Interreg Euro-MED

Co-funded by the European Union

EnerCmed

Deliverable D2.2.1

Assessment of technical and economic sustainability

Document information Table

Project Data			
Project acronym	EnerCmed		
Project ID	Euro-MED0200723		
Project title	Testing energy-community & climate-resilient integrated paradigm for carbon neutrality and energy poverty shielding in MED city-port hinterlands		
Project category	Test project (Thematic Project)		
Project duration	33 months		
Coordinator	UNIGE		
Website	https://enercmed.interreg-euro-med.eu/		
Project acronym	EnerCmed		
Deliverable Document Sheet			
Deliverable no.	2.2.1		
Deliverable title	Assessment of technical and economic sustainability		
Description	Verification, using a standardized business model offered by KFI, of the technical and economic sustainability from the outputs emerged through the sharing and co-design participation, subject to further developments through the analysis of technical & economic sustainability of generation plant.		
WP No.	WP 2		
Related task	Activity 2.2		
Lead beneficiary	Sinloc		
Author(s)	Matteo Meneghetti, Francesca Pozzar		
Contributor(s)	VCE, IRENA, PAT, MGE		
Reviewers			
Type			
Dissemination L.			
Due date	30/06/25	Submission date	

Version	Date	Author(s)	Organisation	Comments
0.1	20-06-2025	Matteo Meneghetti, Francesca Pozzar, Vlada Semkina, Andrea Gianese	Sinloc	Final Draft
0.2	25-05-2026	N.a.	MGE, IRENA, VCE, PAT	Partner Review
1	30-06-2025	Matteo Meneghetti, Francesca Pozzar	Sinloc	Final Version

DISCLAIMER

Abstract

Deliverable D2.2.1 assesses the technical design and economic sustainability of five lighthouse pilots implemented under the Interreg Euro-MED *EnerCmed* project—Genoa (IT), Valencia-Ballester Fandos and Valencia-Ausiàs March (ES), Novigrad and Pula (HR), and Patras (GR). Applying a multi-stage, standardized appraisal protocol, Sinloc collated regulatory, technical and financial data from each pilot, configured site-specific techno-economic models, and tested financial viability under two scenarios: (i) full grant support and (ii) unsubsidized replication. Continuous engagement with local leaders ensured data completeness and contextual accuracy.

The pilots illustrate a spectrum of business configurations aligned to national frameworks—from remote individual self-consumption (Genoa) and municipality-led net-metering (Patras, Pula) to solidarity-based Renewable-Energy Communities (Valencia) and a regional ZOIE association (Novigrad). Capital investments range from €19 k to €114 k and, excluding grants, yield payback periods of 4.5–9.5 years, well within public-sector acceptability for socially oriented projects. Grant-funded variants achieve near-instantaneous payback, freeing cash flow for social initiatives such as energy-poverty alleviation and homeless-shelter support. Key value drivers include high self-consumption ratios, streamlined governance that minimizes administrative overheads, and falling photovoltaic equipment costs.

Technical due-diligence flagged structural constraints at Ausiàs March and Novigrad, underscoring the need for early engineering surveys. Nevertheless, all pilots demonstrate operational robustness, legal compliance and clear social co-benefits—budget relief for schools, protection of vulnerable households, and enhanced community engagement—while remaining replicable under national regulations.

The findings validate photovoltaic-centred self-consumption and community-energy schemes as viable pathways for Mediterranean port cities seeking low-carbon, socially inclusive energy transitions.

EnerCmed Interreg Euro-MED Co-funded by the European Union

Table of contents

List of Tables

List of Figures

List of Acronyms

Acronym	Meaning
REC	Renewable Energy Community
NBS	Natural Base Solution

Introduction

Deliverable D2.2.1 documents the integrated assessment of technical and economic sustainability carried out within Activity A2.2, "Financial modelling, contractual determination & technical design of the lighthouse RECs." The analysis concerns the six renewable-energy communities (RECs) and collective self-consumption schemes that EnerCmed is activating in Valencia, Genoa, Novigrad, Pula and Patras.

Building on the knowledge services of the Knowledge Facility Instrument and on the standardized business-model toolkit supplied by Sinloc, the deliverable benchmarks each pilot against a harmonized set of techno-economic criteria: admissible installed power, annual energy balance, investment outlays, financing mix, operating expenditures, incentive structures, governance architecture and distributional impacts on vulnerable households.

The overarching objective is to verify that every pilot is consistent with both local regulatory constraints and EnerCmed's mission to accelerate an inclusive energy transition in Mediterranean port-hinterland neighborhoods. The output of this assessment will inform the broader life-cycle costing and impact appraisal to be delivered under Activity A2.6. By providing a transparent, comparative evidence base, Deliverable D2.2.1 also supports partner cities in refining their replication strategies and gives external stakeholders—investors, public authorities and community representatives—a clear view of the technical robustness and economic soundness of the proposed REC configurations.

Methodology

The assessment protocol adopts a four-stage analytical sequence that reflects best practice in energy-investment appraisal and ensures comparability across heterogeneous urban contexts.

The first stage establishes the analytical baseline. For each pilot, Sinloc consolidates quantitative and qualitative inputs drawn from three sources:

I. Normative dashboards summarising national regulatory frameworks;

II. Pilot-characterisation files detailing site logistics, demand profiles and proposed photovoltaic (PV) layouts;

III. Supplemental questionnaires and data templates populated by local leaders under Sinloc's guidance.

A targeted gap analysis identifies missing variables and information and triggers iterative data-collection cycles until completeness is achieved.

The second stage configures the techno-economic model. Using Sinloc's validated methodologies, system boundaries and key parameters have been defined: PV array size, expected annual yield (validated through PVGIS), shared-energy coefficients, CAPEX (disaggregated into technical related and administrative related), OPEX, revenyues and incentive entitlements. The model also embeds location-specific escalation factors for electricity prices, maintenance and other pilot specific aspects. Where pilot stakeholders envisage additional technologies or needed intervention (i.e. Roof renovations), sensitivity nodes are added so that incremental impacts can be isolated.

The third stage executes the financial-viability test. Cash-flow projections are run for two scenarios:

I. Program-funded scenario reflecting EnerCmed capital grants and any national incentives;

II. Unsubsidized base to evaluate the replicability of the action out of the project perimeter.

Payback Period are computed to evaluate the sustainability of the operation in both the scenarios. Technical sustainability is appraised in parallel by verifying that the proposed installations.

