, resulting in satisfactory levels of natural lighting, but without any kind of automation for adjusting artificial lighting levels to compensate for external lighting levels (dimming). Furthermore, there are no presence sensors installed.



Figure 5: Existing luminaires

The heating of the building is achieved by circulating hot water in conventional radiators while no cooling system is located. The operation of the heating system is achieved through an installed oil boiler with a thermal power of 345 kW. The heating distribution system is two-pipe with one branch, does not have an installed outdoor temperature compensation system or other automation devices (room thermostats, variable point circulators, etc.), is uninsulated and is deployed for the most part indoors.

The boiler thermostat is set to 75-80 °C and the system operates on weekdays from 7:30 - 7:45 to 13:00 - 13:30 depending on the weather conditions and the requirements of the school. The boiler is supplied by a calibrated oil tank (built internally) in an adjacent area. The boiler chimney does not have any kind of insulation.

The ventilation is achieved manually through the perimeter openings and of course through the moderate airtightness of the frames. No mechanical ventilation system is installed.

Assessment of the energy efficiency of the building

The building was simulated in accordance with the requirements of the national energy efficiency of buildings regulation in force (KENAK) and the technical characteristics concerning their external structural elements, as well as their electrical and mechanical installations were examined: heating, cooling, ventilation and lighting. The General Highschool of Arnea was certified in 2015 (Energy Performance Certificate 48785/2015) and according to the results it was classified in Energy Class D. Within the current project an initial energy audit has already taken place, and an updated EPC will be issued at the next stage of the preparation of the feasibility study. The following Table summarises the key technical and energy features.

Table 16: Key technical and energy features of General Highschool of Arnea

Construction year	1977
Use	Education
Address	Ep. Chrysostomou
Total Floor area (m^2)	3.128,23
Total Building Volume (m^3)	9.384,69
Heated Floor area (m^2)	2.815,407
Heated Building Volume (m^3)	8.446,221
Number of Floors	3
Building Energy Efficiency Class	Energy Class F
EPC Number	-
Estimated annual primary energy consumption (kWh/m^2)	241,3
Estimated annual CO_2 emissions (kg/m^2)	56,2
Heating system	Water Boiler
Heating System - Fuel	Light fuel oil
Heating system - Installed Power (kW)	345
Heating system - Efficiency Rating	86.8
Cooling system	None
Cooling System - Installed Power (kW)	-
Cooling System - Efficiency Rating	-
Small scale Renovation	Yes
Radical Renovation	No
Number of permanent users on a daily basis	220
Average number of visitors on a daily basis	-
Existence of Energy Management System (i.e. ISO 50001)	No
Type of RES system installed in the building	PV panels
Estimated annual heating oil consumption (KWh)	679.259
Annual natural gas consumption (KWh)	0

Estimated annual power consumption (KWh)	158.203

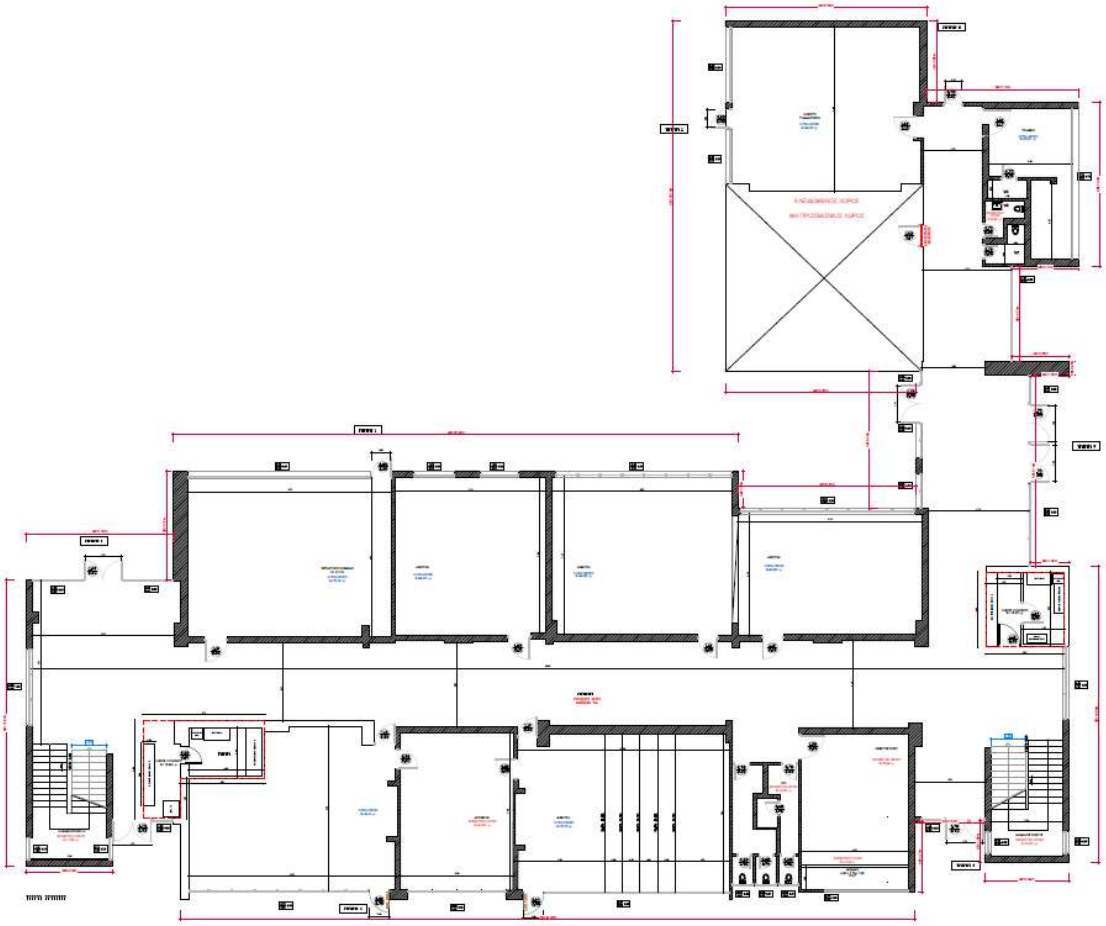


Figure 6: Basement plan view

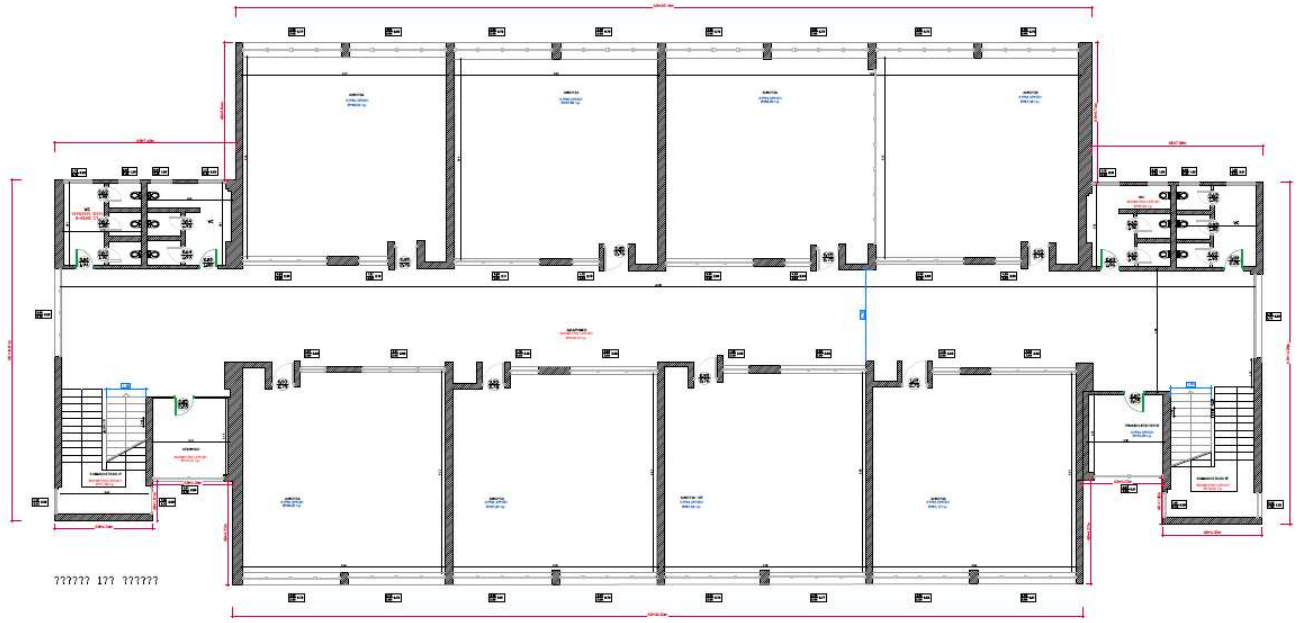


Figure 7: 1st floor plan view

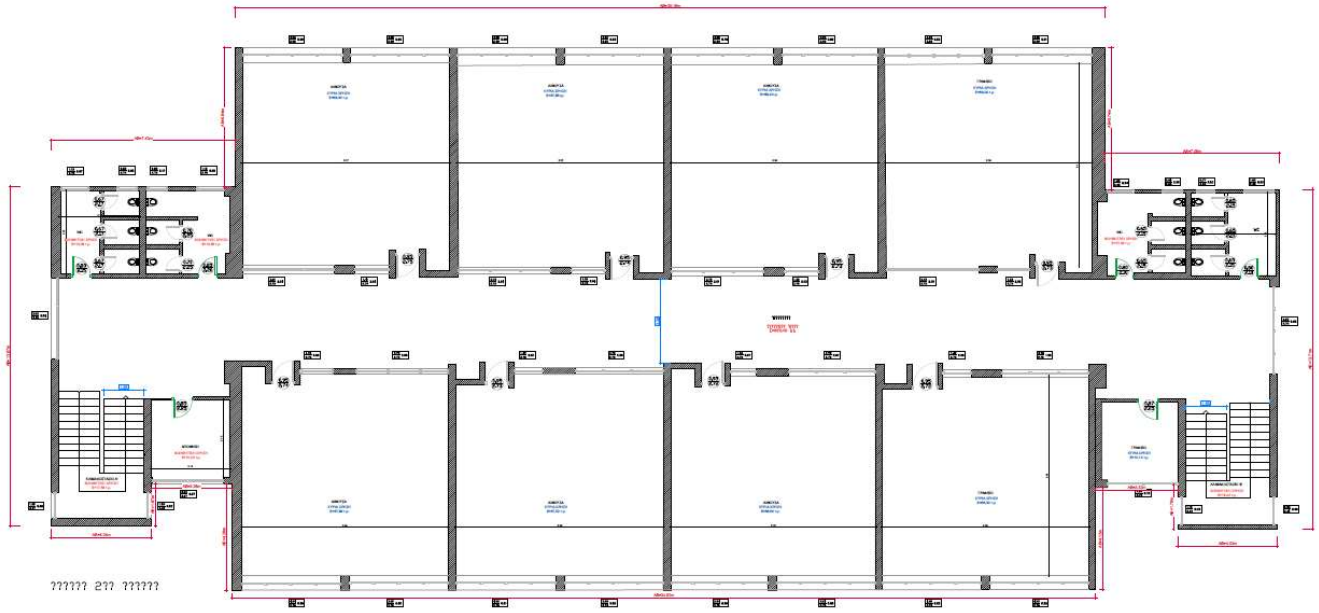


Figure 8: 2nd floor plan view

Junior Highschool of Stavros

The proposed building is located in the local community of Stavros at the Municipality of Vovli. The building was erected in 1997, according to the construction permit 63/1997. It is developed on two levels (ground floor and first floor) and has the use of Secondary Education school housing the Junior Highschool (Middle School) of Stavros.



Figure 9: Building location (source: Google Earth)

The total heated area of the high school is 2094 m^2, consisting of the following spaces:

- Ground floor: Classrooms, library, multi-purpose hall, teachers' offices, canteen, auxiliary spaces and WCs.
- First floor: Classrooms, laboratories (Physics/ Computing) and WCs.

The building was constructed in 1996 with the construction and architectural requirements of the area and the era. According to the information and measurements, the building is not thermally insulated, while on its main facades they have large areas of double-glazed windows with a gap of 6 mm without any film of low solar radiation permeability.

The masonry has been made of reinforced concrete and brickwork, while no type of thermal insulation has been identified. The building is roofed with a tiled roof, made of Byzantine tiles, which rests on a concrete slab which is also the roof of the first floor. The interior masonry as well as the masonry in contact with Non-Heated Spaces are made of uninsulated running brickwork. The thermal transmittance coefficients of the external and internal structural elements are the same as the U-Values presented at Table 15 of the previous subchapter



Figure 10: South (main) elevation section



Figure 11: Section of the East façade of the building



Figure 12: Part of the North façade of the building

Regarding the windows, they are of a synthetic frame and have a double glazing with a gap of 6 mm without thermal break and without any low solar transmittance film. The openings are not certified and have relative high air permeability. All doors are made of metal with very low airtightness as well.

The building is illuminated with lighting fixtures that have T8 fluorescent lamps and more specifically with rectangular luminaires with fluorescent strip and magnetic ballasts, 2x36 Watt, in all spaces except WCs and auxiliary spaces that have LED lighting.

All classrooms have a sufficient number and surface area of openings, resulting in satisfactory levels of natural lighting, but without any kind of automation for adjusting artificial lighting levels to compensate for external lighting levels (dimming). Furthermore, there are no presence sensors installed. The total installed power of the building's lighting systems is 19,140 kW.

The heating of the building is achieved by circulating hot water in conventional radiators while no air-conditioning system was located. The operation of the heating system is achieved through a previously installed natural gas boiler with a thermal power of 350 kW. The heating distribution system is two-pipe with one branch, does not have installed weather-compensated heating controls or other automation devices (room thermostats, variable point circulators, etc.), is uninsulated and is deployed for the most part indoors. The boiler thermostat is set to 75 °C and the system operates on weekdays from 7:30 - 13:00. The heating distribution system is uninsulated with terminal units of the steel radiator type without thermostatic heads and in moderate condition



Figure 13: Existing luminaires



Figure 14: Boiler room



Figure 15: Existing steel radiators

The ventilation is achieved manually through the perimeter openings and of course through the moderate airtightness of the frames. No mechanical ventilation system is installed.

Assessment of the energy efficiency of the building

The building was simulated in accordance with the requirements of the national energy efficiency of buildings regulation in force (KENAK) and the technical characteristics concerning their external structural elements, as well as their electrical and mechanical installations were examined: heating, cooling, ventilation and lighting. Within the current project an initial energy audit has already taken place, and an updated EPC will be issued at the next stage of the preparation of the feasibility study. The following Table summarises the key technical and energy features.

Table 17: Key technical and energy features of Junior Highschool of Stavros

Construction year	1997
Use	Secondary Education
Address	Stavros 57014
Total Floor area (m^2)	2.199
Total Building Volume (m^3)	7.036,80
Heated Floor area (m^2)	2.094
Heated Building Volume (m^3)	6.700,80
Number of Floors	2
Building Energy Efficiency Class	Energy Class E
EPC Number	-
Estimated annual Primary energy consumption (kWh/m^2)	224,1
Estimated annual CO_2 emissions (kg/m^2)	49,3
Heating system	Water Boiler
Heating System - Fuel	Natural Gas
Heating system - Installed Power (kW)	350
Heating system - Efficiency Rating	89,85
Cooling system	None
Cooling System - Installed Power (kW)	-
Cooling System - Efficiency Rating	-
Small scale Renovation	No
Radical Renovation	No
Number of permanent users on a daily basis	320
Average number of visitors on a daily basis	-
Existence of Energy Management System (i.e. ISO 50001)	No
Type of RES system installed in the building	No
Estimated annual heating oil consumption (KWh)	-
Annual natural gas consumption (KWh)	339.058
Estimated annual power consumption (KWh)	35.480

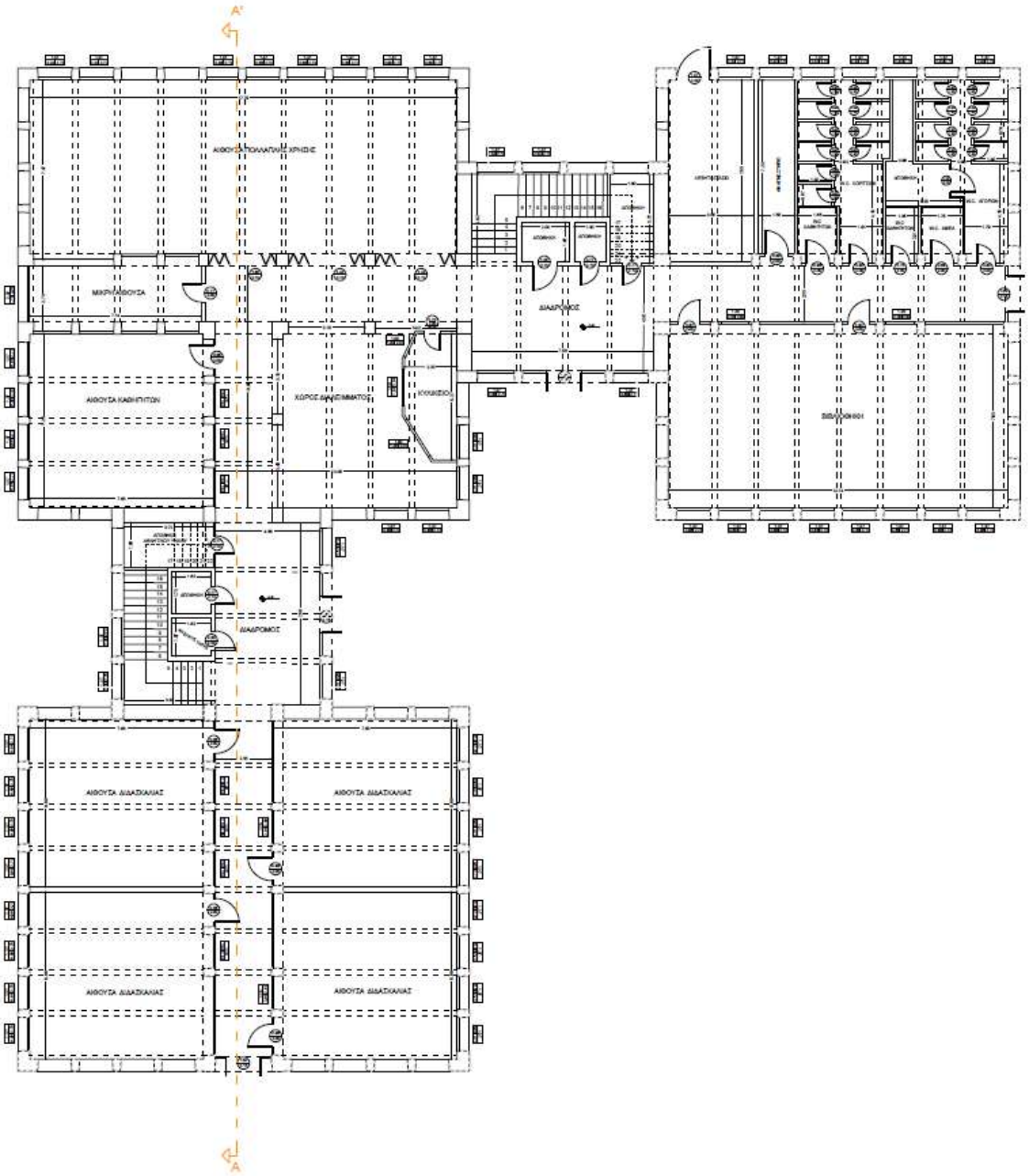


Figure 16: Ground floor plan view

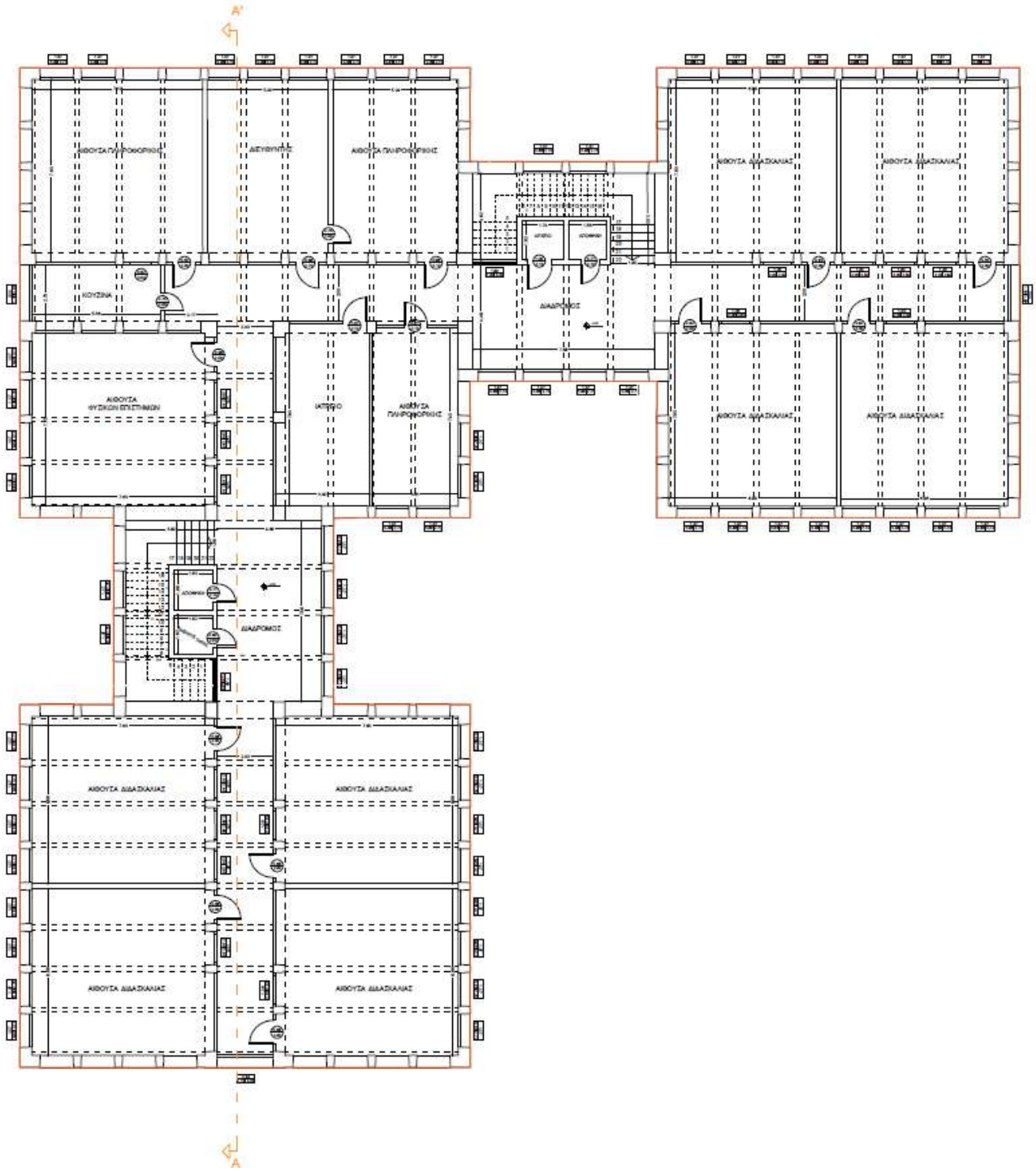


Figure 17: 1st floor plan view

Proposed energy upgrade interventions

Following the completion of the energy audits of the **Arnea High School** and the **Junior Highschool of Stavros**, and the assessment of the buildings' energy performance, a series of energy upgrade scenarios were developed for both the **buildings' envelope** and their **electromechanical systems**. These scenarios included mild, medium, and extensive interventions across a range of cost levels.

Based on the current condition and operational characteristics of the school complex, the following set of interventions was identified as the most effective in terms of **energy savings** and **payback period**:

- Installation of thermal insulation on vertical external structural elements.
- Installation of insulation on horizontal slab and/or sloping tiled roofs.
- Replacement of existing openings with certified PVC-framed double glazing.
- Replacement of existing boilers with high-efficiency heat pumps of lower heating output.
- Replacement of existing circulators with new high-efficiency variable-flow.
- Repair and insulation of the thermal distribution network.
- Replacement of existing radiators with new panel-type radiators.
- Replacement of existing fluorescent lights with LED. Installation of presence detectors.

Thermal Insulation of Walls and Roofs

General Considerations

The thermal capacity of the buildings' envelopes and the installation of appropriate thermal insulation play a decisive role in the overall thermal behavior of the buildings. In climates where heating demand is significant, thermal protection of the envelope—ensuring stable and elevated interior surface temperatures—is a prerequisite for achieving high energy efficiency and ensuring thermal comfort.

When cooling is the predominant concern, the presence of adequate thermal mass can contribute to reduced energy consumption, provided that the building is unoccupied during late-afternoon hours and accumulated heat can be released.

Thermal insulation of the building envelope aims to reduce heat transfer through external surfaces, achieving:

- Reduction of energy consumption for heating during the winter period.
- Improvement of indoor thermal comfort, especially in teaching spaces.
- Maintenance of internal surface temperatures above dew point to prevent surface condensation.

Specific Considerations for School Buildings

School buildings constitute a distinct typology due to:

1. Intermittent operation, which may favour internal insulation for faster thermal response and improved efficiency (only at the cases where it is technically feasible).
2. High requirements for thermal comfort and air quality, intensified by student occupancy and frequent natural ventilation during breaks.
3. Seasonal overheating, observed during transitional periods (April–May, September–October).

Proposed Interventions

A certified **External Thermal Insulation Composite System (ETICS)** will be installed to reduce thermal losses, improve comfort, and enhance the building façade. The proposed system includes:

- Rock wool boards, 100 mm thick (λ_D = 0.033-0.034 W/mK), applied to external walls.
- Extruded polystyrene insulation, 100 mm thick (λ_D < 0.033 W/mK), installed on the reinforced concrete slab beneath the tiled or horizontal roof.

The use of rock wool offers multiple benefits compared to polystyrene systems:

- Enhanced fire protection.
- Improved acoustic insulation.
- High vapour permeability and moisture regulation.
- Increased thermal inertia, improving summer performance by delaying heat transfer.
- Reduced risk of building-pathology phenomena (carbonation, corrosion, mold growth).
- Long-term dimensional stability, contributing to reduced façade-maintenance requirements.

Replacement of Frames and Glazings

Existing Condition

A considerable percentage of both buildings' envelope consists of openings. Current frames are aluminum without thermal break and with double glazing exhibiting poor airtightness. Several windows on the ground and first floors also include security railings.

According to the Energy Efficiency of Buildings Regulation, the maximum permissible thermal transmittance values U_w are as follows:

Structural Element	**Uw [W/(m²k)]**
Opening frame (with glazing)	2,4
Opening frame (without glazing)	2,4
Glass façade (non-opening or partially opening)	1,75

Proposed Intervention

To improve energy performance and thermal comfort, all existing frames will be replaced with PVC frames with thermal break and high energy performance.

Key specifications:

- Total frame thermal transmittance: Uw ≤ 2.0 W/(m²·K), below the permitted Umax = 2.4 W/(m²·K).
- Capacity to accommodate 40-mm double glazing.
- Glazing configuration: 4 mm + 4 mm laminated low-e exterior pane, 16 mm argon-filled cavity (90% argon), and 4 mm + 4 mm laminated interior pane.
- Glass thermal transmittance: Ug ≤ 2.4 W/(m²·K).
- Installation of airtight gaskets and silicone sealing. Ensuring air tightness, Class 4.

Certification Requirements. Frames and glazing must comply with:

- Regulation (EU) 305/2011 – Construction Products Regulation.
- ELOT EN 14351-1 – Performance of windows and doors.
- ELOT EN 12207 / 12208 / 12210 – Air permeability, watertightness, wind-load resistance
- QUALICOAT coating certification.
- Anti-burglary protection: Class WK2.
- The manufacturer/installer must hold CE certification.

Additional Notes

- Final RAL color will be determined by the Contracting Authorities (Municipalities).
- Existing railings will be removed and reinstalled; repairs and repainting will be carried out as required.

Heating Systems

Existing Condition

Heating is currently provided by:

- Highschool of Arnea: outdated oil-fired burner–boiler system.
- Junior highschool of Stavros: relatively new natural gas boiler system.

The reduced heating demand resulting from the envelope improvements at both buildings renders the existing systems both inefficient and oversized.

Proposed Interventions

The following actions are proposed:

- Dismantling of the existing burner–boiler units.
- Installation of air-to-water heat pumps with lower heating capacity and higher efficiency
- Replacement of existing radiators with panel-type radiators designed for the new thermal loads.
- Retention of the existing two-pipe distribution network, with installation of thermostatic radiator valves.
- Integration of an inertia tank, allowing optional operation of the existing systems as backup.

Circulators and Pipe Insulation

- Replacement of existing circulators with inverter-type high-efficiency circulators with automatic speed control (Δp-c, Δp-v, Δp-T)
- Insulation of distribution pipes using closed-cell synthetic rubber with λ < 0.037 W/mK (10°C) and λ < 0.04 W/mK (40°C), fire class 1 per BS 476 Part 7.
- Additional 0.6-mm aluminum sheathing for insulation in mechanical rooms or exposed areas.

Lighting Systems

A comprehensive replacement of the lighting system is proposed:

- Installation of new LED luminaires with >50,000 h lifespan.
- LED fixtures for all entrances and outdoor spaces.
- Replacement of lamps in auxiliary areas (WC, storage rooms) with LED lamps.
- Surface-mounted installation throughout.

To comply with lighting-control requirements:

- Spaces over 15 m² will be fitted with multiple lighting circuits.
- Presence sensors will be installed in intermittently occupied areas such as toilets, corridors, and auxiliary rooms.

Photovoltaic Panels

Solar energy constitutes an inexhaustible and clean energy source. Once installed, photovoltaic systems operate without fuel costs and without exposure to energy-price fluctuations, while reducing greenhouse-gas emissions associated with fossil-fuel use.

The building of the Arnea High School is already equipped with **photovoltaic panels of 10 kW capacity**, installed in previous years, which will contribute significantly to covering electricity consumption for lighting and heating/cooling loads.

As far as the Junior high school of Stavros is concerned the installation of a 10 KW photovoltaic station combined with a battery storage system will be examined at the final stage of the feasibility study.

1.7 Techno-economic analysis and evaluation

This chapter includes the description of the methodology for the techno-economic analysis and evaluation of the proposed energy-upgrade interventions in the two municipal buildings and the presentation of the results of their financial macroeconomic evaluation.

Methodology

According to the template Guide for the Energy Performance Plan of Regions and Municipalities (Ministry of Environment – Energy), the macroeconomic analysis is carried out by taking into account the social benefit of the project (macroeconomic approach) and is performed over a time horizon of 25 years.

The methodology selected for the preparation of the techno-economic study is Methodology Type B. It was formulated based on the standard of the Ministry of Environment & Energy and CRES (Center for Renewable Energy Sources) as well as on the available data of the buildings of both Municipalities, especially as the interventions costs are concerned. This methodology has been chosen to analyse the municipal buildings and to compare the economic evaluation indicators of the energy-upgrade scenarios on a common reference basis so that comparative evaluation is reliable.

Under the Type B methodology, the percentage of energy savings results from the Energy Performance Certificates (EPCs), taking into account the difference achieved through the interventions of the final energy-upgrade scenario. Likewise, the budget draws data from the initial investment cost of the final scenario, as calculated in the EPCs.

Economic Analysis of Energy-Saving Projects

Investing in energy-efficient projects and services can reduce operating and maintenance costs, further improve the environment, avoid substantial burdens, and ultimately provide positive financial outcomes for each municipality. These savings translate into reduced expenses and the freeing of significant resources that can be allocated to other projects. The variables evaluated in this chapter concern direct and indirect energy savings and capital cost savings.

Direct Energy Savings

Energy saving, broadly defined, means achieving the same results in municipal buildings at lower cost. An energy-efficient service or structure uses less energy to provide the same level of service compared to a conventional one. Energy-upgrade projects that produce direct energy savings—i.e., a reduction in actual outputs—include:

- Replacement or support of heating/cooling systems using conventional fuel with systems that use renewable energy sources.
- Replacement of heating/cooling systems with others of higher energy efficiency.
- Improving the operating conditions of systems.
- Reducing energy requirements of building units.
- Enhancement of indoor environmental quality for building occupants, especially for the school students.

Indirect Energy Savings

Direct energy savings in a final use may lead to indirect savings due to interactive effects between end-uses. When the opposite occurs—meaning indirect savings fail to support direct ones—the results of direct-saving interventions may be less desirable. Projects producing indirect energy savings include:

- Replacing lighting systems in parallel with cooling systems, leading to further reduction of cooling loads.
- Installation of mechanical ventilation systems (not applicable).
- Installation of automation and smart-management systems.
- Installation of adequate building-envelope insulation.

Capital Cost Savings

The additional cost of efficient energy systems must be offset by the lower capital cost of smaller systems. Examples include:

- Replacing an oversized boiler with a more efficient one combined with operational time compensation or replacing it with a central heat pump of lower capacity.
- Installation of efficient lighting systems resulting in equipment replacement, increased lifespan, and reduced maintenance costs.

Variables of Macroeconomic Analysis

Discount Rate

The discount rate represents how future cash flows (from energy savings) relate to present values. It determines the reduction factor applied to future amounts to express them in today's terms. The discount rate for each building included in this plan is set at **6,0%**.

Annual Change in Energy Prices

The annual change in energy prices is a forecast scenario based on recorded price variations after the base year 2025. The annual change in energy prices is set at **1,5%** after the base year.

Inflation

Inflation is factored into the yearly rise of other expenses such as operational and maintenance costs after the base year 2025. The annual rate of inflation is set **1,5%**.

Unit Cost of Oil

The unit cost of oil refers to the cost in euros per kWh of oil-based energy, adjusted to the 2025 base year. The unit cost for the base year is: **0,14 €/kWh**

Unit Cost of Natural Gas

The unit cost of natural gas refers to the cost in euros per kWh of natural-gas energy, adjusted to the 2025 base year. The unit cost for the base year is: **0,115 €/kWh**

Unit Cost of Electricity

The unit cost of electricity refers to the cost in euros per kWh of electricity, adjusted to the 2025 base year. The unit cost for the base year is: **0,19 €/kWh**

Investment Evaluation Years

These years represent the time horizon for assessing the benefits of the investment. For each building, the investment evaluation period is set at **25 years**.

Initial or Capital Cost

The capital cost refers to the estimated initial investment cost considering a subsidy rate of 60%. For the building-upgrade studies, the full cost is calculated at year zero (project start) rather than being distributed across years. Since the costs have not been calculated at detail at the current stage of the project, an estimated rate of **606 €/ m^2** of heated area was foreseen. This rate derived as an average from similar project studies.

Emission Trading Price

The National Energy and Climate Plan (NECP) defines the cost of emitted pollutants in [€2016/ton CO_2-eq]. Using linear interpolation, the emission-trading values for each evaluation year are derived. However, since the current price of **€0,065/kg CO_2** differs from the predefined price for 2025 (**€0,030108/kg CO_2**), it was decided to use the updated price, adjusted annually according to the change in energy prices (1.5%).

Quantification of Non-Energy Benefit

This concerns identifying non-energy benefits resulting from implementing the investment. For this project, this variable is not taken into account directly, but its interpretation is included in the prioritization-model parameters and variable weighting.

Indicators of Macroeconomic Analysis

The indicators used for the macroeconomic analysis of all buildings in this plan are described below.

Simple Payback Period of Investment

The simple payback period determines the time required for energy savings to repay the initial investment cost. It does not account for system lifetime, alternative investment costs, or the time value of money.

Return on Investment (ROI)

ROI takes into account the effective service life of the project. It measures the return as the ratio of total energy-saving outputs to the initial capital cost.

Internal Rate of Return (IRR)

IRR helps evaluate the performance of investment scenarios based on a discount rate that equates annual cash flows (after taxes and other factors) with the scenario's net present value. In this project—entirely energy-related—cash flows consist of total energy savings, including changes in energy prices, operating and maintenance costs, and environmental benefits from reduced emissions.

Net Present Value (NPV)

NPV accounts for significant investment-related variables and frequently leads to better investment decisions. It measures the increase in investment value based on the required rate of return set by the organization (the Municipality), considering project duration and risk associated with each variable.

Ratio of Initial Investment Cost to Payback Period

Examining this ratio allows evaluation of the weighting of quantitative variables among the selected buildings, after adding more variables to the prioritization function. Neither the estimated initial investment nor the payback period alone determine building selection. Instead, qualitative criteria such as project-readiness, emission-reduction potential, number of users, and promoting environmental awareness have greater importance.

Emission Factors

Emission factors per energy carrier are shown in the following table:

Table 18: Emission factors per energy carrier

Energy Carrier	Emissions per Unit of Energy (kg CO_2/kWh)
Natural gas	0,216
Heating oil	0,260
Electricity	0,368
LPG	0,238
Biomass	—
District heating (from PPC)	0,347

1.1.

Financial Analysis of Energy Upgrade Scenarios

In this chapter, the financial approach follows in time horizon as it results from the energy study of each building separately. The main cash flows included are: the initial investment cost, which includes all costs up to the time the building is delivered for use, including all costs related to the proper execution of the necessary measures according to their specifications. The net benefit of the energy sector is also taken into account operating costs per energy carrier

The following summary table presents the final energy-upgrade scenarios for each municipal building, along with their corresponding macroeconomic evaluation indicators, in accordance with the methodology described in the previous sections. From the analysis of the scenarios, it emerges that both buildings are upgraded to Energy Class B+ whereas the macroeconomic indicators assuming a minimum funding of 60% are very satisfactory.

It must be noted that the macroeconomic analysis cannot quantify additional advantages such as the restoration of both buildings, the improvement of internal environment and air quality conditions for both students and educators (thermal comfort included) , the enhancement of daylight and visual comfort etc.