The results of contained in this document, and the additional information elaborated during the tasks will serve as input for the activity A2.6, "Environmental, economic and social impact assessment associated to the pilots." The study, by implementing a Life Cycle Costing (LCC) method, will integrate the profitability of the photovoltaic component with Natural Based Solution and their impacts on stakeholders.

Italian pilot of Genoa

Italian legislation offers different opportunities for the development of Renewable Energy Communities and Self-Consumption Configurations. The Genova municipality implemented a sustainable model of Remote Individual Self-Consumption by installing two PV plants on public educational buildings.

The following chapters describe the various opportunities available under Italian legislation, including the Municipality's choice to adopt a sustainable energy model and assess the economic sustainability of the pilot project.

Renewable Energy Communities and Self-Consumption Configurations

Italian legislation on CACER (Configurazioni per l'Autoconsumo di Energia Rinnovabile) categorizes four main approaches to collective or shared energy usage (GSE, 2025).

- **Renewable Energy Community** (REC): A formal legal entity grouping multiple participants who share ownership and decision-making. Governance is more complex, with members able to share energy within the same electricity market zone. Self-consumption is calculated per HV/MV primary substation.
- **Citizen Energy Community** (CEC): Similar to REC, CECs manage both renewable and non-renewable electricity within the same market zone. It involves multiple participants, formal legal status, shared ownership, and decision-making, requiring intricate governance.
- **Collective Self-Consumption Group** (CSC): Applicable in single multi-unit buildings such as apartment complexes. This configuration allows shared self-consumption among units within a single building, simplifying governance compared to RECs and CECs.
- **Remote Individual Self-Consumption** (ISC): Focuses on a single entity, whether public or private, owning multiple production and consumption points within one primary substation perimeter. This setup avoids the necessity for forming a new legal entity, streamlining administrative obligations.

The MASE (Ministero per l'Ambiente e la Sicurezza Energetica) Decree 414/2023 clarifies how these configurations can obtain incentives for the portion of renewable energy either self-consumed or shared. The new regulatory environment also provides certain capital contributions from the National Recovery and Resilience Plan (PNRR) if the installations are in municipalities below 50,000 inhabitants. A more detailed description of the Italian normative has been produced as part of the Activity 1.1.

Table 1 presents a concise comparative overview of four three possible configurations.

EnerCmed | Interreg Euro-MED | Co-funded by the European Union

Model	Legal Form Requirement	Members	Location Constraints	Administrative Complexity
Renewable energy community	Yes	Multiple	Same primary substation[1]	High
Citizen Energy Community	Yes	Multiple	Same market area	High
Collective self-consumption group	No	Multiple	Same building or connected buildings	Medium
Remote individual self-consumption group	No	Single (legal owner)	Same primary substation	low

Table 1. Italian Renewable Energy Communities and Self-Consumption configurations

In the case of Genoa, the Municipality opted for remote individual self-consumption (ISC) to avoid the creation of a new legal entity and to streamline the administrative obligations. This opportunity allowed the Municipality to move forward with minimal reorganization of its ownership structure. The creation of a full-scale REC, although beneficial in other contexts, was deemed unnecessary for the immediate scope of deploying a sustainable energy transition model within the end of the year.

The selected arrangement presupposes the presence of at least two connection points under the same holder: one or more points designated as generation sites (in this instance, the two school rooftops) and at least one point (and potentially several) designated as consumption sites. The GSE cross-references injection data from the production points with consumption data from all municipal buildings that fall within the same primary substation.

Legal options and contractual agreements

Because remote individual self-consumption does not require the constitution of a separate legal entity, the Municipality can proceed under existing public law frameworks (Il Sole 24 ore, 2024). It retains ownership of the assets and assigns the relevant usage rights to “Istituto Comprensivo Cornigliano” for partial self-consumption of the produced energy. There is no requirement to set up an association, cooperative, or limited company, as might be the case with a Renewable Energy Community. The only legal acts concern the connection request, the updating of relevant grid documents, and the formal

[1] REC’s Members are able to share energy within the same electricity market zone but self-consumption is calculated per HV/MV primary substation

application to GSE for activation of “remote individual self-consumption of renewable energy” or ISC (in Italian: autoconsumatore individuale di energia rinnovabile a distanza).

Furthermore, under the remote individual self-consumption of renewable energy model, there is no need for contractual agreements among municipalities and other participants. This is because the ISC framework does not envisage the contractualized participation of other members in the scheme, differing fundamentally from REC models that often necessitate such agreements to govern the interactions and responsibilities between various stakeholders. The ISC model simplifies the administrative landscape by centralizing control and responsibility within the Municipality, thus eliminating the complexities associated with multi-party contractual obligations.

One fundamental step is that the Municipality must demonstrate to GSE that both the production sites (the two school rooftops) and the designated consumption points are under the same ownership. Documentation typically includes building cadaster records, proof of municipal property rights, and relevant supply contracts. Once GSE validates this ownership link and verifies that all sites connect to the same primary substation, it authorizes the remote individual self-consumption configuration and calculates the monthly incentive.

Stakeholders map and relational scheme

The Genoa pilot has opted for remote individual self-consumption, an option under Italian law that allows a single entity to consume energy generated in more than one location, as long as all relevant points of consumption and production lie within the same primary substation area.

Municipality of Genoa

In this configuration, there is effectively only one participant who holds legal responsibility for the entire scheme, namely the Municipality of Genoa. Within the Remote individual self-consumption scheme, the Municipality of Genoa is the pillar of the scheme, acting as the only referent for GSE.

E-Distribuzione

Despite the single-participant structure, two main external stakeholders play a substantial role. The first is the distribution system operator, E-Distribuzione, which ensures the proper functioning of the electricity grid in the relevant neighborhood, monitors electricity flows, and oversees maintenance and interconnection for customers and energy producers.

Gestore Servizi Energetici

The second external stakeholder is the public authority GSE, which officially approves the activation of the remote individual self-consumption scheme and administers the incentives on shared or self-consumed energy[3].

Istituto Comprensivo Cornigliano

The *Istituto Comprensivo Cornigliano* is a significant internal stakeholder due to its operational role in the two school buildings equipped with photovoltaic installations. Although not a formal participant in the remote individual self-consumption scheme, the institute influences the energy setup through facility management.