Table 19: Variables of Macroeconomic Analysis

Discount Rate	6,00%
Annual Energy Price Change	1,50%
Inflation	1,50%
Oil Cost [€/kWh]	0,1400
Natural Gas Cost [€/kWh]	0,1150
Electricity Cost without Photovoltaic [€/kWh]	0,1900
Electricity Cost with Photovoltaic – Net Metering [€/kWh]	0,1200
Evaluation Period (Years)	25

Table 20: Macroeconomic Analysis Indicators for Energy Upgrade of the Highschool of Arnea

Internal Rate of Return (IRR)	**28,72%**
Present Value of Costs	**758.310 €**
Present Value of Benefits	**2.411.040 €**
Benefit/Cost Ratio (BCR)	**3,18**
Payback Period	**4,60**
Discounted Payback Period (DPBP)	**5,35**
N.P.V.	**1.652.731 €**

Table 21: Macroeconomic Analysis Indicators for Energy Upgrade of the Junior Highschool of Stavros

Internal Rate of Return (IRR)	**23,29%**
Present Value of Costs	**507.586 €**
Present Value of Benefits	**1.362.439 €**
Benefit/Cost Ratio (BCR)	**2,68**
Payback Period	**5,45**
Discounted Payback Period (DPBP)	**6,49**
N.P.V.	**854.854 €**

Table 22: Macroeconomic Analysis Indicators for Energy Upgrade Scenarios of Municipal Buildings

Building	Energy Upgrade Class	Investment Cost with subsiby	Internal Rate of Return	Ratio of Benefit to Cost	Simple Payback Period	Discounted Payback Period	Net Present Value
	-	(€)	(%)	-	(yr)	(yr)	(€)
Highschool of Arnea	B+	758.309,62 €	28,72%	3,18	4,60	5,35	1.652.731 €
Junior Highschool of Stavros	B+	507.585,60 €	23,29%	2,68	5,45	6,49	854.854 €

Table 23: Macroeconomic Analysis for Energy Upgrade of the Highschool of Arnea – Annual Flows

COSTS Categories	Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Inverstment Cost																										
	Inverstment Cost with subsidy	758.309,62 €																								
Annual Energy Consumption of Existing Situation Per Fuel																										
	Heating Oil	679.259 kWh	679.259 kWh	679.259 kWh	679.259 kWh	679.259 kWh	679.259 kWh	679.259 kWh	679.259 kWh	679.259 kWh	679.259 kWh	679.259 kWh	679.259 kWh	679.259 kWh	679.259 kWh	679.259 kWh	679.259 kWh	679.259 kWh	679.259 kWh	679.259 kWh	679.259 kWh	679.259 kWh	679.259 kWh	679.259 kWh	679.259 kWh	679.259 kWh
	Natural Gas		0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh
	Electricity	158.203 kWh	158.203 kWh	158.203 kWh	158.203 kWh	158.203 kWh	158.203 kWh	158.203 kWh	158.203 kWh	158.203 kWh	158.203 kWh	158.203 kWh	158.203 kWh	158.203 kWh	158.203 kWh	158.203 kWh	158.203 kWh	158.203 kWh	158.203 kWh	158.203 kWh	158.203 kWh	158.203 kWh	158.203 kWh	158.203 kWh	158.203 kWh	158.203 kWh
	Biomass		0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh
	District Heating from PPC		0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh
Energy Cost - Existing Situation																										
	Energy Cost	125.154,83	125.154,83	125.154,83	125.154,83	125.154,83	125.154,83	125.154,83	125.154,83	125.154,83	125.154,83	125.154,83	125.154,83	125.154,83	125.154,83	125.154,83	125.154,83	125.154,83	125.154,83	125.154,83	125.154,83	125.154,83	125.154,83	125.154,83	125.154,83	125.154,83
	Annual Operating Cost		0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
	Annual Maintenance Cost	500,00	507,50	515,11	522,84	530,68	538,64	546,72	554,92	563,25	571,69	580,27	588,97	597,81	606,78	615,88	625,12	634,49	644,01	653,67	663,48	673,43	683,53	693,78	704,19	714,75
	Annual Emissions Cost	15.440,30	15.671,90	15.906,98	16.145,59	16.387,77	16.633,59	16.883,09	17.136,34	17.393,38	17.654,28	17.919,10	18.187,89	18.460,70	18.737,61	19.018,68	19.303,96	19.593,52	19.887,42	20.185,73	20.488,52	20.795,85	21.107,78	21.424,40	21.745,77	22.071,95
Annual Energy Consumption after Energy Efficiency Upgrade																										
	Heating Oil	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh
	Natural Gas		0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh
	Electricity	251.239 kWh	251.239 kWh	251.239 kWh	251.239 kWh	251.239 kWh	251.239 kWh	251.239 kWh	251.239 kWh	251.239 kWh	251.239 kWh	251.239 kWh	251.239 kWh	251.239 kWh	251.239 kWh	251.239 kWh	251.239 kWh	251.239 kWh	251.239 kWh	251.239 kWh	251.239 kWh	251.239 kWh	251.239 kWh	251.239 kWh	251.239 kWh	251.239 kWh
	Biomass		0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh
	District Heating from PPC		0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh
Energy Cost after Energy Efficiency Upgrade																										
	Energy Cost	47.735,33 €	47.735,33 €	47.735,33 €	47.735,33 €	47.735,33 €	47.735,33 €	47.735,33 €	47.735,33 €	47.735,33 €	47.735,33 €	47.735,33 €	47.735,33 €	47.735,33 €	47.735,33 €	47.735,33 €	47.735,33 €	47.735,33 €	47.735,33 €	47.735,33 €	47.735,33 €	47.735,33 €	47.735,33 €	47.735,33 €	47.735,33 €	47.735,33 €
	Annual Operating Cost		0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €
	Annual Maintenance Cost		0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €
	Annual Emissions Cost	6.009,63 €	6.099,77 €	6.191,27 €	6.284,14 €	6.378,40 €	6.474,08 €	6.571,19 €	6.669,75 €	6.769,80 €	6.871,35 €	6.974,42 €	7.079,03 €	7.185,22 €	7.293,00 €	7.402,39 €	7.513,43 €	7.626,13 €	7.740,52 €	7.856,63 €	7.974,48 €	8.094,10 €	8.215,51 €	8.338,74 €	8.463,82 €	8.590,78 €
Total Cash Flows		758.309,62 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €

Benefits Categories		Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21	Year 22	Year 23	Year 24
Financial and Macroeconomic Benefits																										
	Residual Value																									
	Energy Savings	77.419,50 €	77.419,50 €	77.419,50 €	77.419,50 €	77.419,50 €	77.419,50 €	77.419,50 €	77.419,50 €	77.419,50 €	77.419,50 €	77.419,50 €	77.419,50 €	77.419,50 €	77.419,50 €	77.419,50 €	77.419,50 €	77.419,50 €	77.419,50 €	77.419,50 €	77.419,50 €	77.419,50 €	77.419,50 €	77.419,50 €	77.419,50 €	77.419,50 €
	Energy Savings Considering Energy Price Increases	77.419,50 €	78.580,79 €	79.759,50 €	80.955,89 €	82.170,23 €	83.402,78 €	84.653,83 €	85.923,63 €	87.212,49 €	88.520,68 €	89.848,49 €	91.196,21 €	92.564,16 €	93.952,62 €	95.361,91 €	96.792,34 €	98.244,22 €	99.717,88 €	101.213,65 €	102.731,86 €	104.272,84 €	105.836,93 €	107.424,48 €	109.035,85 €	110.671,39 €
	Difference Between Operating Cost and Maintenance Cost	500,00 €	507,50 €	515,11 €	522,84 €	530,68 €	538,64 €	546,72 €	554,92 €	563,25 €	571,69 €	580,27 €	588,97 €	597,81 €	606,78 €	615,88 €	625,12 €	634,49 €	644,01 €	653,67 €	663,48 €	673,43 €	683,53 €	693,78 €	704,19 €	714,75 €
	Difference in Emissions Cost	9.430,67 €	9.572,13 €	9.715,71 €	9.861,45 €	10.009,37 €	10.159,51 €	10.311,91 €	10.466,58 €	10.623,58 €	10.782,94 €	10.944,68 €	11.108,85 €	11.275,48 €	11.444,62 €	11.616,29 €	11.790,53 €	11.967,39 €	12.146,90 €	12.329,10 €	12.514,04 €	12.701,75 €	12.892,28 €	13.085,66 €	13.281,94 €	13.481,17 €
	Annual Benefit from Other Externalities – Non-Energy Benefits		0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €
	Annual Benefit from Increased Domestic Added Value		0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €
Total Cash Flows		164.769,66 €	166.079,92 €	167.409,82 €	168.759,68 €	170.129,78 €	171.520,44 €	172.931,95 €	174.364,64 €	175.818,81 €	177.294,80 €	178.792,93 €	180.313,53 €	181.856,95 €	183.423,51 €	185.013,57 €	186.627,48 €	188.265,60 €	189.928,29 €	191.615,92 €	193.328,87 €	195.067,51 €	196.832,23 €	198.623,42 €	200.441,48 €	202.286,81 €

Net Cash Flows	-593.539,95 €	166.079,92 €	167.409,82 €	168.759,68 €	170.129,78 €	171.520,44 €	172.931,95 €	174.364,64 €	175.818,81 €	177.294,80 €	178.792,93 €	180.313,53 €	181.856,95 €	183.423,51 €	185.013,57 €	186.627,48 €	188.265,60 €	189.928,29 €	191.615,92 €	193.328,87 €	195.067,51 €	196.832,23 €	198.623,42 €	200.441,48 €	202.286,81 €
Cumulative Net Cash Flows	-593.539,95 €	-427.460,03 €	-260.050,21 €	-91.290,53 €	78.839,25 €	250.359,69 €	423.291,64 €	597.656,27 €	773.475,09 €	950.769,89 €	1.129.562,82 €	1.309.876,36 €	1.491.733,30 €	1.675.156,81 €	1.860.170,38 €	2.046.797,85 €	2.235.063,45 €	2.424.991,74 €	2.616.607,66 €	2.809.936,53 €	3.005.004,04 €	3.201.836,27 €	3.400.459,69 €	3.600.901,17 €	3.803.187,97 €
Positive Net Outflow?	FALSE	FALSE	FALSE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE

Table 24: Macroeconomic Analysis for Energy Upgrade of the Junior Highschool of Stavros – Annual Flows

COSTS Categories	Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Inverstment Cost																										
	Inverstment Cost with subsidy	507.585,60 €																								
Annual Energy Consumption of Existing Situation Per Fuel																										
	Heating Oil	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh
	Natural Gas	339.058 kWh	339.058 kWh	339.058 kWh	339.058 kWh	339.058 kWh	339.058 kWh	339.058 kWh	339.058 kWh	339.058 kWh	339.058 kWh	339.058 kWh	339.058 kWh	339.058 kWh	339.058 kWh	339.058 kWh	339.058 kWh	339.058 kWh	339.058 kWh	339.058 kWh	339.058 kWh	339.058 kWh	339.058 kWh	339.058 kWh	339.058 kWh	339.058 kWh
	Electricity	35.480 kWh	35.480 kWh	35.480 kWh	35.480 kWh	35.480 kWh	35.480 kWh	35.480 kWh	35.480 kWh	35.480 kWh	35.480 kWh	35.480 kWh	35.480 kWh	35.480 kWh	35.480 kWh	35.480 kWh	35.480 kWh	35.480 kWh	35.480 kWh	35.480 kWh	35.480 kWh	35.480 kWh	35.480 kWh	35.480 kWh	35.480 kWh	35.480 kWh
	Biomass		0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh
	District Heating from PPC		0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh
Energy Cost - Existing Situation																										
	Energy Cost	45.732,87	45.732,87	45.732,87	45.732,87	45.732,87	45.732,87	45.732,87	45.732,87	45.732,87	45.732,87	45.732,87	45.732,87	45.732,87	45.732,87	45.732,87	45.732,87	45.732,87	45.732,87	45.732,87	45.732,87	45.732,87	45.732,87	45.732,87	45.732,87	45.732,87
	Annual Operating Cost		0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
	Annual Maintenance Cost	500,00	507,50	515,11	522,84	530,68	538,64	546,72	554,92	563,25	571,69	580,27	588,97	597,81	606,78	615,88	625,12	634,49	644,01	653,67	663,48	673,43	683,53	693,78	704,19	714,75
	Annual Emissions Cost	5.168,28	5.245,80	5.324,49	5.404,36	5.485,42	5.567,71	5.651,22	5.735,99	5.822,03	5.909,36	5.998,00	6.087,97	6.179,29	6.271,98	6.366,06	6.461,55	6.558,47	6.656,85	6.756,70	6.858,05	6.960,92	7.065,34	7.171,32	7.278,89	7.388,07
Annual Energy Consumption after Energy Efficiency Upgrade																										
	Heating Oil	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh
	Natural Gas		0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh
	Electricity	9.934 kWh	9.934 kWh	9.934 kWh	9.934 kWh	9.934 kWh	9.934 kWh	9.934 kWh	9.934 kWh	9.934 kWh	9.934 kWh	9.934 kWh	9.934 kWh	9.934 kWh	9.934 kWh	9.934 kWh	9.934 kWh	9.934 kWh	9.934 kWh	9.934 kWh	9.934 kWh	9.934 kWh	9.934 kWh	9.934 kWh	9.934 kWh	9.934 kWh
	Biomass		0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh
	District Heating from PPC		0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh	0 kWh
Energy Cost after Energy Efficiency Upgrade																										
	Energy Cost	1.887,54 €	1.887,54 €	1.887,54 €	1.887,54 €	1.887,54 €	1.887,54 €	1.887,54 €	1.887,54 €	1.887,54 €	1.887,54 €	1.887,54 €	1.887,54 €	1.887,54 €	1.887,54 €	1.887,54 €	1.887,54 €	1.887,54 €	1.887,54 €	1.887,54 €	1.887,54 €	1.887,54 €	1.887,54 €	1.887,54 €	1.887,54 €	1.887,54 €
	Annual Operating Cost		0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €
	Annual Maintenance Cost		0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €
	Annual Emissions Cost	237,63 €	241,20 €	244,81 €	248,49 €	252,21 €	256,00 €	259,84 €	263,73 €	267,69 €	271,70 €	275,78 €	279,92 €	284,12 €	288,38 €	292,70 €	297,09 €	301,55 €	306,07 €	310,66 €	315,32 €	320,05 €	324,86 €	329,73 €	334,67 €	339,69 €
Total Cash Flows		507.585,60 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €

Benefits Categories		Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21	Year 22	Year 23	Year 24
Financial and Macroeconomic Benefits																										
	Residual Value																									
	Energy Savings	43.845,33 €	43.845,33 €	43.845,33 €	43.845,33 €	43.845,33 €	43.845,33 €	43.845,33 €	43.845,33 €	43.845,33 €	43.845,33 €	43.845,33 €	43.845,33 €	43.845,33 €	43.845,33 €	43.845,33 €	43.845,33 €	43.845,33 €	43.845,33 €	43.845,33 €	43.845,33 €	43.845,33 €	43.845,33 €	43.845,33 €	43.845,33 €	43.845,33 €	43.845,33 €
	Energy Savings Considering Energy Price Increases	43.845,33 €	44.503,01 €	45.170,56 €	45.848,12 €	46.535,84 €	47.233,88 €	47.942,39 €	48.661,52 €	49.391,44 €	50.132,32 €	50.884,30 €	51.647,56 €	52.422,28 €	53.208,61 €	54.006,74 €	54.816,84 €	55.639,10 €	56.473,68 €	57.320,79 €	58.180,60 €	59.053,31 €	59.939,11 €	60.838,19 €	61.750,77 €	62.677,03 €
	Difference Between Operating Cost and Maintenance Cost	500,00 €	507,50 €	515,11 €	522,84 €	530,68 €	538,64 €	546,72 €	554,92 €	563,25 €	571,69 €	580,27 €	588,97 €	597,81 €	606,78 €	615,88 €	625,12 €	634,49 €	644,01 €	653,67 €	663,48 €	673,43 €	683,53 €	693,78 €	704,19 €	714,75 €
	Difference in Emissions Cost	4.930,65 €	5.004,61 €	5.079,68 €	5.155,87 €	5.233,21 €	5.311,71 €	5.391,39 €	5.472,26 €	5.554,34 €	5.637,66 €	5.722,22 €	5.808,05 €	5.895,17 €	5.983,60 €	6.073,36 €	6.164,46 €	6.256,92 €	6.350,78 €	6.446,04 €	6.542,73 €	6.640,87 €	6.740,48 €	6.841,59 €	6.944,21 €	7.048,38 €
	Annual Benefit from Other Externalities – Non-Energy Benefits		0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €
	Annual Benefit from Increased Domestic Added Value		0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €
Total Cash Flows		93.121,32 €	93.860,46 €	94.610,68 €	95.372,16 €	96.145,07 €	96.929,56 €	97.725,83 €	98.534,03 €	99.354,36 €	100.187,00 €	101.032,12 €	101.889,93 €	102.760,60 €	103.644,32 €	104.541,31 €	105.451,75 €	106.375,85 €	107.313,80 €	108.265,83 €	109.232,14 €	110.212,94 €	111.208,45 €	112.218,90 €	113.244,50 €	114.285,49 €

Net Cash Flows	-414.464,28 €	93.860,46 €	94.610,68 €	95.372,16 €	96.145,07 €	96.929,56 €	97.725,83 €	98.534,03 €	99.354,36 €	100.187,00 €	101.032,12 €	101.889,93 €	102.760,60 €	103.644,32 €	104.541,31 €	105.451,75 €	106.375,85 €	107.313,80 €	108.265,83 €	109.232,14 €	110.212,94 €	111.208,45 €	112.218,90 €	113.244,50 €	114.285,49 €
Cumulative Net Cash Flows	-414.464,28 €	-320.603,82 €	-225.993,14 €	-130.620,98 €	-34.475,91 €	62.453,65 €	160.179,48 €	258.713,51 €	358.067,88 €	458.254,88 €	559.287,00 €	661.176,93 €	763.937,53 €	867.581,85 €	972.123,16 €	1.077.574,91 €	1.183.950,75 €	1.291.264,56 €	1.399.530,39 €	1.508.762,52 €	1.618.975,46 €	1.730.183,92 €	1.842.402,82 €	1.955.647,32 €	2.069.932,81 €
Positive Net Outflow?	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE

1.8 Funding mechanisms

Booth the Municipalities of Volvi and Aristotelis, within the framework of their strategy for the energy upgrading of their public buildings, are oriented toward utilizing three main funding programs: *Phoebus*, *Electra*, and *Athena*. These programs enable the implementation of energy-saving and energy efficiency improvement projects, focusing on school infrastructures and administration buildings, according to the priorities set in the energy efficiency plans.

The ***Phoebus Program***[1] concerns the energy upgrading of daycare centers, nurseries, and kindergartens. Its goal is to improve energy efficiency and reduce the energy footprint, particularly in buildings serving young children. Eligible buildings must have been constructed before 2000, not have undergone previous major energy renovation, and belong to energy categories E, F, or G. The program aims to reduce primary energy consumption by at least 30% and to correspondingly reduce carbon dioxide emissions. Implementation focuses on interventions such as building envelope insulation, window replacement, heating and cooling system upgrades, and the integration of modern energy-saving technologies.

The total budget of the first call of the *Phoebus Program* amounted €10 million and covered 100% of the eligible public expenditure. The call was open from January to December 2025, while applications were submitted electronically through the information system. Timely preparation by the Municipality's technical department is a prerequisite to ensure compliance with eligibility criteria and to avoid delays.