Genoa Municipality is the contractual holder of the electricity supply agreements for these educational buildings, directly bearing the energy costs of the Istituto Comprensivo Cornigliano. As a result, the Municipality benefits from any on-site self-consumption of renewable energy. The electricity generated and used within the buildings reduces net demand from the grid, leading to direct economic savings through lower electricity bills.

While the institute does not administratively partake in the setup or face cost savings directly, its management of the facilities significantly affects self-consumption levels, underscoring its critical role in the overall scheme.

Neighbourhood citizens

In this stakeholder analysis, families of students or other external entities such as local businesses are not included in the scheme and do not hold formal relationships. However, it is important to keep students' families informed as they serve as key promoters of the initiative.

Stakeholder	Legal Form	Role	Resources	Configuration Membership	Notes
Comune di Genoa	Municipality	ISC Scheme Holder, investor	Full budgetary control	Yes (sole member)	Manages all infrastructure and incentive applications, it benefits from the reduced energy costs
Istituto Comprensivo Cornigliano	Public Educational Body	Building Operator	Operational control	No	It has the higher influence role, trough facility operations and families information

GSE	National Agency	Regulator	Administrative oversight	No	Approves ISC and issues incentives[3]
E-Distribuzione	Private DSO	Grid Operator	Infrastructure access	No	Manages metering and connectivity

Table 2. Genoa pilot stakeholders chart

This single-participant structure is expected to simplify the administrative side, since the Municipality holds ownership of the school roofs, finances the photovoltaic investments, and remains the sole referent for requests to GSE or communications with the distribution system operator. The number of engaged parties is thus reduced compared to a multi-member energy community. The arrangement nonetheless maintains a beneficial outcome for the school, which can tap into on-site solar power for partial self-consumption. As future expansions occur, additional municipal buildings close to the same primary substation might join the arrangement without requiring new legal or ownership changes, provided that the Municipality remains the sole aggregator of the production and consumption points.

Relational Scheme

The relational structure of the Genoa pilot is grounded in the Italian configuration for Remote Individual Self-Consumption (ISC), regulated under the CACER framework. In this model, the Municipality of Genoa acts as the sole entity responsible for both the generation and consumption of renewable energy within the system. Two municipal school buildings—*Scuola Volta and Scuola Ferrero*—host photovoltaic systems owned by the Municipality. The energy generated is first used to cover on-site consumption; any surplus is injected into the grid and, subject to GSE verification, virtually shared with other municipal loads located within the same primary substation area.

No new legal entity is required. All administrative responsibilities, including grid connection procedures with E-Distribuzione and incentive applications to GSE, are carried out directly by the Municipality. GSE processes the registration of the ISC configuration, monitors the shared energy volumes, and disburses the corresponding incentives to the Municipality[3]. E-Distribuzione ensures technical compliance, grid access, and metering accuracy.

Though not formally part of the configuration, the *Istituto Comprensivo Cornigliano* manages school buildings and impacts self-consumption levels and energy cost savings for the Municipality. The Municipality may create service agreements internally to assign operational roles or distribute benefits.

The relational framework thus features streamlined governance, centralized investment and decision-making, and a simplified incentive flow. This structure not only facilitates implementation but also ensures legal and administrative coherence. It sets a replicable model for municipalities aiming to deploy renewable energy infrastructure without forming complex multi-stakeholder entities.

Technical configuration

The technical configuration of the Genoa pilot is based on the installation of two rooftop photovoltaic systems on municipal educational buildings located in the Cornigliano district:

- the “Alessandro Volta” middle school (Via Cornigliano 9)
- the “Domenico Ferrero” primary school (Via Cervetto 42)

Both buildings are publicly owned by Genoa Municipality and operated under the *Istituto Comprensivo Cornigliano*. At the same time, the Municipality is the system owner and scheme holder, directly responsible for the design, procurement, installation, and operation of renewable energy systems.

The two school buildings were selected for their structural suitability, flat roof configuration, absence of shading, and location under the same primary substation, a prerequisite for participation in a Remote Individual Self-Consumption scheme under the CACER framework. Both buildings fall within energy class E, consistent with nearly 50% of the 200 municipal schools in Genoa, indicating significant potential for future replication.

The Alessandro Volta building already hosts 40 monocrystalline silicon panels, totaling a peak capacity of 16 kWp and an estimated annual production of 20,000 kWh. This PV plant has been already financed and installed by Genoa Municipality as first step of the wide energy efficiency operation that brought to the participation to EnerCmed project.

The Domenico Ferrero building will host the core plant of the EnerCmed Italian pilot, with a total peak capacity of 20 kWp and expected annual production of 26,000 kWh. The combined installed capacity of 36 kWp is projected to generate approximately 39,600 kWh per year. The PV system is expected to be grid-connected by the end of 2025.

Thanks to the ISC configuration, surplus energy not self-consumed on-site will be injected into the distribution grid. Through GSE monitoring and validation, this energy will be matched against municipal consumption points under the same primary substation to qualify for remote self-consumption. No storage systems are currently planned. The configuration is designed to maximize simplicity, cost-effectiveness, and replicability across other public buildings within the municipal portfolio.

Business Model

The Genoa Municipality's Remote Individual Self-Consumption (ISC) model aims to optimize energy consumption in public buildings using photovoltaic systems. The model focuses on self-consumption to reduce external energy dependency and costs, while excess energy will be fed into the grid, generating additional revenue through market sales.

The general Italian ISC model offers significant advantages by allowing municipalities to benefit from economic incentives on surplus energy fed into the grid and virtually self-consumed by other PODs within the municipal area. However, in the specific pilot case of the Municipality of Genoa, these incentives are not applicable due to prior financing arrangements for the plant under analysis[2]. Despite this limitation, the model is presented comprehensively to facilitate future expansion funded directly by the Municipality.

The ISC model is preferred over the REC model due to its simplicity and lower associated costs. Implementing the ISC model mitigates the need for complex legal structuring and reduces governance costs, as no new legal entity is required. This streamlined structure allows the Municipality of Genoa to manage metering, connectivity, and administrative responsibilities directly, without the burden of establishing and maintaining an additional administrative body.