The ***Athena Program*** focuses on the energy upgrading of kindergartens and primary schools. The program is designed to support educational facilities by ensuring improved energy efficiency and energy savings. Eligible buildings must have been constructed before 2000, belong to energy categories E, F, or G, and not have undergone major energy renovations. Interventions include insulation, window replacement, heating and cooling system upgrades, incorporation of RES and ensuring accessibility for people with disabilities.

The total budget of the first call of the program amounted €30 million, of which €10 million was allocated to kindergartens and €20 million to primary schools. The program covers 100% of eligible expenses. Applications are evaluated based on energy performance, degree-day data, and other technical criteria. Program implementation extends until December 2026, while the applications of the initial call have been submitted electronically, accompanied by full documentation such as technical studies, EPCs, and other supporting documents. The program offers significant opportunities to improve the energy performance of school units, promoting both environmental sustainability and comfort in educational facilities.

The *Electra Program*[2] constitutes the largest initiative for the energy upgrading of public buildings, aiming to increase energy efficiency and achieve at least energy category B. The program targets the reduction of the energy footprint of public buildings, including school and administrative facilities. Eligible buildings must have been constructed before 2000, belong to categories C to G, and not have undergone a major energy renovation.

The interventions include building envelope insulation, upgrading of heating and cooling systems, integration of renewable energy sources, and installation of modern energy management systems. Automation systems are also planned to improve energy management. The total budget of the program's first call amounted to €640 million, with expected leverage up to €1 billion. The funding rate ranges from 50% to 70% of total expenditure, depending on the objectives achieved, such as upgrading to energy category B+ or complete renovation.

Program completion is expected by 2026, with the goal of reducing electricity consumption by 600 GWh and upgrading 2.5 million square meters of public buildings. The integration process includes submitting a

[1] https://exoikonomo-scholeia.gov.gr/go-beyond/
[2] https://hlektra.gov.gr/home

dossier with technical studies, Energy Performance Certificates (EPCs), and other documentation. Applications are evaluated based on financial feasibility and energy performance. The Municipality of Aristotle has already submitted to Electra proposal and technical studies for the energy upgrade of schools.

In addition to the above programs, both Municipalities may also consider utilizing the European financial instruments ELENA, JESSICA and European Energy Efficiency Fund).

ELENA[3] (European Local Energy Assistance) is a European financial instrument that aims to provide technical assistance to regional and local authorities in order to accelerate their investment programs in the fields of energy efficiency, renewable energy sources, and sustainable transport. ELENA finances only technical support, covering up to 90% of the activities required for project development and maturity. The investment programs themselves must be implemented through other financial mechanisms, such as loans, own resources, structural funds, etc. The investment programs that can be supported by ELENA include:

- Investments to increase energy efficiency in public and private buildings, including social housing and street or square lighting.
- Integration of renewable energy sources (RES) into the built environment.
- Investments in the upgrade, expansion, or construction of new district heating/cooling networks, including networks based on combined heat and power (CHP) generation, as well as decentralized CHP systems (at building or neighborhood level).
- Urban transport initiatives aimed at increasing energy efficiency and integrating renewable energy sources.

Indicative actions financed by ELENA:

- Market research.
- Techno-economic studies and feasibility studies.
- Energy audits.
- Tender documents.
- Procurement and tendering procedures, etc.

The **European Energy Efficiency Fund (EEEF)**[4] aims to support the climate objectives of the European Union by promoting a sustainable energy market and fostering climate protection through a collective approach that contributes to addressing climate change. The Fund supports the enhancement of energy efficiency and the promotion of renewable energy sources through a targeted public–private partnership, primarily by providing direct financing and by collaborating with financial institutions.

The Fund facilitates sustainable investments in the public sector, where projects are often hindered or delayed due to budgetary constraints and a lack of expertise in this type of investment. It invests at the level of local authorities (communities, municipalities, regions) in EU member states, financing energy efficiency technologies, small-scale renewable energy projects, and clean urban transport, with all projects required to achieve at least 30% annual primary energy savings or a reduction in greenhouse gas emissions.

As part of project implementation, the Fund assesses and monitors carbon emissions and primary energy savings periodically throughout each individual investment, fully aligned with the International Performance

[3] https://www.eib.org/en/products/advisory-services/elena/index
[4] https://www.eeef.lu/home.html

Measurement and Verification Protocol (IPMVP), which requires each project to establish a baseline energy consumption in order to evaluate its energy efficiency performance comparatively.

Alternatively funding mechanisms can be **Energy Performance Contracting (EPC),** that enables the financing of energy efficiency measures through the anticipated reductions in energy costs. The EPC is a contractual agreement drawn up in writing between the beneficiary and the energy service provider (usually an ESCO – Energy Service Company), with the objective of implementing energy efficiency improvement measures. Under this agreement, the provider's financial compensation for the investment made is linked to the contractually agreed level of improvement in energy performance.

Funded actions: Energy Service Companies (ESCOs) provide, through EPCs, energy services and other means of improving energy efficiency in the facilities or buildings of the end user. The EPC regulates, in particular, the following:

- The design and management of the provided energy service and energy project.
- The methodology for estimating the energy savings and assessing the resulting total economic benefit.
- The procurement, installation, and commissioning of the necessary energy equipment, such as electromechanical and electronic systems, as well as fixed or non-fixed building envelope materials that improve energy efficiency in end use.
- The management, operation, and maintenance of the equipment.
- The total cost of the project, which consists of the cost of supplying and installing the necessary equipment, the cost of operation and maintenance, financing costs, and the ESCO's remuneration.
- The process for evaluating the energy benefit.
- The method and schedule of repayment.

The Register of Energy Service Companies (ESCOs)[5] is maintained by the Directorate of Energy Policies and Energy Efficiency of the Ministry of Environment and Energy, in accordance with Ministerial Decision **ΔΕΠΕΑ/Γ/οικ.176381/2018** (Government Gazette 2672/B'/21.06.2018) titled *"Energy Service Companies. Energy Services, Register, and Code of Conduct for Energy Service Companies."*

[5] www.escoregistry.gr

2. Portuguese target area (by AREANATEJO)

2.1 Priority Action Selection

2.1.1 Background and context

The task 3.3 — Strategy Definition, that integrates Work Package 3 (IMTSs at Work) from LIFE-SMART – Support small Municipalities towArds Energy Transition (LIFE22-CET-SMART) Project, funded by the European Commission's LIFE Clean Energy Transition program.

This task aims to support the intermunicipal technical teams (IMTS) in the definition and structuring of strategies for the implementation of priority actions identified in Task 3.2 — Plans alignment and updating, with a view to the future implementation of energy transition measures within the framework of Task 3.4 — Preparation for the implementation of local initiatives.

In Portugal, the implementation is coordinated by AREANATejo, in conjunction with the municipalities of Alter do Chão, Avis, Castelo de Vide, Marvão, Monforte and Sousel, which constitute the LIFE-SMART pilot territory of Alto Alentejo.

The choice fell on the creation and implementation of Renewable Energy Communities (RECs), a measure highlighted in the Municipal Climate Action Plans (PMAC) and in the Action Plans for Sustainable Energy and Climate (PAESC) under preparation, as it represents a concrete response to decarbonization, municipal energy autonomy and local empowerment.

Task 3.3 thus consolidates the intermunicipal vision of shared energy transition that AREANATejo has been promoting, transforming municipal diagnoses into replicable and coherent technical strategies on a regional scale.

2.1.2 Selection process

The process of selecting the priority action was conducted by AREANATejo, as a technical structure for coordination and support to municipal teams.

Based on the measures identified in the PMAC/SEAP, a comparative analysis of potential impact and feasibility was developed, which highlighted the Renewable Energy Communities (RECs) as the most consistent measure with the objectives and capacities of the territory.

The decision was based on three main axes:

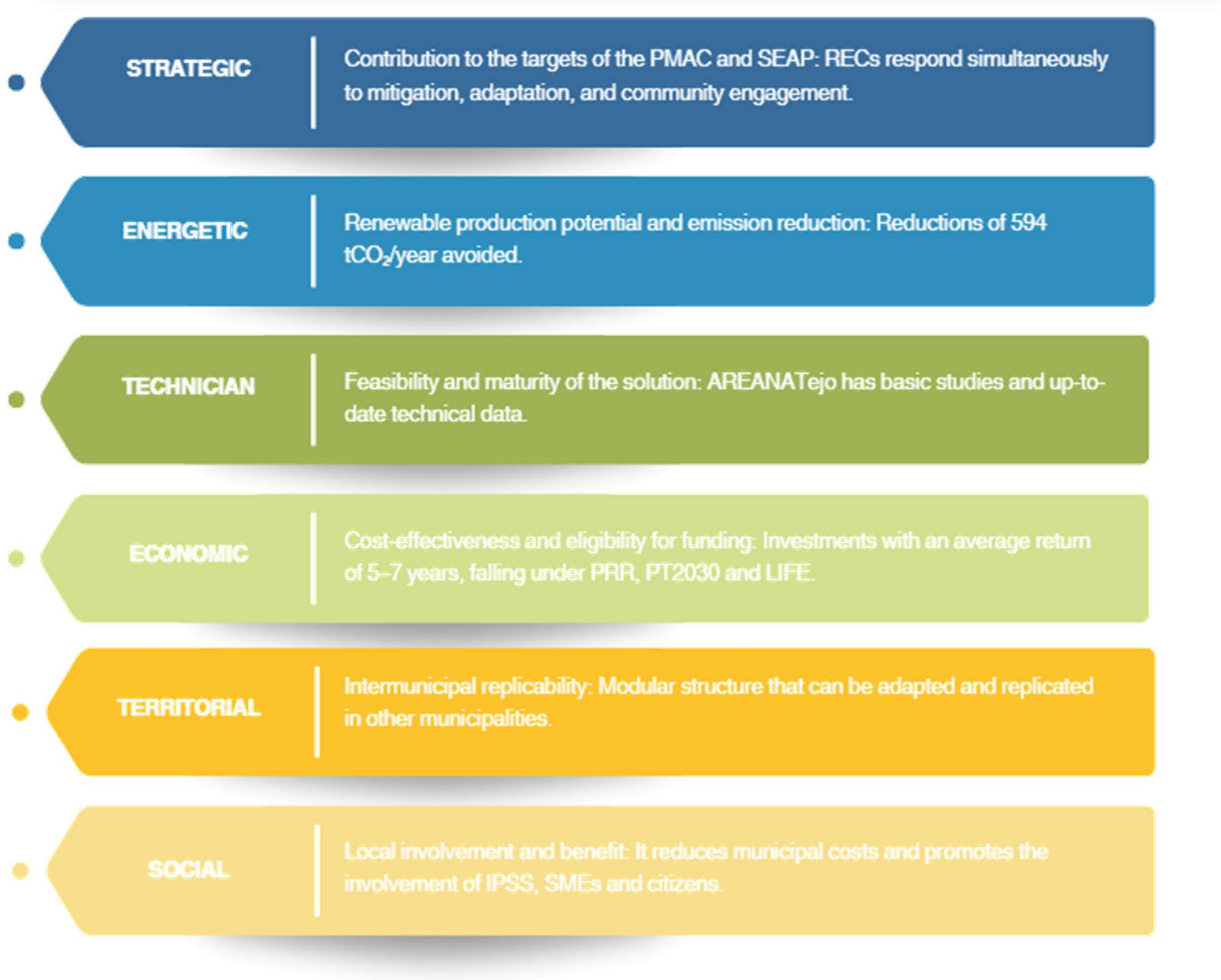
- Strategic relevance, due to its transversal integration into local and national energy transition policies;
- Technical maturity, supported by previous studies carried out by AREANATejo that identify the feasibility of RECs in each municipality;

- Aggregating and replicable character, since the same methodology can be applied to different local contexts, allowing to harmonize approaches and enhance intermunicipal cooperation.

Thus, the chosen measure is not only the result of a logic of technical opportunity, but also of a structuring and unifying vision, which places energy as a point of convergence between different municipalities, but with common challenges and ambitions.

Criteria applied

The selection was based on criteria of a technical, strategic and socio-economic nature, applied in an integrated manner:



2.1.3 Participation of municipalities

The selection process was participatory and collaborative, articulating with the work developed in the PMAC and PAESC, where the municipalities defined their energy priorities. AREANATejo ensured the technical alignment between the six municipalities, promoting exchanges of information and informal validation throughout the process.

The measure concerning the creation of RECs was unanimously recognized by the municipalities as structuring and transversal**,** due to its ability to aggregate efforts, reduce costs and stimulate collective learning around a common goal.

The formal communication sent in November 2025 confirmed the decision, assuming consensus between the parties, unless a better opinion was given.

This choice reinforces the importance of networking, transforming a set of local actions into a shared strategy with regional impact**.**

2.1.4 Results of the Selection Process

The technical and strategic analysis conducted by AREANATejo allowed us to consolidate the implementation of REC as the most relevant, feasible and mobilizing priority action for the territory.

RECs make it possible to:

- estimated annual production of ≈ 2.37 GWh,
- avoidance of around 594 tonnes of CO_2 per year,
- and average annual energy savings of €47,000 per municipality.

In addition to the technical and economic benefits, this measure is distinguished by its aggregating capacity: although implemented separately in six municipalities, it promotes a common planning and implementation model, fosters the sharing of knowledge and technical know-how, and creates conditions for replication and mutual learning that last beyond the duration of the project.

With this decision, we reinforce the joint commitment of the municipalities of Alto Alentejo and AREANATejo to a fair, collaborative and territorially cohesive energy transition, transforming energy into a vector of union, innovation and regional autonomy.

2.2 Implementation Strategy

2.2.1 Objectives and Scope of the Strategy

This strategy aims to establish a common technical and organisational basis for the implementation of Renewable Energy Communities (RECs) in the six municipalities of the pilot territory.

The general objective is to define a coherent, sustainable and replicable intermunicipal model, which translates the guidelines of the PMAC and PAESC into operational plans for energy transition.

Specific objectives:

2.2.1 Consolidate the energy diagnosis and the renewable potential of the municipalities;

2.2.2 Harmonise technical and legal criteria applicable to the constitution of RECs;

2.2.3 Identify inter-municipal synergies and funding opportunities;

2.2.4 Promote technical cooperation and knowledge transfer;

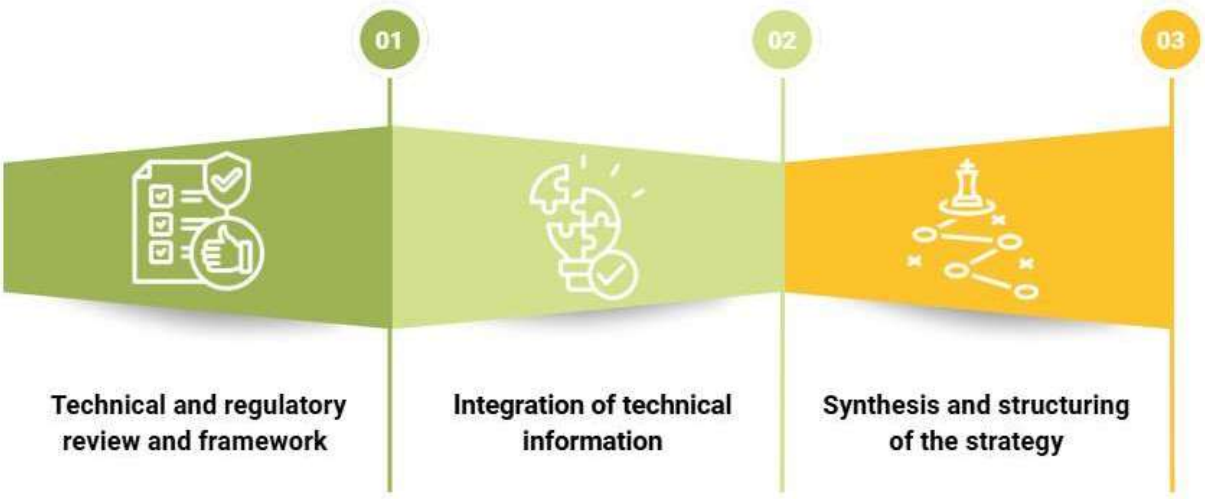
2.2.5 Prepare the implementation phase (Task 3.4).

The strategy has a guiding and demonstrative character: it does not replace municipal projects, but provides the technical and methodological framework that underpins their future implementation.

2.2.2 Work Methodology

The methodology adopted for the elaboration of this strategy was based on the systematization of the existing technical information and on the use of the studies developed by AREANATejo in the context of the elaboration of the Action Plans for Sustainable Energy and Climate (PAESC) and other technical support works carried out with the municipalities of the LIFE-SMART territory.

The process was essentially based on three stages:



1. Review and technical and regulatory framework — Analysis of the technical and strategic content of the Sustainable Energy and Climate Action Plans (SECAP) in the process of being

finalized and the national legislation applicable to Renewable Energy Communities (Decree-Law No. 15/2022), ensuring consistency with the energy transition and carbon neutrality goals.

2. Integration of existing technical information — Compilation of energy data and descriptive reports prepared by AREANATejo for each municipality, containing the sizing of photovoltaic installations, production, investment and economic return estimates.
3. Synthesis and structuring of the strategy — Organization of the information collected in an intermunicipal technical document, which presents in a consolidated way the results and guidelines for the implementation of Renewable Energy Communities (RECs), in line with the objectives of Task 3.3 of the LIFE-SMART project.

The methodology followed favored a practical and reasoned approach, focused on the valorization of the technical knowledge already available and its joint application to the six municipalities of the territory. In this way, the work carried out does not correspond to the creation of new studies, but rather to the consolidation and standardization of existing information, allowing the establishment of a technical reference basis for the next phase of implementation (Task 3.4).

2.2.3 Main results and conclusions

The results obtained under Task 3.3 confirm that the implementation of Renewable Energy Communities (RECs) in the six municipalities of the pilot territory is technically feasible, economically sustainable and environmentally relevant.

Based on the analyses carried out under the Sustainable Energy and Climate Action Plans (SECAP) and the descriptive reports prepared by AREANATejo, it was possible to quantify the aggregate energy and economic impact of the measure, as shown in the following image:



The following table presents the values disaggregated by Municipalities, demonstrating the impact of each project on a local scale:

Municipality	Total installed photovoltaic power (kW)	Area (m^2)	Estimated annual renewable energy production (kWh)	CO_2 emissions avoided ($tonCO_2$)	Expected annual economic savings	Estimated total investment (€) - excl. VAT
Chão						
Alter do	183,6	888	316 885	79	34 756,87 €	220 320,00 €
Opinion	236,52	1 144	407 879	102	51 586,35 €	283 824,00 €
Vide						
Castelo de	260,28	1 259	453 264	113	49 883,60 €	312 336,00 €
Marvão	129,6	627	225 040	56	22 137,49 €	155 520,00 €
Monforte	200,34	969	346 923	87	42 005,75 €	240 408,00 €
Sousel	363,4	1 758	627 410	157	83 143,98 €	436 104,00 €

The detailed data by municipality can be found in the attached technical document – Annex A: "Aggregate Study for the implementation of Renewable Energy Communities"

These results highlight the potential impact of the measure and reinforce the technical and territorial coherence of the strategy, demonstrating that the constitution of RECs:

- it contributes directly to the goals of reducing emissions and increasing local renewable production;
- it represents an investment with a quick return and direct benefits for municipal budgets;
- and enhances cooperation and the replication of good practices between the six municipalities of Alto Alentejo
- It enhances the production of electricity in a decentralized manner, minimizing losses in transport and transformation.