Capital expenditure for the project includes investments in a 36 kWp PV system, covering procurement, installation, and commissioning costs. Operational expenditure involves ongoing maintenance, administrative management, and insurance to ensure long-term efficiency and reliability of the system. By avoiding the establishment of a new legal entity, the ISC model reduces these expenditures significantly.

Revenue streams are primarily derived from savings on avoided electricity costs and earnings from the sale of surplus energy through the "Ritiro Dedicato" (RID) scheme. In the general case of ISC application, additional incentive tariffs on virtually shared energy provided by the GSE's CACER scheme would further enhance the model's economic viability. However, for the Genoa pilot project, the absence of these incentives does not negatively impact the Municipality's finances, given the initial funding provided by project funds.

Below is a block-by-block description of the **Business Model Canvas** for the Genoa pilot Remote Individual Self-Consumption intervention:

Value Proposition

[2] The limitation has been introduced with the Decree of the Ministry of Enevironemnt end Energy Security 7th December 2023, n. 414 (Decreto CACER), after EnerCmed project writing design.

- Reduction of public electricity expenditure through self-consumption and shared energy incentives[3].
- Improved environmental performance and carbon footprint.
- High replicability across other municipal buildings.
- Local co-benefits: awareness, visibility, and indirect savings for school operations.

Key Partners

- Istituto Comprensivo Cornigliano: local school operator, facilitates operational site access and benefits from reduced energy bills.
- E-Distribuzione: distribution system operator responsible for metering, grid access, and compliance.
- GSE (Gestore dei Servizi Energetici): public body validating ISC configuration, disbursing incentives on remote self-consumption and remunerating the energy surplus[3].

Key Activities

- Installation and commissioning of two rooftop PV plants.
- ISC configuration activation via GSE.
- Monitoring of energy production and consumption.
- Administrative reporting and incentive application.

Key Resources

- Rooftops of Scuola Volta and Scuola Ferrero.
- PV plants and technical infrastructure.
- Municipality's technical and financial departments.
- Monitoring devices and interfaces.

Customer Segments

- Public school sector (indirect beneficiary).

Channels

- Internal energy management and accounting.
- In general case[3]: GSE platform for incentive disbursement.

[3] In the specific case of the EnerCmed pilot the public financing of the PV plant exclude it from obtaining energy sharing incentives

- E-Distribuzione metering.

Cost Structure

- CAPEX: estimated investment for 36 kWp PV systems.
- OPEX: maintenance, administrative management, and insurance.

Revenue Streams

- Avoided costs on purchased electricity for the buildings hosting PV systems (self-consumption savings).
- Ritiro Dedicato (GSE) for any residual energy fed into the grid not matched under ISC. (Market sale revenue estimations not yet available.)
- In general case[3]: Incentive tariff on virtually shared energy from GSE (ISC under CACER).

Economic sustainability assessment

The assessment of economic sustainability for the Genoa pilot project considers both photovoltaic plants installed. The primary investment cost is related to the procurement of photovoltaic systems, complemented by design and engineering activities. In the general scenario, the remote individual self-consumption scheme enables revenue generation through physical self-consumption, supplemented by incentives for remote self-consumption. However, in the real scenario, the grant secured by the municipality to finance the project precludes eligibility for such incentives[3]. The analysis demonstrates how operational sustainability is assured in both scenarios, achieved effectively through careful planning and execution. Further details are provided in subsequent sections.

Investment costs

The investment costs associated with the Italian pilot in Genoa are primarily technical, with only a small portion allocated to administrative expenses, amounting to approximately €88,400. The largest expense item involves the procurement and installation of the photovoltaic system, particularly the photovoltaic modules themselves. The remaining costs are linked to the design and project management activities, while administrative costs, such as connection fees, are minimal.

Given the ISC self-consumption configuration planned for implementation, no legal establishment fees are required; this configuration does not necessitate the formation of a legal body (such as an association or cooperative) or the authorization or recognition of an ISC model.

A fixed cost of €14,700 has been determined for design and engineering activities as a result of a completed tender process, with the relevant contract already awarded. However, the overall estimated costs for the procurement and installation of the photovoltaic system during the tender phase remain subject to reduction, which cannot currently be forecasted. A detailed breakdown of the costs is provided in Table 3.

All costs will be directly covered by the Municipality of Genoa, which is responsible for conducting tender procedures and executing contracts with suppliers.

Investment costs	Unitary cost	Units	€
Design and engineering	14.700 €	1	14.700 €
PV plant purchase			
PV cells	27.000 €	1	27.000 €
Inverters	3.700 €	1	3.700 €
Other plant costs	20.000 €	1	20.000 €
Monitoringor devices (or other software/hardware)	4.200 €	1	4.200 €
Installation	18.300 €	1	18.300 €
Connection costs	500 €	1	500 €
TOTAL			**88.400 €**

Table 3. Genoa pilot investment costs

Financing strategy

As showed in Table 4, the entire project is financed through public funds, with 80% of the costs, covered by EnerCmed funds, and the remaining 20 percent financed by Municipality Equity.

Financing opportunity	Value
EnerCmed fund (Grant)	70.720 €
Municipality Equity	17.680 €
TOTAL	88.400 €

Table 4. Genoa pilot Financing strategy

These resources are fully secured, but they impose certain restrictions regarding the "Cumulation of the incentive tariff" associated with self-consumed energy. Specifically, the national regulations for Self-consumption Configurations for Renewable Energy Sharing (CACER) stipulate that the incentive tariff provided by GSE for shared energy can only be combined with capital contributions (CAPEX) up to a maximum of 40% of the eligible investment costs, which include design, equipment procurement, and the construction of the photovoltaic plant. Should the CAPEX contribution exceed this 40% threshold, the premium rate for self-consumed energy will not be granted. Since all eligible costs are fully subsidized by EnerCmed funds, the ISC configuration will not receive the incentive tariff.

In potential future expansions, the photovoltaic installations could serve as a foundation and be incorporated into new self-consumption configurations. If these future projects are developed without exceeding the 40% CAPEX contribution limit, they could distribute financial benefits through incentive tariffs and encourage participation from citizens and families in the creation of a Renewable Energy Community. Pursuing this strategy, the Municipality of Genoa may consider allocating its own funds for future development.