In addition to the energy and economic gains, the process has made it possible to consolidate a common technical and institutional base, where the sharing of knowledge and the replicability of solutions play a central role.

The measure is, therefore, aggregating: separated in time and space, but united by the same logic of sustainable and cooperative energy transition, capable of generating collective impact and shared learning.

2.2.4 Difficulties and Lessons Learned

The development of this strategy took place in parallel with the preparation of the Sustainable Energy and Climate Action Plans (SECAPs), which required careful management of time and technical priorities.

While this simultaneity ensured consistency between documents, it also entailed a more concentrated pace of work and some additional revisions.

There were also differences in the availability and format of energy data between municipalities, which required additional effort of consolidation and validation by the technical team. The practical interpretation of the legal framework for Renewable Energy Communities (Decree-Law No. 15/2022) was also a challenge, given its recent and evolving nature.

Despite these constraints, the process proved to be fundamental to strengthen intermunicipal technical cooperation, reinforcing the importance of a coordinated and shared approach in the energy transition of Alto Alentejo.

The lessons learned from this phase will serve as a basis for the implementation of the first concrete measures in Task 3.4 and for the continuous improvement of regional energy planning methodologies.

2.2.5 Next Steps and Articulation with Task 3.4

The completion of this strategy forms the necessary technical and organisational basis for the transition from the planning phase (Task 3.3) to the practical implementation phase (Task 3.4) of the LIFE-SMART project.

In the coming months, AREANATejo will share this report and the Intermunicipal Feasibility Study with the six municipalities of the pilot territory — Alter do Chão, Avis, Castelo de Vide, Marvão,

Monforte and Sousel — ensuring its internal dissemination and technical-institutional alignment on the results obtained.

Task 3.4 provides for the practical implementation of the priority measures set out in this strategy, which may include:

- the identification and preparation of pilot cases of Renewable Energy Communities (RECs) in buildings or groups of municipal buildings;
- the articulation with national and European financing mechanisms (PRR, Portugal 2030, LIFE, among others);
- and the promotion of technical and administrative capacity building actions, which reinforce local knowledge on governance models, energy sharing and CER management.

AREANATejo will maintain the role of an intermunicipal technical support and coordination structure, ensuring coherence between the municipalities and the capitalization of the work developed. The replication of this methodology in other territories of Alto Alentejo sub-region will be a natural step in the consolidation of the regional vision of collaborative energy transition, which the LIFE-SMART project intends to affirm and demonstrate.

3.French target area (by CCI NCA)

3.1 Selection of the Priority Action

3.1.1 Process and tools used

Following the completion of the municipal energy action plans under Task 3.2, CCI NCA organised individual feedback meetings with each participating municipality. These meetings had a dual objective: (i) to present the results of the energy diagnosis and (ii) to jointly identify one priority action for implementation.

The process was organised as follows:

- One dedicated meeting was held with each municipality.
- Approximately one hour was devoted to presenting the energy roadmap, including the baseline situation, the regulatory framework (Décret Éco-Énergie Tertiaire, Décret BACS, Loi LOM), and the full list of proposed actions, in accordance with the methodological guide developed for the project.
- Based on this presentation, the external energy expert carried out an initial pre-selection of several priority actions per municipality.

The pre-selection was based on evaluation tools developed in spreadsheet format (priority matrices), ensuring a transparent and comparable assessment of actions. Each action was systematically analysed against the following criteria:

- Investment cost (including potential subsidies),
- Estimated annual energy savings (MWh/year),
- Estimated annual economic savings (k€ incl. VAT/year),
- Cost-effectiveness ratio (kWh saved per euro invested),
- Estimated reduction in carbon emissions (tCO_2e/year),
- Regulatory relevance and associated compliance deadlines, where applicable.

Each action was scored against these criteria, resulting in a ranked list from highest to lowest priority. These evaluation matrices constitute the main decision-support tools and are provided in annex (Excel matrices and summary sheets).

3.1.2 Involvement of municipalities and local stakeholders

Municipalities were closely involved throughout the prioritisation phase. During the meetings:

- The external expert presented each pre-selected action in detail, including the concerned building or asset, technical characteristics, regulatory implications, and implementation modalities.
- Exchanges with elected representatives and technical staff allowed the technical assessment to be confronted with local constraints, such as budgetary capacity, political priorities, ongoing projects, internal resources, and implementation timelines.

Following the meetings, municipalities were given time to make their internal decisions, with the possibility of additional support from the external expert if required. This approach ensured ownership of the final decision and alignment with local governance processes.

3.1.3 Illustrative example: Saint-Vallier-de-Thiey

In Saint-Vallier-de-Thiey, 17 actions were assessed using the evaluation matrix (Annex 1 – Synthesis of the Saint-Vallier-de-Thiey energy roadmap) and ranked accordingly.

- The highest-ranked action was the “Repair of insulation and replacement of exterior joinery”, representing an investment of approximately €550,000, with estimated energy savings of 297 MWh/year and economic savings of around €31,000/year.
- However, following discussion and internal deliberation, the municipality chose to prioritise another action identified as more operationally urgent: “BMS programming and training of maintenance staff in its use”. Although ranked 5th by the expert, this action required a significantly lower investment (approximately €5,000) while still generating energy savings of around 38 MWh/year, economic savings of €9,000/year, and a reduction of 4–6 tCO_2e/year.

This example illustrates how final prioritisation combines quantitative assessment with qualitative local considerations, including budgetary constraints, urgency, technical feasibility, and political priorities.

3.1.4 Final priority actions selected

The priority actions validated by the municipalities are as follows:

- **Tende**: Energy audit of a municipal building and associated action plan.
- **Biot**: Technical assistance for the selection of contractors for photovoltaic panel installation.
- **Saint-Martin-Vésubie**: Solar energy potential study.
- **Saint-Vallier-de-Thiey**: Building Management System (BMS/GTB) diagnosis of the Espace Culturel du Thiey.

For example, in Biot, the selected action consists of launching a works contract following a photovoltaic pre-feasibility study already completed (Annex 2 – Synthesis of the Biot energy roadmap). This action represents an investment of approximately €64,000, with estimated energy savings of 28 MWh/year, economic savings of €6,000/year, and a carbon emissions reduction of approximately 2 to 4.3 tCO_2e/year.

3.1.5 Lessons learned

- Energy action plans often required adjustments following exchanges with municipalities.
- Public decision-making and procurement processes are time-consuming and must be anticipated.
- The concept of “priority” is relative and depends on political choices, budgetary capacity, implementation timelines, and operational urgency.

3.2 Implementation Strategy and Articulation with Task 3.4

3.2.1 Key elements and structure

The selected priority actions provide the necessary technical and organisational basis for transitioning from the planning phase (Task 3.3) to the implementation phase (Task 3.4) of the LIFE-SMART project.

The implementation strategy defines how the external expert supports municipalities in implementing the selected actions, and the detailed steps required for each action beyond what was discussed during the prioritisation meetings.

Given that the selected actions were clearly defined, concrete, and fully financed by the project, a complex implementation strategy was not required. The strategy was nevertheless designed to ensure

that actions could be realistically and efficiently implemented by small municipalities. It builds on the energy roadmaps developed in Phase 1 and focuses on:

- Clear definition of each selected action and its scope,
- Identification of the required implementation steps,
- Clarification of roles and responsibilities,
- Support to municipalities in decision-making and procurement processes.

3.2.2 Challenges and mitigation measures

Several challenges were identified:

- **Data collection**: Access to necessary data (e.g. for solar potential studies) proved difficult due to reliance on national energy providers and multiple interlocutors. In the case of photovoltaic contractor selection, delays in obtaining results from an existing study led to a risk for the project timeline. This was mitigated by the external expert carrying out an independent analysis to ensure continuity. This highlights the importance of anticipating risks when actions depend on multiple external stakeholders.
- **Lengthy public decision-making and procurement procedures**: These were addressed through early anticipation, phased approaches (studies prior to works), and alignment with municipal budget cycles.

Overall, the implementation strategy is characterised by pragmatism, adaptability, and close cooperation with municipalities, ensuring the effective delivery of the selected priority actions within the project framework.

4. Spanish target area (by FAMP + U-SPACE)

4.1 Selection of the Priority Action

The selection of the Priority Action was carried out through the development of a common Energy Transition Strategic Plan, concerning the territory covered by La Loma Occidental region and their municipalities. This strategy has followed a structured, transparent and participatory process designed to ensure that the chosen intervention responds to the real needs of the region and contributes effectively to the overarching goals of the Energy Transition Strategic Plan. The process combined technical analysis, and structured codesign with the eight municipalities (Baeza, Begíjar, Canena, Ibros, Lupión, Rus, Torreblascopedro and Villatorres), the minor local authority (El Mármol) and the Provincial Council of Jaén, which are members of Life SMART IMTS of La Loma Occidental.

The design of a general strategy for the energy transition of La Loma Occidental region, rather than a strategy plan for a single priority action, has been done with the aim of better responding to the alignment of a shared inter-municipal vision, which involves work that goes beyond a specific action. Thus, the design of a broader strategy provides municipalities with a roadmap of different common actions that have been identified for the benefit of the energy transition of La Loma Occidental as a whole.

In this way, tasks 3.2 and 3.3 are interrelated, as task 3.2 identifies the main lines of action shared by the municipalities of La Loma Occidental and demonstrates the willingness of the municipalities of La Loma Occidental and the Provincial Council of Jaén to work together on them, Task 3.3 develops a strategic plan with specific axes and actions for the development of the lines of action defined in Task 3.2 and, finally, an action is selected that is expected to be promoted within the framework of the Life-SMART project. In addition, among the specific actions, the Energy Transition Strategic Plan identifies the consolidation of the IMTS (Task 4.1) as a measure to be achieved, and as the best way to develop the other actions of the strategic plan in a coordinated manner between the different municipalities.

4.1.1 Methodological Process

The design of the global strategy was conducted in four main phases:

<u>Phase 1 – Identification of Needs and Challenges</u>

The starting point was the diagnostic phase of the Strategy, which analysed the current situation of the region in terms of energy consumption, emissions, mobility patterns, public building performance, governance structures, and socio-economic conditions.

This diagnosis enabled the identification of key challenges, such as the fragmentation of local energy management, limited data availability, insufficient renewable production, and a high dependency on private vehicles

Phase 2 – Strategic Definition Based on SWOT Analysis and Participatory Inputs

The second phase was centred on the consolidation of a shared strategic vision for La Loma Occidental, grounded in a detailed SWOT analysis and an extensive participatory process involving municipal political and technical representatives from the municipalities of La Loma Occidental and the Provincial Council of Jaén, all of whom are part of the IMTS. This phase ensured that the definition and prioritisation of actions was not only technically sound but also strategically aligned with the common challenges and opportunities identified by IMTS members and with recently developed strategic documents, such as the Municipal Climate Change Plans (MCCP) for each municipality, an initiative developed in 2025 by the Regional Government of Andalusia (this is explained at the end of section 1).

- SWOT Analysis as the foundation for strategic choices

A comprehensive SWOT analysis (Strengths, Weaknesses, Opportunities and Threats) was conducted to understand the energy transition context of La Loma Occidental region. The SWOT included:

- *Strengths* such as the IMTS creation or the disposal of renewable sources (mainly solar and biomass).
- *Weaknesses* including insufficient data on energy consumption, limited human resources, dependency on private vehicles and financial constraints.
- *Opportunities* related to EU and national funding schemes, emerging community energy initiatives, collaboration between municipalities, and growing public awareness about sustainability.
- *Threats* such as rising energy prices, climate change impacts, depopulation trends, and economic vulnerability of small municipalities.

This SWOT provided a shared analytical framework to identify the most strategic intervention areas, highlighting where collective action could generate the highest added value.

- Participatory process to validate needs and define strategic priorities

The SWOT analysis was complemented by an extensive participatory process, ensuring that the Strategy reflected both technical evidence and the reality experienced by the municipalities integrated into the IMTS. This participatory work included not only meetings with the IMTS members but also the organisation of meetings with other regional entities such as the Andalusian Energy Agency and the Andalusian Office for Climate Change.

This participatory approach allowed the municipalities to converge on a set of common priorities: improving energy governance, reducing dependency on fossil fuels, increasing the use of renewals, and modernising mobility patterns. This process has been also useful in ranking the different actions from highest to lowest priority.

- Definition of the Strategic Framework

Based on the consolidated SWOT analysis and the participatory insights, a structured strategic framework was defined, composed of:

- Five Strategic Axes, each addressing one of the major thematic challenges identified: Governance, renewable energies, energy efficiency, mobility and citizens engagement and awareness.
- Specific objectives within each axis, reflecting opportunities and gaps highlighted in the SWOT.
- Potential lines of action, grounded in real needs and feasible for the municipal context.

These elements were collectively validated in a joint municipal session, ensuring that the Strategy served as a common roadmap for the whole region.

Phase 3 – Definition of a common Energy Transition Action Plan

During the third phase, a shared Energy Transition Action Plan has been defined. It is composed of twelve coordinated actions structured across the five strategic axes. Each action was designed to address the challenges identified in the diagnostic and SWOT analysis, while ensuring feasibility across all municipalities. The specific actions have been defined in a technical data sheet including objectives, description, involved actors, monitoring indicators and a drafted budget of every action:

Strategic Axe 1 – Common energy governance and intermunicipal cooperation

- Action 1.1. Consolidation of the IMTS as the coordination and monitoring structure for the action plan. To strengthen intermunicipal governance and ensure consistent implementation of the Transition Strategy. Formalisation and reinforcement of the IMTS as the central body for coordination, technical follow-up, data sharing, and joint planning of energy transition measures across all municipalities. (Task 4.1 of the Life-SMART project, this task is included in the strategy to generate complementarity and coherence with the work carried out within the framework of the project, interrelating the different tasks).
- Action 1.2. Establishment of a common system for monitoring energy consumption and emissions. To generate reliable, centralised data for informed decision-making. Development of a shared monitoring platform to track municipal energy use, public lighting consumption, renewable production and CO_2 emissions, enabling transparent follow-up of the Action Plan.

Strategic Axe 2 – Deployment of Local Renewable Energy

- Action 2.1. Installation of photovoltaic self-consumption systems in municipal buildings. To increase clean energy generation and reduce municipal energy expenditure. Deployment of rooftop photovoltaic installations in public buildings with high consumption, prioritising sites with the greatest technical potential and economic return.
- Action 2.2. Identification, support and creation of Local Energy Communities (LECs). To promote community-led renewable energy production and citizen participation. Technical and

administrative support for neighbourhood groups, associations and SMEs to launch and manage Local Energy Communities, including legal guidance, feasibility analysis and stakeholder mobilisation.

Strategic Axe 3 – Improving energy efficiency in buildings

- Action 3.1. Energy renovation of municipal buildings. To reduce energy demand and operating costs in public facilities. Implementation of insulation improvements, high-efficiency HVAC systems, LED lighting, and smart energy management solutions in priority public buildings.
- Action 3.2. Promotion of residential energy rehabilitation. To increase the energy performance of the existing housing stock. Awareness campaigns, advisory services and support for access to funding schemes to encourage homeowners and communities to undertake energy-saving renovations.

Strategic Axe 4 – Sustainable and low-emission mobility

- Action 4.1. Review and improvement of the public transport service in the territory. To enhance accessibility and reduce reliance on private vehicles. Assessment and optimisation of bus routes, frequencies and services, exploring demand-responsive transport options and improving user information systems.
- Action 4.2. Creation of safe pedestrian and cycling routes. To promote active mobility for short-distance travel. Development of new walking and cycling infrastructures, traffic-calming measures, and safe routes connecting key municipal facilities and school areas.
- Action 4.3. Development of an electric vehicle charging network in the territory. To support the uptake of electric mobility. Installation of publicly accessible charging points in strategic locations, coordinated at intermunicipal level to ensure coverage and avoid duplication.

Strategic Axe 5 – Citizen awareness and participation in the energy transition

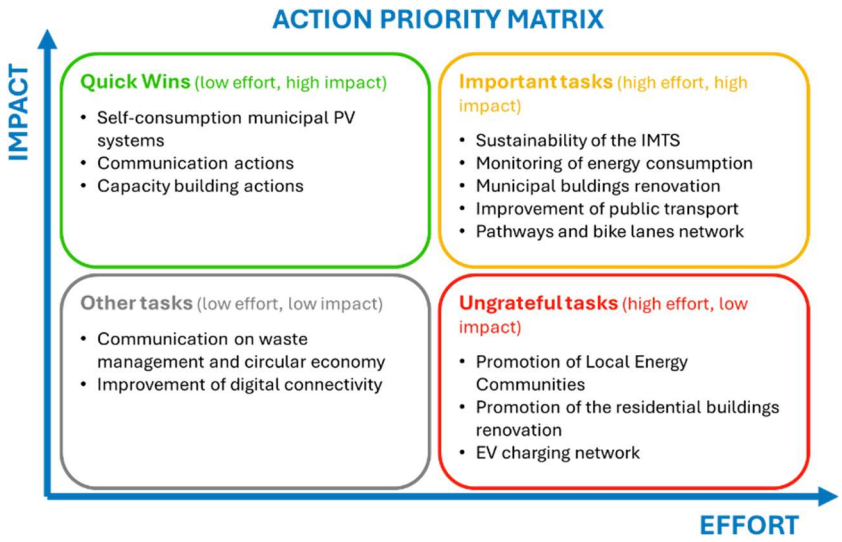
- Action 5.1. Awareness activities for efficient energy use in households and businesses. To encourage behavioural change and reduce energy consumption. Organisation of workshops, practical sessions and informational materials aimed at improving energy habits in homes and small commercial establishments.
- Action 5.2. Intermunicipal communication campaign on the energy transition. To increase public understanding and support for the Strategy. Implementation of a unified communication campaign including visual identity, digital content, public information panels, and regular progress updates.

- Action 5.3. Education and awareness on sustainable mobility and road safety. To reduce private car use and promote safer, more sustainable mobility choices. Educational programmes in schools, public events, and safety campaigns encouraging walking, cycling, and responsible vehicle use, especially around school zones.

- *Action priority matrix*

  Considering the view of the IMTS members (political and technical representatives from the eight municipalities of Loma Occidental and the Provincial Council of Jaén) as expressed in particular at the last meeting of the inter-municipal participatory process carried out within the framework of the

Life-SMART project, the action priority matrix results as follows:



Considering this result and assessing the possibilities of financing that could currently be available through grants to local councils, especially in the region of Andalusia, the action selected, as it has the most options for obtaining financing in the short/medium term and therefore meets the objectives of task 3.4 of the Life SMART project, is *2.1 Installation of photovoltaic self-consumption systems in municipal buildings*. Therefore, the final months of the Life-SMART project will focus on seeking funding for the implementation of this action, although other identified actions may be taken into account depending on the funding opportunities that may arise.

4.1.2 Involvement of the municipalities and other local actors

Throughout the implementation of the Life-SMART project in La Loma Occidental, several meetings of the IMTS were held, playing a crucial role in advancing a shared vision for the transition towards clean energy and improved energy efficiency across the territory. It should be noted that, in this case, the IMTS is not only made up of political and technical representatives from the eight municipalities and a minor local entity but also includes representatives from the Provincial Council of Jaén as members, meaning that a provincial perspective has also been included in this process. Representatives from different departments of the Regional Government of Andalusia linked to the energy transition have also attended some IMTS meetings. In addition, thanks to Life-SMART, experts in the field of energy transition also participate, giving support to the IMTS.

In total, four IMTS meetings were organised -two in person and two online- with the common objective of developing an intermunicipal strategic plan to promote a more sustainable energy model in the municipalities of the comarca. Three of these meetings also included participatory workshops, which were essential for deepening the identification of key sectors and selecting priority actions for the intermunicipal strategy.

Below is a brief description of the four meetings carried out (see Annexes linked to section A):

July 2024 – La Loma Occidental (On line)

The first meeting served as a presentation of the Life-SMART project to IMTS members and also allowed them to meet the experts hired to provide technical assistance on energy transition. At this meeting, it was explained that one of the main objectives of the project is to develop a joint energy transition strategy for the eight municipalities of La Loma Occidental, including an action plan with specific measures, one of which would be selected to be promoted within the framework of the project.

October 2024 – Baeza (In person)

A participatory workshop focused on joint actions for the energy transition was held in Baeza. Political and technical representatives from the municipalities identified critical sectors in terms of greenhouse gas emissions (municipal public services, residential, tertiary, industrial, agriculture, and transport) and worked collaboratively to propose solutions adapted to local needs and scalable to the intermunicipal level. This meeting also served as an opportunity for representatives from all the entities forming part of the IMTS in Loma Occidental to sign a collaboration agreement for the creation and development of the IMTS within the framework of the Life SMART project.

May 2025 – Torreblascopedro (In person)

A participatory session was organised in Torreblascopedro to address the development of a common Action Plan for the municipalities of La Loma Occidental. The focus of the session was the definition of an intermunicipal strategy, aimed at identifying shared priority areas on which to structure a joint Action Plan.

October 2025 – La Loma Occidental (On line)

A participatory workshop was held to further refine the objectives and main action lines of the joint strategy. The results emphasised the need to strengthen collaborative governance at intermunicipal level and to secure the appropriate technical and financial resources. The workshop also highlighted that the energy transition represents an opportunity to enhance sustainability in the territory. Priority areas identified included energy efficiency, the deployment of renewable energy, and active citizen participation.The workshop also served to prioritise the actions proposed by the participants.

These participatory sessions have been key to generating synergies, building agreements, presenting progress, and defining concrete actions for intermunicipal energy sustainability.

Furthermore, during the May and October 2025 sessions, the draft Municipal Climate Change Plans (MCCP) were taken into consideration. Thanks to this initiative launched by the Regional Government of Andalusia for municipalities under 50 000 inhabitants, updated information was available for each municipality of La Loma Occidental. These drafts were essential for Task 3.2 (alignment of plans) and also helped to identify/confirm priority thematic areas that could be planned at the supra-municipal level. This initiative (MCCP) has been developed by the Andalusian Climate Change Office, under the Ministry of Sustainability and Environment of the Regional Government of Andalusia.

4.2 Implementation Strategy

4.2.1 Key elements of the selected action

The action "*2.1 Installation of photovoltaic self-consumption systems in municipal buildings*" aims to increase municipal renewable energy generation and reduce energy costs by installing solar self-consumption systems on the municipal buildings with the highest potential across the region. This measure responds directly to the challenges and opportunities identified in the diagnostic and participatory process and constitutes one of the most impactful actions for advancing the local energy transition in La Loma Occidental.

Indeed, the province of Jaén offers excellent solar potential, making photovoltaic energy one of the most cost-effective and strategic solutions for the local energy transition. This measure aims to promote and implement photovoltaic self-consumption systems on municipal buildings throughout the municipalities, reducing conventional electricity consumption, lowering associated emissions, and positioning local governments as leaders and role models in the transition toward a renewable energy model.

The action can be developed through the following activities:

- Technical assessment of photovoltaic potential for municipal buildings in each municipality.
- Identification of at least 2–4 priority buildings per municipality, such as schools, sports halls, town halls, cultural centres, and wastewater treatment facilities.
- Preparation of basic and execution projects, including system sizing, technical specifications, and economic feasibility analysis.
- Submission of applications to regional or national funding programmes to co-finance the installations. This step is particularly relevant given that the Regional Government of Andalusia is expected to publish a new call specifically designed to support renewable energy installations in municipal buildings, an opportunity that the comarca intends to leverage collectively.

- Implementation of the photovoltaic installations in annual phases, depending on budget availability.
- Dissemination of results as exemplary actions for citizens and the local business sector, reinforcing public awareness and demonstrating the benefits of renewable energy.

In order to monitor the results of the actions, the following monitoring indicators have been defined:

- Number of municipal buildings equipped with photovoltaic systems
- Total installed capacity (kWp)
- Annual renewable energy production and energy consumed (kWh)
- Reduction in municipal electricity consumption (%)
- Avoided emissions (t CO_2/year)

As a first approximation, it has been estimated that the action could cover 10% of municipal buildings. Thus, it has been estimated that the photovoltaic installation will cover 40% of the buildings and that between 50% and 100% of the electrical energy produced will be used (depending on whether backup batteries are used or not - it has been estimated that 50% of the installations will incorporate batteries). A preliminary estimate of the development of this action is included in the annex, with some calculations of the impact of this measure. (see Annex linked to section B).

To do this, the main actors involved should be: the municipalities, public works and services departments, installation companies, IMTS, energy supply companies, etc.

4.2.2 Implementation strategy

The strategy to implement this measure is structured around a coordinated, intermunicipal approach that maximises technical, economic, and administrative efficiency, while ensuring that all municipalities—regardless of size or resources—can benefit from clean energy generation.

Alignment with the Common Energy Transition Plan

The installation of PV systems in municipal buildings was identified as a priority through the SWOT analysis and during multiple IMTS participatory workshops. This recognition of renewable energy as a regional priority represents a key opportunity to:

- Reduce municipal energy bills and free up budgetary resources
- Decrease greenhouse gas emissions linked to public service operations
- Increase local energy autonomy
- Generate direct and visible benefits for the community
- Create a demonstrative effect that encourages households and businesses to follow the same path

This measure aligns with the core objectives of the common strategy: promoting renewable energy, improving energy efficiency, and reducing emissions in the public sector—while laying the foundation for more advanced models such as Local Energy Communities in the medium term.

Identification and prioritisation of suitable municipal buildings

Once the strategic process is completed, the following tasks are expected to focus on enabling each municipality to identify the public building stock with the highest potential for PV installation. Criteria considered should include:

- Roof surface availability and structural viability
- Orientation and shading conditions
- Annual electricity consumption
- Potential for collective self-consumption or future integration in energy communities
- Current energy costs and expected payback

Buildings with high daytime energy consumption, such as town halls, cultural centres, sports facilities, and water service infrastructures, will be prioritised due to their high potential for immediate self-consumption and economic return.

This identification of buildings will enable a phased, technically robust deployment plan for all municipalities in La Loma Occidental.

Shared technical and administrative framework

To ensure coherence and efficiency, it is intended to establish a common and coordinated technical framework. This includes:

- Standardised procedures for technical feasibility assessments
- Shared procurement criteria for PV installations
- Harmonised monitoring and maintenance protocols
- Joint training for municipal staff on PV operation and energy management

By establishing a unified approach across municipalities, the region reduces administrative burden, strengthens negotiation power with suppliers, and ensures consistent quality of installations.

Financing strategy

Currently, the municipalities of La Loma Occidental do not have their own financial resources that can directly address the implementation of the selected action. Therefore, the financing strategy must be clear and realistic.

Thus, in order to implement the selected action, it will be necessary to combine scarce municipal resources with external funding opportunities.
In the current context, these opportunities could include the publication by the Regional Government of Andalusia of a new funding call specifically aimed at supporting the installation of renewable energy systems in municipal buildings.

This call would represent a major opportunity to co-finance the PV installations and would significantly reduce the financial burden on local governments. The IMTS will coordinate a joint approach to:

- Ensure that all municipalities are eligible and competitive.
- Prepare harmonised technical documentation.
- Submit applications that demonstrate the intermunicipal added value.
- Maximise the number of funded installations across the territory.

By acting collectively, La Loma Occidental increases the likelihood of securing funding and accelerates implementation.

Flexibility

Task 3.4 of the Life-SMART project envisages the implementation of an inter-municipal initiative. Although the selection of a priority action (*2.1 Installation of photovoltaic self-consumption systems in municipal buildings*) is intended to address task 3.4 through its implementation, during the final months of the Life-SMART project, the initiative implemented could change in the event of:

- A call for grants is identified that allows financing another action included in the energy transition strategy developed within the framework of the IMTS Life-SMART for the La Loma Occidental region.
- The regional call to support the installation of renewable energy systems in municipal buildings is not published during the final months of the project.

Furthermore, in anticipation of some of these issues arising, the description sheet for each priority action identified may serve as a basis for the implementation of a priority other than the one initially selected.

5. Italian target area (by CMRC + CRAS)

5.1 Selection of the Priority Action

5.1.1 The three actions of the Common Vision

The identification of possible lines of action relating to the promotion of energy transition in the municipalities of the Ustica Valley was the result of a participatory process involving the municipalities, IMTS members and project staff.

The three lines of action identified have since been fully integrated into the strategic activities of the Ustica Valley Union's SECAP, which is currently awaiting endorsement from the local authorities concerned.

The potential actions identified were as follows:

1. **Renewable Energy Community of the Ustica Valley**
2. **Energy requalification of municipal building stock**
3. **Intervention of tourism territorial marketing among the municipalities of the Ustica Valley**

The **first line of action** was developed in accordance with prevailing European, national, and regional directives. These policies acknowledge that RECs and locally generated energy consumption represent prime opportunities for nurturing public awareness and stimulating the wider adoption of renewable power sources, delivering substantial positive impacts across ecological, fiscal, and societal dimensions. Specifically, this initiative was driven by the aim of bringing the remaining municipalities of the Ustica Valley Union into the Roccagiovine REC, which commenced operation on February 16, 2023, thus broadening the environmental, communal, and financial benefits of the scheme throughout the entire territory of the Union.

Regarding the financial arrangements, the path for municipalities to guide the development of new energy facilities required the evaluation of two main financing channels: either securing a commercial loan, utilizing dedicated financial products for RECs offered by banking institutions, or engaging in a public-private partnership model, which would involve an external partner through specialized Project Finance mechanisms. A significant potential source of monetary assistance for this endeavor was the availability of NRRP grants, administered by the GSE (the energy service management company fully owned by the Italian Ministry of Economy). These funds are earmarked for constructing plants serving RECs in municipalities with populations under 5,000 residents. This specific funding envelope covers a maximum of 40% of the incurred expenditures and concluded on November 30, 2025.

In addition, the IMTS conducted an in-depth study of the legal and administrative solutions for expanding the existing REC, which led to the identification of the most appropriate solution for establishing the new REC.

The **second line of action** was centered on enhancing the energy performance of buildings owned by the local authorities. This was intended to launch a broader environmental and energy transition, commencing with the work of public institutions before expanding throughout the community.

As an initial step to prepare for the execution of this particular strategy, extensive data was compiled regarding the current yearly usage of electricity and heating, along with an assessment of the potential for comprehensive energy optimization within properties managed by the municipality.

Two primary funding streams were provisionally identified as possible routes to finance this intervention. The first was non-refundable grants available for the energy transformation of both public and private structures through the “Conto Termico 3.0” incentive scheme, which is administered by the GSE (energy service management company fully owned by the Ministry of Economy). These contributions cover portions of the investment ranging from 40% up to 65% and offer especially advantageous terms for smaller municipalities with fewer than 15,000 residents, particularly when dealing with educational facilities or healthcare establishments. The second opportunity was the C.S.E. 2025 tender—named "Municipalities for Sustainability and Energy Efficiency"—which provided financial assistance to local governments for procuring assets and services related to the category of ‘Renewable Sources and Energy Efficiency’. The call was open until November 30, 2025.

The **third line of action** focused on the synergic development of two separate initiatives that had already been incorporated into the Ustica Valley Union's Three-Year Planning document.

The first of these was the project titled 'Interventions to improve the route of the Saint Benedict Walk'. This project involved upgrading and restoring the existing network of footpaths, promoting the local cycling routes, and digitizing the trail system. This particular endeavor had already secured financing amounting to €1 million from the Ministry of Tourism.

The second initiative, known as the 'BiBo Project – BIciturismo dei Borghi', aimed to establish a fully equipped circuit for bicycle tourists. This circuit was designed to foster a form of sustainable and enduring growth in complete alignment with the social and environmental characteristics of the local area.

To fully implement these improvements, it was recognized that beyond the resources already committed, it would be essential to develop more comprehensive and detailed project plans. Following that, supplementary funding would need to be secured through competitive tender processes or by accessing other specific grant programs.

5.1.2 Selection process

The selection process of the priority action has been carried out by the local team (staff of CMRC and CRAS involved on Life SMART project), with the support of the members of the IMTS and the involvement of the municipalities.

The selection was based on the following criteria:

- Environmental, economic and social impact of the action on the territories of the Municipalities involved, considering also the limited dimension of the municipalities;
- Feasibility of the action, in particular from a financial, technical and political point of view;
- Strategic relevance: coherence with the Union’s SECAP and CMRC’s strategic objectives, replicability of the action in other local contexts.

Impact	Feasibility	Strategic relevance
•Environmental impact: potential renewable energy production and/or emission reduction •Economic impact: economic benefits for the municipalities and the citizens •Social impact: active involvement of the community	•Financial feasibility: availability of funding opportunities in the period of implementation of Life SMART project •Technical and administrative feasibility •Political aspects: shared agreement and active participation of each Municipality	•Coherence with the Union's SECAP objectives and local strategic priorities •Replicability of the action in other local contexts

Funding opportunities have been constantly monitored, as they have a strong impact on the selection of the priority and the context evolves quickly. Some funding opportunity have been extended, while others planned at national level have not yet been published.

5.1.3 Involvement of the Municipalities

The Municipalities have been involved throughout the project implementation, both for the definition of the shared vision and for the following selection of the priority.

The IMTS team includes the technical expert of the Union of the Ustica Valley Municipalities and he participated in the periodic on-line IMTS meetings, sharing information and acting as intermediary between the project team and the municipalities.

Moreover, the two experts hired for the project and member of the IMTS met and interacted with the mayors and technical staff of the Municipalities to gather information and study the different technical and administrative options. They met also with local stakeholders, such as the new President of the REC of Ustica Valley.

The involvement of the Municipalities has been also carried out at political level. Various online and in person meetings have been organized with the mayors of the Municipalities:

- 30 May 2024: in person meeting with the mayors of the Municipalities
- 24 September 2024: in person meeting with the mayors of the Municipalities
- 18 March 2025: online meeting with the mayors of the Municipalities
- 16 April 2025: online meeting with the mayor of Mandela
- 10 April, 15 September and 23 October 2025: in person meetings with the mayor of Roccagiovine

Finally, the energy literacy activities organized locally in June and July, in particular the local assemblies, were also the occasion to meet with representatives of the Municipalities as well as with local citizens and the discuss the priorities identified in the shared vision.

The constant involvement of the Municipalities in designing and selecting the priorities has been essential to ensure the coherence between the project's activities and the realities of the territory and their needs, and to ensure the success of the project.

However, the participation has been uneven between the Municipalities: while some have demonstrated a strong interest, others have been less present. Moreover, the situation in one the five Municipalities, Vicovaro, currently under special administration with functions limited to ordinary administration, has not permitted its participation in the project.

5.1.4 Result of the selection process

The selection process has led to the identification of one priority: the creation of the Renewable Energy Community of the Ustica Valley.

- Impacts of the action:
  - It is estimated that a REC could produce up to 669,50 MWhel/year, avoiding 170,54 tCO2/year.[6]
  - The realization of the REC will have an economic impact both for the municipalities and the participating citizens, thanks to the subsidies for the shared energy.
  - As demonstrated by many studies, the realization of RECs has a strong social impact, strengthening the sense of community, mitigating the risk of energy poverty and increasing the awareness about energy transition.
- Feasibility of the action:
  - The availability of funds for the realization of this action has been an important factor, considering also that no funds are currently accessible for building energy renovation with procedures compatible with the project timeline.
  - Moreover, an in-depth study of the legal and administrative solutions for expanding the existing REC has been carried out, leading to the identification of the most appropriate solution for establishing the new REC.
  - From a political point of view, all municipalities (except Vicovaro for its particular situation) expressed a strong interest in the realization of the REC and successively became of member of the community.
- Strategic relevance: the realization of the REC of the Ustica Valley is fully coherent with the Union's SECAP and CMRC strategic objectives.

In general, the realization of a new REC is the action which, considering the limited dimension of the municipalities involved, the funding available and the limited time remaining before the end of the project, has the highest probability to be successful.

However, the other actions will not be abandoned and the Municipalities will continue to study and develop them in the future thanks to the support of CMRC.

[6] The MWhel/year produced has been estimated considering the installation of PV systems on municipal rooftops.

5.2 Implementation Strategy

5.2.1 Key elements and structure of the developed strategy

The development of the Valle Ustica **Renewable Energy Community (REC)** represents a significant step in the energy transition of the territory and offers substantial benefits both currently and for future development. Over the entire lifespan of the REC (the incentive is guaranteed for 20 years), benefits will be realised for all members, as well as for the entire territory:

- **Economic:** reduction of energy costs, access to incentives and public funding, and reduced dependence on energy price fluctuations.
- **Social:** community involvement, energy education, and local economic development through the enhancement of rural or marginal areas.
- **Environmental:** reduction of CO_2 emissions, promotion of energy consumption models with low environmental impact, and integration with green policies.

Furthermore, in the long term, benefits are expected for the development of the entire territory thanks to synergy with other sectors such as sustainable mobility and energy efficiency, the scalability of the energy production and sharing model, and the attraction of public and private investment.

To facilitate the activation and development of the Valle Ustica REC, a program structured into four types of activities has been developed:

1. Administrative steps,
2. Knowledge-deepening activities,
3. RES systems implementation,
4. Promotion activities.

Some of these activities can be considered implemented within the scope of the SMART project. Those still to be completed have been classified according to their timeframe, considering three intervals:

- Short term: by June 2026 (Life SMART project Final Report),
- Medium term: by December 2026,
- Long term: by December 2029 (approximately 3 years from the conclusion of the Life SMART project).

The strategy for the development of the Valle Ustica REC will be submitted to the approval of the Union of Municipalities by the end of 2025, similarly to the document of the Common vision which was approved in July.

The following table summarizes the activities included in the strategy and their current progress. Afterwards, some comments regarding each activity are provided.