Additionally, beyond the scope of the EnerCmed Project, the Municipality of Genoa has allocated €20,000 of its own funds to equip administrative offices and the headmaster's office with air-conditioning systems powered by heat pumps. The increased energy consumption resulting from these new systems will be offset by the self-consumption of energy produced by the photovoltaic system.

Operational costs

As with capital expenditure (CAPEX), operational costs (OPEX) primarily involve technical aspects, while the administrative costs related to the ISC configuration are marginal. The plant operational costs are mainly constituted by ordinary maintenance and for less than 20% by the cost of the monitoring system of photovoltaic plants.

Recently, the Municipality of Genoa has entrusted, through a service contract, a jointly owned company (ASTER) with the maintenance of all the electrical systems of the Municipality, which also includes photovoltaic systems. The maintenance cost of the individual system is calculated based on the power of the plant itself.

For the monitoring system, the software SolarLog™ will be used, already adopted by the Municipality of Genoa for the management of other photovoltaic systems, the cost is represented by an annual fee. The estimated costs for both maintenance and monitoring are presented in Table 5.

Plant operational cost	Unitary cost	Units	€/year
Ordinary maintenance	1.760 €	1	1.760 €
Monitoring system	400 €	1	400 €
Total			**2.160 €**

Table 5. Genoa pilot operational costs

Regarding the ISC administration costs, since the configuration is extremely simple from a legal point of view, the only expenses foreseen concern ISC management and administrative costs, which can be estimated at an additional annual cost of €100.

The above-mentioned costs will be borne by the Municipality of Genoa, through contracts with suppliers. It is important to note that these costs may fluctuate over time, depending on the agreements with service providers.

Revenue stream and savings

The primary source of economic benefit is derived from energy savings. This is attributed to the utilization of energy produced by photovoltaic (PV) systems and self-consumed on site. The total savings on the utility bill amount to approximately €8,365 per year. This figure is based on the current energy supply tariff paid by the Municipality of Genoa for electricity procurement, which stands at €300 per MWh.

Additionally, there is revenue generated from selling excess energy to the grid operator (RID), with an expected average annual income of €1,201 paid by GSE. Regarding the Remuneration Value for energy injected into the grid, as indicated on the GSE website, the simulation platform demonstrates a tariff of €80 per MWh. Nonetheless, recent energy market trends suggest higher volatile situation, with a minimum guaranteed price of €46.8 per MWh. For the purpose of this economic evaluation, the €80 per MWh value has been adopted, subject to future adjustments.

Furthermore, GSE offers modest compensation (€10.6 per MWh) for self-consumed energy at a distance over the initial 20 years of PV system operation, reflecting the avoidance of network losses. This compensation averages around €140 in the first year, decreasing to a minimum of €118 by the twentieth year.

As previously stated, due to the regulatory framework, no incentive tariff for shared renewable energy is provided because of the inclusion of public grants.

Table 6 presents the estimated revenue streams divided by energy category, where the indicated price for *Energy shared or virtually consumed* also consider the previously mentioned GSE compensation.

Revenues	**Amount**		**Price**		**Value**	
Physical self-consumption	27.884	kWh/year	0,300	€/kWh	8.365	€/year
Energy shared or virtually consumed	13.260	kWh/year	0,091	€/kWh	1.201	€/year
Energy surplus not shared	2.791	kWh/year	0,080	€/kWh	223	€/year
Total					**9.790**	**€/year**

Table 6. Genoa pilot revenue streams

All the outlined economic benefits will be allocated to the Municipality of Genoa, which is the sole entity involved in the ISC configuration. The schools hosting the PV plants do not receive direct economic incentives, as they do not incur energy costs; these expenses are covered by the Municipality. Furthermore, no internal transfers between institutions (e.g., from the Municipality to the schools) are planned.

Key parameters influencing the revenue stream include fluctuations in the energy purchase tariff paid by the Municipality and the tariff paid by GSE to the Municipality for energy sales (RID remuneration rate). An internal factor that may impact long-term operational outcomes is the variation in these tariffs.

Operational sustainability

A preliminary analysis highlights the clear sustainability of the investment, even when considering only savings from energy self-consumption and grid injection. The absence of the need to establish and manage a dedicated legal entity significantly reduces both costs and procedural complexities, positively impacting CAPEX and OPEX. In comparison with a conventional self-consumption models, the ISC model requires only a small additional annual cost to cover management and administrative expenses.

In the reference scenario, assuming the absence of contributions provided by the EnerCmed fund, revenues—including operational savings—are expected to recover the initial investment within 11–12 years, considering the identified operating costs.

Assuming the application of an incentive (the so-called premium tariff) of €120/MWh, along with a regional adjustment of €10/MWh, which is only feasible if grant financing remains below 40%, the additional revenue stream could reduce the payback period to approximately 9–10 years.

In the real scenario, where the Municipality is required to cover only 20% of the project costs due to grant financing, the return on investment is projected to be approximately two years.

A more detailed analysis will be conducted as part of Activity A2.6, titled "Environmental, Economic, and Social Impact Assessment Associated with the pilots." This study, using the Life Cycle Costing (LCC) method, will evaluate not only the sustainability of the photovoltaic component but also the integration of Nature-Based Solutions (NBS) and their impacts on stakeholders, such as the homeless shelter.

Spanish pilot of Valencia

The Municipality of Valencia, in collaboration with València Clima i Energia, is spearheading two distinct initiatives under the framework of Renewable Energy Communities: the CEIP Ballester Fandos and CEIP Ausiàs March pilots. The CEIP Ballester Fandos initiative operates within an established REC, leveraging existing community structures to enhance energy sustainability. Meanwhile, the CEIP Ausiàs March pilot will integrate a new solidarity-based REC, focusing on fostering collective energy solutions aligned with social inclusion principles.

Both projects adhere to the Spanish regulatory framework for RECs, establishing legally recognizes non-profit associations. This designation enables participants to benefit from simplified compensation mechanisms for energy virtually self-consumed within the community.

Renewable Energy Communities Configurations

The technical configuration of the Spanish pilot in Valencia is based on the current legislative framework and practical implementation of Renewable Energy Communities (RECs) in Spain. Despite Spain not having fully transposed the European Directives on Energy Communities (EU 2018/2001 and 2019/944), RECs have been partially introduced into Spanish law through the modification of article 6 of Spanish law 24/2013, which pertains to the Electric Sector.