Activities	Progress	Time frame

1. Administrative steps		
1.1. Adoption of Municipal Council Resolutions requiring adhesion to the existing REC	✓	(9/2025)
1.2. Approval of amendments to the original structure of the Roccagiovine CER by the current (name and steering committee)	✓	(10/2025)
1.3. Statute update and filing with the Revenue Agency (Agenzia delle Entrate)	On going	Short term
1.4. Adhesion to the REC by consumers and producers (citizens, businesses, associations, etc.) from the Valle Ustica municipalities	On going	Short term (continues)
1.5. Registration of the initial REC configuration on the GSE portal	Planned	Medium term
2. Knowledge-Deepening Activities		
2.1. Analysis of electrical energy needs and potential for the installation of municipal RES plants	✓	(3/2025)
2.2. Identification of the financial resources necessary for the implementation of new public RES plants	On going	Short term (continues)
2.3. Survey on RES systems installed by privates in the last 2 years	On going	Short term
3. RES systems implementation		
3.1. First REC production systems (small-scale PV) allowing for the registration of the initial configuration	On going	Short term
3.2. PV systems on municipal rooftops	Planned	Medium-long term
3.3. Ground-mounted PV system on land already available to the Union of Municipalities	Planned	Long term
3.4. PV systems on private rooftops and ground-mounted PV system on private land	Planned	Medium- term
4. Promotion activities		
4.1. Application for the 1st EECF call	✓	
4.2. Facilitation activities targeted to the REC members/potential members	Planned	Short term (continues)

1.Administrative steps

The first group of activities consists of **administrative steps** and includes all the processes necessary for the ratification of the enlargement of the original Renewable Energy Community (CER). These steps have been partially completed and comprise the following:

1.1 Adoption of Municipal Council Resolutions requiring adhesion to the existing REC

The municipalities declared their intent to join the CER through a Municipal Council Resolution, and the CER's Steering Committee accepted the municipalities as new members. This activity was partially concluded in September 2025 with the resolution of adhesion to the CER by all the Municipalities of Valle Ustica, with the exception of the Municipality of Vicovaro, which is currently under a temporary commissioner with limited administrative functions.

1.2 Approval of amendments to the original structure of the Roccagiovine CER by the current members

1.3 Statute update and filing with the Revenue Agency

In coherence with the expansion of the association, the CER's name has been changed from "CER of Roccagiovine" to "CER of Valle Ustica," and the composition of the Steering Committee has been revised to ensure representation for the new member-municipalities. These changes, along with other modifications resulting from alignment with updated sectoral regulations, necessitates an amendment to the Association's Statute, which must be filed with the Revenue Agency (Agenzia delle Entrate). The CER's members' assembly approved these changes in September 2025. The filing of the new Statute is currently in progress at the Revenue Agency, Tivoli office.

1.4 Adhesion to the REC by consumers and producers

1.5 Registration of the initial REC configuration on the GSE portal

Following the enlargement of the CER to the other municipalities, it is necessary to relaunch the adhesion campaign for citizens, businesses, and associations. In the first quarter of 2026, both the Union and the individual municipal administrations will publish a new notice on their institutional channels to encourage new members to join the CER.

For the CER to be considered effectively operational, it is necessary to register at least one configuration on the GSE portal (Gestore dei Servizi Energetici, Energy Service Management Authority) and communicate the “Point of Delivery” codes related to the consumption and production units connected to the CER. The completion of this registration is currently dependent on the identification of the production units.

2. Knowledge-Deepening Activities

The second group of activities involves the in-depth analyses required to identify the first configuration to be connected to the CER, along with its related production and consumption units:

2.1 Analysis of electrical energy needs and potential for the installation of municipal RES plants

In order to define the municipalities' actual contribution (in terms of consumption) and potential contribution (in terms of production) to the CER, data on the electrical and thermal consumption of municipal properties were collected, and the availability of roof spaces/areas capable of hosting photovoltaic systems was verified. The table summarizes the results of this study, which was concluded as part of the Life SMART project (task 3.1).

Municipality	Units	Electrical consumptions	Public buildings	Potential PV power
Licenza	23	189.158 kWh/y	6	105 kWp
Mandela	21	149.410 kWh/y	8	205 kWp
Roccagiovine	14	121.648 kWh/y	5	39 kWp
Vicovaro	22	302.228 kWh/y	7	106 kWp
Percile	11	105.927 kWh/y	5	60 kWp
Total - Valle Ustica Union	**91**	**868.371 kWh/y**	**31**	**516 kWp**

Given the available surfaces, the photovoltaic power installable on the rooftops of municipal properties is estimated at 516 kWp, equivalent to a renewable electrical energy production capacity of approximately 670,800 kWh/year, capable of covering about 77% of the current consumption of the local administrations' properties.

2.2 Identification of the financial resources necessary for the implementation of new public RES plants

With the goal of converting the potential identified on public property into production units to be connected to the CER, and having verified the impossibility of realizing investments using only budgetary resources, available national incentives and credit opportunities were thoroughly investigated. Attention was focused on a fund accessible to CER members registered in municipalities with fewer than 5,000 inhabitants (a threshold later raised to 50,000). This involved a program outlined by a NRRP measure (National Recovery and Resilience Plan) and managed by the GSE, which offered capital contributions equivalent to 40% of the costs related to new Renewable Energy Source (RES) plants. For the coverage of the remaining 60%, both direct access to bank credit and project finance were evaluated.

2.3 Survey/Inventory of systems installed by private entities in the last 2 years

This activity serves the purpose of involving new members in the CER who are able to share the energy produced by systems already active, provided they are compatible with the requirements for accessing the incentives for the valorization of self-consumed energy made available by the CACER Decree n.414/2023.

3. RES systems implementation

The activation of the CER—as well as the corresponding cash flow from the GSE incentive for self-consumed energy—is conditional upon the registration of a first configuration that includes at least one production unit and one consumption unit. However, the current membership base includes several consumers but still no production plants that comply with the necessary requirements. Therefore, the development of public projects and support for private investments in RES is a decisive factor for the CER's activation.

Specifically, regarding publicly owned systems, the plan is to resume and develop a series of initiatives already partially explored by the IMTS in the recent months which despite being of great interest, proved to be incompatible with the Life SMART timeline due to procedural and financial issues.

Concerning private systems, the plan is to support current and future CER members in implementing investments in new RES plants, starting with some initiatives already identified and under development. The strategy has therefore incorporated the following measures:

- 1 short-to-medium-term measure (private initiative)
- 3 medium-to-long-term measures (both public and private initiatives).

3.1 First REC production systems (small-scale PV) allowing for the registration of the initial configuration

This measure is essential for registering a first configuration on the GSE portal and allowing the CER access to incentives. To complete this action, interest has been gathered from several private citizens in building small-scale photovoltaic systems, and a process has begun to support them in defining the projects and finalizing the investments.

3.2 PV systems on municipal rooftops

This activity involves the progressive realization of the systems identified as potential within Action 2.1. Each new system installed would be added as a new production unit serving the CER. After noting the lack of sufficient resources for the construction of new plants within the municipal budgets, the IMTS has initiated a process to identify possible financial partners. However, the negative feedback received from potential third-party entities regarding the realization of all systems in a single solution does not exclude the possibility that the municipalities may intervene independently on individual buildings in the future—perhaps as part of public building energy requalification projects—and make the constructed systems available to the CER at a later stage.

3.3 Ground-mounted PV system on land already available to the Union of Municipalities

This activity involves the construction of a new, medium-sized publicly owned plant that would significantly elevate the potential for energy to be shared within the CER. Among the possible locations, an area with industrial zoning, about 1200 mq, located in the municipality of Mandela and already available to the Union (as it was previously designated for a composting plant), has been considered.

The plans for the new composting plant are currently suspended due to changed needs; therefore, an alternative use of the area for a solar farm was evaluated. Based on an initial assessment, the area is correctly exposed and could host a ground-mounted system of about 100 kW with an annual production of approximately 130,000 kWh. The original estimated cost is in the order of 350,000 euros and included expenses for purchasing a storage system, a component that would become less relevant if the system were connected to the CER.

3.4 PV systems on private rooftops and ground-mounted PV system on private land

This activity implies the future development of the CER in the medium/long term, the adhesion of new members, and the updating of the configuration with new systems built on the rooftops of buildings and on the land of private citizens and local businesses. Among the initiatives already started, a ground-mounted photovoltaic system with a power of 500 kWp can be mentioned. This is to be built on land in the municipality of Mandela owned by the current President of the Valle Ustica CER, which can be made available to the community. For this system, a business plan was prepared as part of the LIFE project, estimating a cost of approximately €500,000 and an annual producibility of 650,000 kWh. The implementation process requires carrying out an authorization procedure (Procedura Abilitativa Semplificata), which prevented access to the incentives that expired at the end of November 2025. However, contacts with potential financiers are currently underway.

4. Promotion activities

4.1 Application to the 1st call of European Energy Communities Facility

With the objective of pursuing additional resources to continue supporting the consolidation of the CER beyond the conclusion of the Life SMART, the IMTS developed a proposal for applying to the first call of the EU ENERCOM Facility, published in June 2025 and closed on September 30th (https://energycommunitiesfacility.eu/). The program provides for lump-sum grants of 45,000 euros for the development of business plans, feasibility studies, technical and financial assessments, and legal and administrative procedures to support energy communities in member states and partner countries. If access to the contribution is granted, the subsidy will cover all expenses necessary to prepare a business plan related to new energy systems.

4.2 Facilitation activities targeted to the REC members/potential members

This activity is functional to encouraging the involvement of new prosumer members in the CER, specifically by supporting the realization of new domestic and small-scale energy systems. As part of this activity, the plan is to launch a list of companies and experts who can support the citizens of Valle Ustica in purchasing and installing RES plants for residential use, thereby facilitating the connection between supply and demand. To compile this list, the Union of Municipalities will soon launch a market survey to identify interested companies and technicians willing to offer their services in the area. There are no fees for the companies and no obligations for the citizens. The applications submitted by technicians and companies will be subject to a verification of basic requirements (registration with the Chamber of Commerce, ATECO code, past experience, minimum turnover). The list will be published on the institutional websites of the Union and the Municipalities.

5.3 Emerging challenges

While confirming the interest in the development and consolidation of an energy community among the municipalities of the Valle Ustica Union, it is necessary to highlight some critical issues that emerged during the process of defining an implementation strategy, which led the working group to partially modify its approach and focus areas.

Following the elections that took place in June 2024, a political turnover occurred in the municipality of Vicovaro, resulting in a certain reduction in the level of involvement in the Life-SMART activities. As Vicovaro is the most populous municipality, this circumstance partially affected the other municipalities as well, leading to less momentum than expected and to an uneven participation of mayors and technical staff in the meetings organized to give substance to the CER proposal.

In this context, it was not possible to identify concrete solutions for the construction of publicly owned photovoltaic systems to serve the community that could be submitted for financing within the deadlines provided by the incentive program identified as the most advantageous for the Valle Ustica area. This program, outlined by a PNRR measure and managed by the GSE, offered capital contributions equal to 40% of the costs related to new RES plants to CER members registered in municipalities below 5,000 inhabitants (a threshold later raised to 50,000). The call for applications closed on November 30, 2025, unfortunately without the Union being able to submit any project.

Despite having explored multiple site proposals and financing options, the short-term possibility of launching the CER by registering a first configuration with municipal users in the role of "prosumer" was missed.

The financial issue once again proved to be the weak point: the hypothesis of building one or more small systems on the rooftops of public buildings was abandoned due to the lack of budgetary resources and the impossibility of incurring debt, both by the individual municipalities and the Union. The alternative of building a single, medium-sized plant involving third parties (ESCOs) also did not progress, as it was deemed not particularly attractive in terms of return on investment for private investors. Further slowdown factors were related to the need for expenditure to carry out certain procedures necessary to verify the feasibility of the proposals (e.g., connection cost estimates).

These circumstances prompted the IMTS to shift its focus from potential public investments to the most effective ways of encouraging the involvement of private citizens, families, and businesses willing to invest in RES and share the energy produced by their systems within the CER. The projects explored over the months, both those of public and private initiative, have been included in the strategy as medium-to-long-term actions.

PART III – CONCLUSIONS (by task leader, CCI NCA)

1. Overall Conclusion and Crossed insights

The comparative analysis of the D3.3 Country Reports demonstrates a strong alignment of challenges, priorities and strategic responses across the participating territories, despite differences in national frameworks, governance structures and levels of local capacity. Across all countries involved, small and medium-sized municipalities are confronted with similar structural constraints: an aging and energy-inefficient public building stock, limited internal technical and financial resources, increasing regulatory obligations, and the need to translate ambitious climate and energy objectives into concrete, implementable actions.

In this context, Task 3.3 has proven to be a decisive step in moving from planning to action. The structured methodology adopted within LIFE SMART — combining energy diagnostics, transparent prioritization tools and close collaboration between municipalities and inter-municipal technical support teams (IMTS) — has enabled local authorities to identify realistic priority actions and to develop mature, investment-ready strategies. This approach has reinforced coherence between local energy strategies and national or European funding mechanisms, while ensuring that projects are adapted to local constraints and opportunities.

2. Examples of Common Priority Actions identified

Across the country reports, several recurring categories of priority actions can be identified. In Greece, municipalities focused primarily on the deep energy renovation of public buildings, particularly schools, addressing both high energy consumption and binding regulatory requirements under the EPBD and national legislation, while improving comfort and service quality. In France, the emphasis was placed on the systematic assessment and optimization of municipal building stocks, using prioritization matrices aligned with national regulatory frameworks such as the Décret Éco-Énergie Tertiaire, ensuring both compliance and cost-effectiveness.

In Italy, the reports highlight a strong focus on the activation of Renewable Energy Communities combined with enabling infrastructure, notably electric vehicle charging systems. This integrated approach reflects a broader vision of energy transition, linking renewable energy production, local energy sharing and sustainable mobility. Italian municipalities emphasized the importance of governance models, stakeholder engagement and legal structuring of energy communities, underlining the need for clear institutional coordination and technical assistance to manage complex, multi-actor projects.

In Spain, the selected priority actions reflect the need to balance energy efficiency improvements with territorial cohesion and administrative capacity. The reports underline the importance of structured planning tools, inter-municipal cooperation and regulatory alignment to enable municipalities to move from diagnostics to implementation. Spanish partners highlighted the value of scalable and replicable solutions, particularly those that can be adapted to municipalities with very different sizes, resources and socio-economic contexts, reinforcing the relevance of shared methodologies and collective learning.

Portugal stands out for the coordinated and inter-municipal selection of Renewable Energy Communities as a priority action across six municipalities. This choice reflects a strategic shift towards decentralised, cooperative and citizen-oriented energy models, strongly embedded in local Climate and Energy Action Plans. The Portuguese experience illustrates the added value of harmonised technical approaches and shared implementation frameworks at regional level.

3. Key Lessons Learned

Several key lessons emerge consistently from the reports. First, **robust technical and organisational support** is essential for small municipalities to design and prepare complex energy transition projects. IMTS and external experts play a critical role in consolidating data, navigating regulatory and financial frameworks, and structuring viable governance models. Second, **data availability and quality** remain a major challenge, often requiring additional coordination and harmonisation efforts. Third, **early involvement of elected officials**, municipal staff and local stakeholders significantly enhances ownership, feasibility and long-term sustainability. Finally, **inter-municipal cooperation** consistently emerges as a major success factor, enabling economies of scale, knowledge sharing and improved replicability of solutions.

4. Main Recommendations

Based on the findings, the reports put forward several strategic recommendations aimed at enhancing energy project planning and implementation at the municipal and inter-municipal levels. First, there is a strong need to **strengthen local and inter-municipal energy engineering capacities**. This involves not only hiring or training skilled personnel but also fostering knowledge exchange networks between municipalities to leverage expertise and best practices.

Second, the reports emphasize the value of **systematizing the use of prioritization and decision-support tools**. Municipal teams should integrate these tools into standard project planning workflows to ensure that energy investments are both efficient and aligned with broader sustainability

goals. Early adoption of these tools can facilitate evidence-based decision-making and optimize resource allocation.

Third, **anticipating regulatory requirements at an early stage of project design** is critical. Proactive consideration of evolving national and European regulations can reduce implementation delays, avoid compliance risks, and improve the overall feasibility of energy initiatives.

Fourth, the reports highlight the importance of **diversifying financing sources**. Combining national funding, European support, and innovative mechanisms—such as Energy Performance Contracting—can provide more resilient and sustainable financing structures for energy projects. This approach can also enable municipalities to leverage private investment and reduce upfront capital constraints.

Finally, the recommendations stress **investing in capacity building** through targeted training programs and long-term support for municipal teams. Continuous professional development, mentorship schemes, and dedicated advisory services can strengthen institutional knowledge, ensure continuity in project management, and enhance the overall quality of energy interventions.

Together, these measures aim to create a robust, integrated framework for municipal energy planning, combining technical expertise, strategic financing, and proactive regulatory alignment to accelerate the transition to sustainable energy systems.

5. Opening perspective: Renewable Energy Communities as a Structuring Solution

Looking ahead, one solution emerges particularly clearly and repeatedly across all national contexts: **Renewable Energy Communities**. RECs address multiple challenges simultaneously, including decarbonization, energy cost control, local energy autonomy and citizen engagement. The country reports confirm that RECs are evolving and already offer operational solutions, supported by evolving legal frameworks and by a growing ecosystem of technical, legal, economic and governance tools.

From a practical perspective, Renewable Energy Communities offer **complementary benefits for all stakeholders**. Municipalities can **reduce energy expenditure, valorize public assets and strengthen territorial resilience**. Businesses gain ac**cess to locally produced renewable energy** while reinforcing their **sustainability strategies and competitiveness**. Citizens benefit from **collective self-consumption, increased awareness and direct participation in local energy governance**. The reports also emphasize the availability of concrete support structures to accompany these initiatives. In the French context, for example, the CCI Nice Côte d'Azur has developed dedicated tools, training programs and methodologies through initiatives such as the RECROSSES project (Interreg ALCOTRA) and through direct support to the MERIDIA Renewable Energy Community, illustrating the feasibility, transferability and scalability of such approaches.

Overall, the D3.3 Country Reports confirm that there is an interest in the development of Renewable Energy Communities. Moreover, when supported by adequate technical assistance, governance models and capacity-building actions, Renewable Energy Communities can represent a highly replicable, inclusive and impactful pathway to accelerate the energy transition in small and medium-sized municipalities across Europe.

LIST OF ANNEXES IN NATIONAL LANGUAGES

Annexes related to the Greek target area

ANNEX I

Greek National Laws & Regulations Relevant to Municipal Buildings

Legal Instrument	Key Provisions / Obligations for Municipal/Public Buildings
Law 4122/2013 — "Energy Performance of Buildings"	Transposes EPBD (2010/31/EU) into Greek law. Sets minimum energy performance requirements for new and significantly renovated buildings; requires EPCs; mandates NZEBs as per dates above.
KENAK (Regulation on the Energy Performance of Buildings) via Joint Ministerial Decision DEPEA/ oik.178581/12.07.2017	Provides technical regulation: methodology for calculating energy performance, minimum technical specs (thermal insulation, HVAC, solar heating, lighting, envelope, etc.). Inclusive of public buildings.
Law 4342/2015	Transposes Energy Efficiency Directive. Includes obligations for public bodies: e.g. that a certain % of the floor area of heated/cooled public buildings be renovated annually to meet minimum performance.
Law 5037/2023, **Law 5106/2024**	Newer regulations which strengthen NZEB standards, RES usage, stricter EPC rules, energy management systems thresholds, etc. Public buildings must comply with updated NZEB, incorporate renewables, etc.
Law 4936/2022 – Greek Climate Law	Introduces Municipal Emission Reduction Plans; requires municipalities to inventory buildings, set emission reduction targets for their building stock and infrastructure used by the local authority; tie in with eligibility for funding.