Article 6 of Spanish law 24/2013 defines RECs and allows membership to individuals, SMEs, and local authorities, including municipalities. Further details are found in the draft version of the Royal Decree, which expands on the definition and establishes that associations of individuals, SMEs, or local authorities can be members of RECs. These members must adhere to the principles of openness, democratic control, and financial limits not exceeding those established for SMEs (i.e., an annual turnover or total annual balance sheet not exceeding 10 million euros).

The technical and administrative requirements for promoting self-consumption from renewable sources are detailed in Royal Decree 244/2019. Among the various types of self-consumption projects, **collective self-consumption with simplified compensation** of surplus energy is considered the most suitable for RECs. The key requirements for these projects include:

- Associated consumers must be within a radius of 2 km from PV installations.
- At least one consumer must be internally connected to the PV plant.
- Consumers must prepare and send an "Energy Sharing Agreement" including allocation coefficients to be applied to each consumer.

The focus of the configuration is on promoting collective self-consumption and ensuring that surplus energy not self-consumed on-site is injected into the distribution grid and virtually consumed by the REC members. This energy is monitored and validated by the relevant authorities to qualify for remote self-consumption, providing significant potential for future replication.

Legal options and contractual agreements

Currently, no specific legal forms are required for Energy Communities. However, several grant programs driven by the Spanish Ministry and its public body IDAE (Institute for Energy Diversification and Savings) aim to foster the creation and support of Energy Communities at the national level (CE-Implementa). These programs require beneficiaries, which can have any legal form, to meet the basic principles of EC definitions and have at least 5 members.

In practice, according to comprehensive legal studies from various institutions, it is widely accepted that **associations** and **cooperatives** are ideal legal forms that comply with the principles that any Energy Community should follow according to current European and national regulations. Among the two options, associations are the simpler legal form in the Spanish model. Therefore, the RECs developed in the Valencia pilot will be configured as two associations.

The decision to implement associations was motivated by the ease with which this legal form allows compliance with the principles of openness, democratic control, and financial limits established by Spanish regulations. Associations must be officially recognized and follow a series of government-established regulations. This ensures that each member has a say in decisions and that financial operations are transparent and controlled.

As such, they will be equipped with a statute, drafted by the founding members, that clearly outlines the principles, objectives, and functioning methods of the REC. The statute will be a fundamental document guiding the governance of the associations and ensuring that all activities comply with current laws and regulations.

Additionally, REC members will formalize their membership through a formal subscription process. This contractual process strengthens the bond between members and the association, ensuring that everyone understands and accepts the rights and responsibilities associated with participating in the REC.

Stakeholders map and relational scheme

Stakeholders in the Valencia pilot drive collective energy initiatives, involving municipal bodies, social services, and vulnerable households. Their collaboration ensures effective governance, technical coordination, and equitable energy distribution, promoting social inclusion and sustainability. The two initiatives differ in their approach to REC associations' engagement: one involves existing associations, while the other requires creating a new association.

Municipality of Valencia

As the owner of the buildings and energy contracts for the two educational buildings, the Municipality of Valencia is the primary institutional actor responsible for physical self-consumption and receives direct economic benefits from reduced electricity costs. It retains decision-making power in infrastructure investments and governance of the pilot's implementation.

Fragile households

Fragile residents from Natzaret and Malva-Rosa participate through virtual self-consumption, benefiting from the energy shared by PV systems installed on public buildings. They do not invest or manage the systems, but their involvement is key to addressing energy poverty and supporting social goals.

Valencia Clima Y Energia

This municipal foundation plays a technical and coordination role, assisting in the identification of legal models, REC formation, and social engagement strategies. It provides direct technical support to both the Municipality and civil society groups. At the same time VCE is part of both the RECs directive board to provide proper technical support.

Social services

These services support the identification and engagement of fragile households in the pilot. Their role is critical in facilitating social inclusion, particularly in Natzaret, where social marginalization is a key concern.

Specific for the CEIP Ballester Fandos pilot

CEIP Ballester Fandos Management

The school in Malva-Rosa plays an active role in managing facilities where PV systems are installed. While it is not a direct administrative participant in the REC, it influences energy consumption and indirectly supports the educational component of the initiative.

Coensoma REC association

This existing Renewable Energy Community will operate the Ballester Fandos pilot. It was founded by the school's board and VCE, with a structure that enables participation of NGOs and citizens, ensuring collective governance and compliance with national REC regulations.

Additional NGOs

NGOs play a vital role in REC participation and citizen engagement. They promote inclusiveness and help integrate socially marginalized populations into the energy transition process. Additionally, NGOs are eligible members in RECs participation allowing them to benefit from virtual self-consumption economic savings.

Specific for the CEIP Ausiàs March pilot

CEIP Ausiàs March Management

Will actively participate to the REC scheme taking part to the energy sharing mechanism. Additionally, is the final beneficiary of the NBS intervention.

Additional NGOs

In Ausiàs March pilot, new NGOs will establish the REC association, not yet constituted. They aim to promote inclusiveness and assist marginalized populations in integrating into the energy transition process. NGOs can participate in RECs and benefit from economic savings through virtual self-consumption.

Stakeholder	Legal Form	Role	Resources	Configuration Membership	Notes
Municipality of Valencia	Municipality	Owner, energy bill beneficiary	Building & contracts	No	Owns facilities and receives energy cost savings
Fragile Households	Citizens	Virtual self-consumption beneficiaries	None	Yes	Receive shared energy from public PV production
Valencia Clima i Energia	Public Foundation	Technical facilitator	Technical expertise	No	Guides REC setup and social strategy and part of RECs' directive board
Social Services	Public Department	Social engagement	Social worker network	No	Supports identification

					and engagement of vulnerable households
CEIP Ballester Fandos	Public School	PV building operator	Operational control	Yes	Supports REC through facility management
Coensoma REC	Association (REC)	REC operator (Ballester Fandos)	Governance & admin.	Yes	Manages energy community with VCE and school participation
NGOs	Civil Society	Engagement and REC participation	Community involvement	Yes	Help co-found and expand RECs, ensure social inclusion
CEIP Ausiàs March	Public School	PV building operator, REC founder	Operational control	Yes	Supports REC through facility management

Table 7. Valencia pilot stakeholders chart

Relational scheme

The relational structure of the Valencia pilot is grounded in the Spanish regulatory framework for RECs, which are legally recognized entities operating under the form of non-profit associations. These communities are responsible for the collective generation, management, and distribution of renewable energy produced by photovoltaic systems installed on public buildings.

In this model, the Municipality of Valencia—through VCE—plays a dual role: initially as the driver of the initiative and installer of the photovoltaic systems under the EnerCmed budget, and subsequently as a key institutional member of each REC. The Municipality retains ownership of the photovoltaic assets during the initial operational phase. To comply with public investment regulation, the Municipality covers maintenance and operational costs during the first five years. After this period, full operational and administrative responsibility is transferred to the corresponding REC association.

Energy not self-consumed physically on-site is distributed through a virtual self-consumption mechanism. The allocation follows a three-tier priority structure:

- **Municipal buildings**, including schools and administrative facilities, which receive a portion of the surplus energy;
- **Participating NGOs**, both founding and affiliated, which are granted a limited quota and must contribute proportionally to maintenance and operational costs; and
- **Fragile households**, identified by municipal social services, who receive the majority share of the surplus energy as a social support measure. This energy is assigned virtually, ensuring targeted economic relief without requiring infrastructural modifications.

Each participating entity, including public institutions, NGOs, and households, formalizes its participation through a membership agreement with the REC association. These agreements define rights, duties, energy quotas, and cost contributions where applicable.

In the case of **CEIP Ballester Fandos**, the pilot is embedded within an already established Renewable Energy Community under the legal form of a non-profit association. The REC, named *Coensoma – Comunitat Energètica Solidària Malva-Rosa*, was founded by the school's governing board together with *Valencia Clima i Energia*. The REC acts as the contractual operator of the PV plant and is responsible for energy distribution, administrative compliance, and stakeholder coordination. The Municipality of Valencia remains the owner of the PV installation but delegates operational roles to the REC through a formal service agreement. The REC membership includes school representatives, NGOs, and community members, with a defined quota of energy earmarked for each stakeholder group. Participation agreements are signed individually by each member, ensuring traceability and legal robustness.

For the **CEIP Ausiàs March pilot**, the energy generated will be managed by a newly designated REC. Rather than initiating a public call, the Municipality of Valencia will assign the operation of this second PV plant to an existing solidarity-based REC, in accordance with the exemption provisions under Spanish law for non-commercial, social-benefit associations. The selected REC will then incorporate new members—NGOs and vulnerable households from the Ausiàs March district—and establish formal participation contracts outlining energy distribution and responsibilities. As with Ballester Fandos, the Municipality will fund installation and cover O&M for the first five years, after which full governance is transferred to the REC.

Technical configuration

The Valencia deployment comprises two medium-scale photovoltaic plants sized deliberately below the regulatory ceiling of 120 kWp (100 kW inverter limit) in order to benefit from Spain’s streamlined permitting and the low-voltage connection regime that avoids costly grid reinforcements. Both host sites—CEIP Ballester Fandos in Malva-Rosa and CEIP Ausiàs March in Nazaret—sit in districts with a high concentration of migrant and low-income households and an active fabric of NGOs, circumstances that favour the creation of solidarity-based Renewable-Energy Communities with strong social reach. In both pilots the primary design objective is not municipal bill reduction but the virtual allocation of solar output to vulnerable families under Royal Decree 244/2019, which allows surplus compensation to be credited directly on each participant's bill.

At **CEIP Ballester Fandos** the roof geometry and loading capacity have been confirmed by a preliminary survey, allowing the direct installation of a 26.4 kWp array with an expected annual yield of approximately 33,140 kWh. The array will export on a single low-voltage feeder, enabling immediate activation of virtual self-consumption under Royal Decree 244/2019. Because the principal objective is to channel renewable electricity to vulnerable households rather than to offset municipal bills, the bulk of production will be allocated to residential members and partner NGOs through the simplified surplus-compensation mechanism, maximizing bill relief for the target groups.

The situation at **CEIP Ausiàs March** is less certain. Preliminary engineering diagnostics indicate that the school's ageing roof may not safely accommodate the originally proposed 64 kWp installation. A full structural audit is in progress and will be completed in Q3-2025. Should the survey confirm insufficient load capacity, the project will switch to the nearby municipal facility *Avifauna*, located 500 m from the school, whose expansive reinforced roof can host the plant without structural remediation. In that contingency the array will be configured at 55 kWp, delivering an estimated 71,498 kWh per year while remaining within the power threshold and on the same low-voltage network segment. All other technical parameters—module specification, inverter selection, monitoring architecture and grid-code compliance—mirror those adopted at Ballester Fandos to preserve economies of scale and simplify maintenance logistics.

In both pilots, energy allocation will follow the "energy-sharing agreement" embedded in each REC's statute. Every participant receives a pro-rata share of generation; any residual exports are remunerated through the simplified compensation tariff and netted directly on the consumer's bill, reinforcing the economic benefit for end-users without introducing complex invoicing chains. By aligning capacity design, interconnection strategy and regulatory positioning, the two installations offer a scalable template for high-impact, community-owned solar generation within the Valencian metropolitan area.

Business model

The Valencia pilot adopts Spain's Renewable-Energy Community association model to deliver a socially oriented, legally robust business structure. Within this framework the Municipality of Valencia acts first as initiator and investor—installing two rooftop photovoltaic plants under the EnerCmed budget—and subsequently as an institutional member of each REC. During an initial five-year transition the Municipality retains ownership of the assets and finances all operating and maintenance activities, thereby safeguarding service continuity while the community association consolidates its governance capacity. Thereafter, full operational control and cost responsibility pass to the non-profit REC, ensuring long-term autonomy and compliance with public-investment regulations.

Energy flows are managed through Spain's virtual self-consumption regime. Surplus generation that is not physically absorbed on-site is allocated according to a three-tier priority: municipal buildings receive a baseline share, partner NGOs are granted a bounded quota proportional to their cost contribution, and the majority of the surplus is channelled to fragile households identified by municipal social services. This allocation mechanism delivers immediate electricity-bill relief to vulnerable citizens without requiring additional network infrastructure, while simultaneously lowering public-sector energy expenditure and underpinning the social mission of participating NGOs.