Obligation	What It Requires	Legal Source(s)	Deadline or Effective Date	Applies to Public / Municipal Buildings	Notes
Annual Renovation Rate: 3% of public building floor area	Public bodies (central government) must renovate **3% of total heated/cooled floor area** of their buildings each year to meet *minimum energy performance requirements*.	Law 4342/2015 (transposing the EED), Article 7	From 1 January 2014 onward	Central Government public buildings: over a threshold of size (heated/cooled, etc.)	In practice, there has been updating of which buildings qualify, updating of lists (by area thresholds etc.). ca-epbd.eu+1
NZEB for new buildings	All **new public buildings** must be Nearly Zero-Energy Buildings; later all new buildings (public + private) must meet NZEB standard. Also, incorporation of solar thermal / RES for hot water where required.	Law 4122/2013 (Energy Performance of Buildings), Law 5037/2023, KENAK, EPBD Directive.	Public sector: by 1 January 2019 (or earlier) for new public buildings to comply; For all new buildings: by 1 January 2021 in Greece	New municipal (public sector) buildings, in their design/permit stage.	"Nearly Zero Energy Building" standards include tight energy performance + a large share of on-site or nearby renewable energy.
Rented or Purchased Buildings by Public Bodies – Energy class requirement	Buildings rented or purchased by public bodies before a certain date must have at least energy class **B**.	Law 4342/2015 amendments.	Before 1 January 2020: rented or purchased buildings must be class B	Municipalities when they purchase or rent existing buildings, or when ownership / occupancy changes.	If not, they need upgrading or must bring the building to class B.
Zero-Emission Buildings (ZEB) requirement under revised EPBD	New public buildings must become **zero-emission buildings** (no on-site fossil fuel emissions; high performance + renewables).	Revised EPBD (EU/2024/1275), transposed via laws like 5037/2023	From 1 January 2028 for new public buildings	All new municipal / public-authority owned buildings from that date forward.	"Zero emission" standard is stricter than NZEB; requires that fossil fuel emissions on-site are essentially zero.

Obligation	What It Requires	Legal Source(s)	Deadline or Effective Date	Applies to Public / Municipal Buildings	Notes
Minimum Energy Performance Requirements (MEPR) for major renovations	Buildings undergoing **major renovations** must meet an energy class or performance standard (minimum envelope, systems etc.), per "cost-optimal" studies & KENAK.	KENAK (Regulation on Energy Performance of Buildings), Ministerial Decisions (e.g. DEPEA/oik.178581/2017, etc.)	Already in force with respect to renovations since amendment of KENAK around 2017	Municipal buildings undergoing renovation work deemed "major".	"Major renovation" means substantial work to envelope or systems, especially if cost exceeds certain proportion of value.
Transposition of Revised EPBD & buildings regulation deadlines	Must transpose certain articles of EPBD (new version) into national law and adhere to deadlines for ZEB, GWP, etc.	EPBD revised EU/2024/1275; national laws and amendments (e.g. Law 5037/2023 etc.)	EPBD revised enters into force: 28 May 2024 Deadline for transposition of general revised EPBD: 29 May 2026 From 1 January 2028 public buildings new to be zero emission buildings under revised standards	Municipal buildings that are new from those dates, or undergoing major renovation, must comply under new standards.	
Long-Term Renovation Strategy / Building Renovation Plans	Obligation to have national plans and for public bodies to implement renovation strategies.	Law 4122/2013, EPBD (and revisions), NECP.	Already in place; updated with the revised EPBD; deadlines for national building renovation plans: **31 December 2025** (draft) and final		

ANNEX II

Energy Performance Certificates of Municipal Buildings included in the META-Build project Action Plan

I/N	Building	Municipality	Year of Construction	Address	Total Surface (m^2)	Floors	Use	Heating System	Cooling System	Annual CO_2 Emissions (kg/m^2)	Energy efficiency class	Coordinates	Primary Energy Consumption (kWh/m^2)	Primary Energy Savings (kWh/m^2)	Primary Energy consumption TARGET. (kWh/m^2)	Total annual Difference kWh
1	1st - 2nd Kindergarten of Arnea	Aristotle	1989	Aristotelous 95,Arnea	690,57	3	Education	Oil boiler	Does not exist	94,9	G	40.48828250726382, 23.598336925938423	305,8	273,5	32,3	188.870,9
2	Arnea Primary School	Aristotle	1998	Arnea	1075,13	3	Education	Oil boiler	Does not exist	49,24	E	40.48745367434062, 23.597695951894945	177,5	123,92	53,58	133.230,1
3	Arnea Middle School	Aristotle	1995	Provincial road Arnea-Apollonia	935,91	2	Education	Oil boiler	Does not exist	25,94	B	40.48745367434062, 23.597695951894945	88,7	61,68	27,02	57.726,9
4	Arnea High School	Aristotle	1977	Prov. Bukova Chrysostomou	3128,23	3	Education	Oil boiler	Does not exist	29,3	D	40.486599570480124, 23.599261139432976	107,5	85,63	21,87	267.870,3
5	Paleochori Primary School	Aristotle	1972	Paleochori, Arnea	1374,84	2	Education	Oil boiler	Does not exist	16	C	40.530711447180984, 23.67076968793881	123,7	70,4	53,3	96.788,7
6	Paleochori Middle School	Aristotle	1980	Paleochori	1386,5	2	Education	Oil boiler	Does not exist	159,6	E	40.511703555152096, 23.452985362975916	540,9	530,79	10,11	735.940,3
7	Megali Panagia Primary School	Aristotle	1932	M. Panagia	1047,96	3	Education	Air Conditioning Units/ Electricity	Does not exist	-	B	40.44297909307608, 23.680323152926153	340,3	275	65,3	288.189,0
8	Megali Panagia Middle School	Aristotle	1980	M. Panagia	1280	2	Education	Oil boiler	Does not exist	-	B+	40.445771314724354, 23.674700297101506	-	-	-	-
9	2nd Kindergarten - 2nd Primary School of Ierissos	Aristotle	1999	26th of September	951,76	2	Education	Oil boiler	Does not exist	-	F	40.40062558599261, 23.873014839429704	-	-	-	-

I/N	Building	Municipality	Year of Construction	Address	Total Surface (m^2)	Floors	Use	Heating System	Cooling System	Annual CO_2 Emissions (kg/m^2)	Energy efficiency class	Coordinates	Primary Energy Consumption (kWh/m^2)	Primary Energy Savings (kWh/m^2)	Primary Energy consumption TARGET. (kWh/m^2)	Total annual Difference kWh
10	Ierissos Middle and High School	Aristotle	1976	King George	2484,14	3	Education	Oil boiler	Does not exist	25,63	B	40.39514276284994, 23.87468189709965	242,4	149,9	92,5	372.372,6
11	Ierissos Indoor Gymnasium	Aristotle	1999	Ierissos	1577,71	1	Culture-Sports-Catering	Oil boiler	Does not exist	132	F	40.40551251780956, 23.872692527780476	464,5	-	464,5	0,0
12	Aristotle Spiritual Center	Aristotle	2001	Ierissos	1573,11	2	Culture-Sports-Catering	Oil boiler	Does not exist	161,6	D	40.3973727271195, 23.877210075646488	502,5	-	502,5	0,0
13	Town Hall of Asprovalta	Volvi	1987	Asprovalta ,173	1571,18	3	Multipurpose	Oil boiler	Air Conditioning Units	115	E	40.71927102913551, 23.70807696644568	353,7	279,5	74,2	439.144,8
14	Town Hall of Vrasna	Volvi	1997	N/A	488,61	2	Multipurpose	Oil boiler	Air Conditioning Units	86,2	D	40.70545216170705, 23.651726060292365	276,8	217,6	59,2	106.321,5
15	Town Hall of Stavros (KAPI)	Volvi	1988	Stavros	846	2	Multipurpose	Oil boiler	Air Conditioning Units	109,2	D	40.665450866998, 23.699802041309137	308,4	195,3	113,1	165.223,8
16	Town Hall of Stavros (KEP)	Volvi	1975	Stavros	457,18	3	Offices	Oil boiler	Air Conditioning Units	286,2	E	40.665450866998, 23.699802041309137	286,2	246,3	39,9	112.603,4
17	High School - Middle School of Nea Madytos	Volvi	-	Nea Madytos	2236,8	3	Education	Oil boiler	Does not exist	35	D	40.62569809195447, 23.56374944551264	118	66,5	51,5	148.747,2
18	Elementary School of Nea Apollonia	Volvi	1932	N/A	1332,7	2	Education	Oil boiler	Does not exist	50,4	E	40.62527240438132, 23.440682235211952	182,4	145	37,4	193.241,5

I/N	Building	Municipality	Year of Construction	Address	Total Surface (m^2)	Floors	Use	Heating System	Cooling System	Annual CO_2 Emissions (kg/m^2)	Energy efficiency class	Coordinates	Primary Energy Consumption (kWh/m^2)	Primary Energy Savings (kWh/m^2)	Primary Energy consumption TARGET. (kWh/m^2)	Total annual Difference kWh
19	Elementary School of Arethousa	Volvi	1954	N/A	628,84	1	Education	Oil boiler	Does not exist	60,8	F	40.741924904734944, 23.590506685490993	221,4	185,2	36,2	116.461,2
20	Middle School of Arethousa	Volvi	1986	N/A	1017,32	2	Education	Oil boiler	Does not exist	40,2	D	40.7419348021508, 23.589660123998886	136,4	90,8	45,6	92.372,7
21	Middle School of Nea Apollonia	Volvi	1986	N/A	1325,76	2	Education	Oil boiler	Does not exist	37,1	D	40.63378945675626, 23.441712203448212	123,6	74,1	49,5	98.238,8
22	Junior High School of Stavros	Volvi	1997	Stavros	2099.43	2	Education	Natural Gas boiler	Does not exist	49,3	E	40.664709794825384, 23.694751988815906	224,1	161,35	62,75	131.708

Local Community	ARNEA			
Element				
	1st-2nd Kindergarten of Arnaia	Primary School of Arnaia	Junior High School of Arnaia	General Lyceum of Arnaia
Construction year	1989	1998	1995	1977
Use	Education	Education	Education	Education
Address	Aristotelous 95, Arnaia	Arnea	Arnaia-Apollonia road	Ep. Bukoba Chrysostomou
Heated Floor area (m^2)	690.57	1075.13	935.91	3128.23
Heated Building Volume (m^3)	2071.71	3225.39	1871.82	9384.69
Total Floor area (m^2)	621.513	967.617	842.319	2815.407
Total Building Volume (m^3)	1864.539	2902.851	1684.638	8446.221
Number of Floors	3	3	2	3
Building Energy Efficiency Class	Energy Class H	Energy Class E	Energy Class B	Energy Class D
EPC Number	2018	50022/2015	48783/2015	48785/2015
Estimated annual Primary energy consumption (kWh/m^2)	90.4	81.6	75.3	66.5
Estimated annual primary energy consumption (kWh/m^2)	367.9	177.5	58	100.5
Estimated annual CO_2 emissions (kg/m^2)	94.9	49.24	25.94	29.3
Heating system	Oil Boiler	Oil Boiler	Oil Boiler	Oil Boiler
Heating System - Fuel	Petroleum	Petroleum	Petroleum	Petroleum

Local Community	ARNEA			
Element				
	1st-2nd Kindergarten of Arnaia	Primary School of Arnaia	Junior High School of Arnaia	General Lyceum of Arnaia
Heating system - Installed Power (kW)	50 to 100	100 to 200	50 to 100	200 to 300
Heating system - Efficiency Rating	81.8	85	81.8	86.8
Cooling system	None	None	None	None
Cooling System - Installed Power (kW)	-	-	-	-
Cooling System - Efficiency Rating	-	-	-	-
Legally existing in its entirety	Yes	Yes	No	No
In Operation / Closed	In operation	In operation	In operation	In operation
Small scale Renovation	Yes	Yes	Yes	Yes
Radical Renovation	No	No	No	No
Number of permanent users on a daily basis	84	286	180	819
Average number of visitors on a daily basis	60	30	5	5
Existence of Energy Management System (i.e. ISO 50001)	No	No	No	No
Type of RES system installed in the building	None	None	None	Solar panels
Annual heating oil consumption (KWh)	170667.47	129660.68	42200.18	228047.97
Annual natural gas consumption (KWh)	0	0	0	0
Annual power consumption (KWh)	14108.35	42091.34	37146.27	74608.29

Local Community	PALEOCHORI	
Elements		
	Primary School of Palaiochori	Junior High School of Paleochori
Construction year	1972	1980-1982
Use	Education	Education
Address	Palaiochori Arnaia	Palaiochori Arnaia
Heated Floor area (m^2)	1374.84	1386.5
Heated Building Volume (m^3)	2749.68	2773
Total Floor area (m^2)	1237.356	1247.85
Total Building Volume (m^3)	2474.712	2495.7
Number of Floors	2	2
Building Energy Efficiency Class	Energy Class C	Energy Class E
EPC Number	47508/2015	83422/2023
Estimated annual primary energy consumption or reference building (kWh/m^2)	40	326.3
Estimated building's annual primary energy consumption (kWh/m^2)	53.3	633.1
Estimated annual CO_2 emissions (kg/m^2)	16	159.6
Heating System	Oil Boiler	Oil Boiler
Heating System - Fuel	Petroleum	Petroleum
Heating System - Installed Power (kW)	100 to 200	100 to 200
Heating System - Efficiency Rating	81.8	81.8
Cooling system	None	None
Cooling System - Installed Power (kW)	0	0

Local Community	PALEOCHORI	
Elements		
	Primary School of Palaiochori	Junior High School of Paleochori
Cooling System - Efficiency Rating	0	0
Designated energy manager	No	No
Legally existing in its entirety	No	Yes
In Operation / Closed	In operation	In operation
Small-scale renovation	Yes	Yes
Radical Renovation	No	No
Number of permanent users on a daily basis	427	200
Average number of visitors on a daily basis	10	5
Existence of Energy Management System (i.e. ISO 50001)	No	No
Type of RES system installed in the building	None	None
Annual heating oil consumption (KWh)	28830.39	645013.67
Annual Natural Gas Consumption (KWh)	0	0
Annual electricity consumption (KWh)	37120.68	29948.4

Local Community	MEGALI PANAGIA	
Elements		
	Primary School of M. Panagia	Junior High School of M. Panagia
Built	1932	1980
Use	Education	Education
Carrier	Municipality of Aristotle	Municipality of Aristotle
Address	M. Panagia	M. Panagia
Heated Floor area (m^2)	1047.96	1280
Heated Building Volume (m^3)	3143.88	2560
Total Floor area (m^2)	943.164	1152
Total Building Volume (m^3)	2829.492	2304
Number of Floors	3	2
Building Energy Efficiency Class	Energy Class B	Energy Class B+
EPC Number		
Estimated annual primary energy consumption or reference building (kWh/m^2)	89.2	-
Estimated building's annual primary energy consumption (kWh/m^2)	86	-
Estimated annual CO_2 emissions (kg/m^2)		
Heating System	Air Conditioning Units	Oil Boiler
Heating System - Fuel	Electricity	Petroleum
Heating System - Installed Power (kW)	100 to 200	100 to 200
Heating System - Efficiency Grade	81.8	81.8

Local Community	MEGALI PANAGIA	
Elements		
	Primary School of M. Panagia	Junior High School of M. Panagia
Cooling system	None	None
Cooling System - Installed Power (kW)	0	0
Cooling System - Efficiency Grade	0	0
Legally existing in its entirety	No	Yes
In Operation / Closed	In operation	In operation
Small-scale renovation	Yes	Yes
Radical Renovation	No	No
Number of persistent users on a daily basis	282	253
Average number of visitors on a daily basis	10	5
Existence of Energy Management System (π.χ. ISO 50001)	No	No
Type of RES system installed in the building	Photovoltaic Panels	Solar panels
Annual heating oil consumption (KWh)	-	-
Annual Natural Gas Consumption (KWh)	-	-
Annual electricity consumption (KWh)	-	-

Local Community	IERISSOS			
Element				
	2nd Kindergarten- 2nd Primary School of Ierissos	Junior High School of Ierissos	Ierissos Indoor Gym	Aristotle Cultural Center
Built	1999	1976	1999	2001
Use	Education	Education	Culture-Sports	Culture
Address	26th September	Vasileos Georgiou	Ierissos Halkidiki	Ierissos Halkidiki
Heated Floor area (m^2)	951.76	2484.14	1577.71	1573.11
Heated Building Volume (m^3)	1903.52	7452.42	1577.71	3146.22
Total Floor area (m^2)	856.58	2235.726	1419.939	1415.799
Total Building Volume (m^3)	1713.17	6707.178	1419.939	2831.598
Number of Floors	2	3	1	2
Building Energy Efficiency Class	Energy Class G	Energy Class B	Energy Class G	Energy Class D
EPC Number	0	48145/2015	0	257909/2018
Estimated annual primary energy consumption of reference building (kWh/m^2)	-	71	761.4	353.3
Estimated building's primary energy (kWh/m^2)	-	64.1	464.5	502.5
Estimated annual CO_2 emissions (kg/m^2)	-	25.63	132	161.6
Heating system	Oil Boiler	Oil Boiler	Oil Boiler	Oil Boiler
Heating System - Fuel	Petroleum	Petroleum	Petroleum	Petroleum
Heating system - Installed Power (kW)	100 to 200	200 to 300	100 to 200	200 to 300
Heating System- Efficiency Grade	81.8	86.8	81.8	86.8

Local Community	IERISSOS			
Element				
	2nd Kindergarten- 2nd Primary School of Ierissos	Junior High School of Ierissos	Ierissos Indoor Gym	Aristotle Cultural Center
Cooling system (description)	None	None	None	None
Cooling System - Installed Power (kW)	0	0	0	0
Cooling System- Efficiency Grade	0	0	0	0
Legally existing in its entirety	No	No	No	No
In Operation / Closed	In operation	In operation	In operation	In operation
Small-scale renovation	Yes	No	Yes	Yes
Radical Renovation	No	No	No	No
Number of permanent users daily	195	553	-	-
Average number of visitors daily	5	20	-	-
Existence of Energy Management System	No	No	No	No
Type of RES system installed in the building	Photovoltaic Panels	Photovoltaic Panels	Solar panels	Solar panels
Annual heating oil consumption (KWh)	-	114692.74	123818.68	10760.72
Annual consumption of natural gas (KWh)	-	0	0	0
Annual power consumption (KWh)	-	28617.29	189561.86	207131.39

Annexes related to the Portuguese target area

- Annex A. Aggregate Study for the implementation of Renewable Energy Communities.
- Annex B. Technical Appendices by Municipality:

  I – Renewable Energy Community of the Municipality of Alter do Chão;

  II – Renewable Energy Community of the Municipality of Avis;

  III – Renewable Energy Community of the Municipality of Castelo de Vide;

  IV – Renewable Energy Community of the Municipality of Monforte;

  V – Renewable Energy Community of the Municipality of Sousel;

  VI – Renewable Energy Community of the Municipality of Marvão.

Annexes related to the French target area

- Annex 1 - Methodology
- Annex 2 – Action Plan SAINT-VALLIER
- Annex 3 – Action Plan BIOT
- Annex 4 – Action Plan SAINT MARTIN
- Annex 5 – Action Plan TENDE

Annexes related to the Spanish target area

- Annex_B

Annexes related to the Italian target area

- Annex_Valle Ustica REC implementation strategy

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