Two governance configurations exemplify the model's flexibility. At CEIP Ballester Fandos, the existing Coensoma – Comunitat Energètica Solidària Malva-Rosa association already fulfils the REC operator role, coordinating energy distribution, regulatory reporting and stakeholder engagement under a service agreement with the Municipality. At CEIP Ausiàs March, the Municipality will appoint an established solidarity-based REC to assume identical functions, enlarging membership to include local NGOs and qualifying households. Capital expenditure covers PV procurement, installation and the legal formalisation of the REC, while operating costs comprise routine maintenance, metering and insurance. Revenues accrue chiefly from avoided electricity purchases across all member segments and, where excess production remains, from market remuneration for energy exported to the grid, thereby securing an economically balanced and socially inclusive pathway for replication throughout Valencia's municipal estate.

Below is a block-by-block description of the **Business Model Canvas** for the Valencia pilot RECs:

Value Proposition

- Reduction of public electricity expenditure through self-consumption.
- Energy cost savings for NGOs and Fragile Households trough energy sharing.
- Improved environmental performance and carbon footprint.
- High replicability trough REC associations involvement.

Key Partners

- CEIP Ballester Fandos Management: Supports REC through facility management.
- CEIP Ausiàs March Management: Supports REC through facility management.

- Coensoma REC association: Manages energy community with VCE and school participation.
- Additional NGOs: Help co-found and expand RECs, ensure social inclusion.
- Social Services: Supports identification and engagement of vulnerable households".

Key Activities

- Installation and commissioning of two rooftop PV plants.
- REC establishment with local NGOs and other shareholders.
- Energy sharing with REC participants.
- Administrative reporting.

Key Resources

- Rooftops of public buildings.
- PV plants and technical infrastructure.
- Municipality's technical and financial departments.
- REC participants' energy consumptions.
- Monitoring devices and interfaces.

Customer Segments

- Participating NGOs: structural part of the RECs and energy consumers.
- Fragile households: identified by municipal social services, receive the majority share of the surplus energy.

Channels

- Internal energy management and accounting.
- DSO metering.

Cost Structure

- CAPEX: investment in PV systems, legal constitution of the RECs.
- OPEX: maintenance, administrative management, and insurance.

Revenue Streams

- Avoided costs on purchased electricity for all the REC participants (Municipality, NGOs, fragile households).

- Revenues for any residual energy fed into the grid not matched under RECs.

Economic sustainability assessment

This sustainability assessment examines the two Valencian lighthouse pilots—CEIP Ballester Fandos and CEIP Ausiàs March—implemented under the EnerCmed programme. Both schemes adopt Spain's Renewable-Energy Community association model, yet they progress along different maturities: Ballester Fandos expands an already-operational solidarity REC, whereas Ausiàs March must first resolve structural constraints before finalising its business plan.

Investment costs

Both pilots follow the standard Valencia-region procedure for Renewable-Energy Community projects.

Technical costs cover the procurement and erection of photovoltaic modules, inverters and balance-of-system equipment; mechanical and electrical installation; grid-connection hardware; commissioning tests; and the deployment of smart-metering and monitoring devices needed for self-consumption allocation.

Administrative capital outlays encompass the legal formalities associated with REC constitution or enlargement, grid-code registration, drafting of energy-sharing contracts, and the social-engagement activities required to bring vulnerable households into the scheme.

Ballester Fandos benefits from an existing REC structure and from a roof that is already suitable for a 26,4 kWp plant, avoiding major adaptation works. Site-specific technical costs therefore concentrate on equipment supply, installation and on a limited package of safety upgrades to the skylight anchoring points. As outlined in Table 8, the total estimated expenditure for installation and technical activities amounts to €27,468, with the capital requirements effectively distributed across various investment categories.

Investment cost	Unitary cost	Units	€
Design and engineering	3.933 €	1	3.933 €
PV cells	100 €	48	4.792 €
Inverters	4.007 €	1	4.007 €
Other plant costs	4.501 €	1	4.501 €
Monitoringor devices (or other software/hardware)	796 €	1	796 €
Installation	5.755 €	1	5.755 €
Connection costs	358 €	1	358 €
Civil works	3.328 €	1	3.328 €
TOTAL			**27.468 €**

Table 8. CEIP Ballester Fandos pilot investment costs

Since the REC is already established, administrative expenses are limited to statutory notifications and incorporating the new capacity into the REC's digital platform. These tasks are seamlessly managed within VCE's routine operations. Additionally, legal and administrative costs include acquiring a digital certificate for entity representation, amounting to €14.

The investment profile for the **Ausiàs March pilot** cannot yet be finalised. Preliminary surveys indicate that the school's concrete deck may lack the residual load capacity required for a rooftop photovoltaic array. A comprehensive structural audit is in progress and will be concluded in the next quarter; until its findings are available the scope—and therefore the cost—of any remedial works remains indeterminate. Two mutually exclusive scenarios are therefore being maintained:

- On-site reinforcement: if the roof can be upgraded economically, CAPEX will need to cover structural strengthening in addition to the photovoltaic equipment and standard connection hardware. The magnitude of this civil-works package cannot be estimated reliably until the audit specifies the extent of intervention.
- Relocation to Avifauna: should the audit rule out on-site installation, the project will migrate to the nearby Avifauna municipal building. While this option eliminates structural risk, it triggers a new set of cost drivers—roof preparation, electrical routing, and amended permitting—none of which have yet been quantified.

Because the investment baseline is still fluid, any statement on economic sustainability would be premature. Grid-connection expenses are expected to mirror those at Ballester Fandos, but administrative costs will be higher: the Nazaret installation must be integrated into a newly constituted solidarity REC, complete with service agreements, participation contracts and social-engagement activities. A revised capital budget and sustainability appraisal will be issued once the definitive site and engineering solution are validated.

Financing strategy

The capital program for the Valencia pilots is anchored in the EnerCmed envelope, which fully underwrites the technical deployment, administrative set-up and social-engagement actions for both photovoltaic schemes.

At **CEIP Ballester Fandos**, this funding is complemented by grants already mobilized by the pre-existing solidarity REC, enabling the installation to reach the 26,4 kWp optimum without recourse to additional municipal appropriations. The installation planned for **CEIP Ausiàs March** will be financed exclusively through the EnerCmed budget, given that a new REC must be constituted for this site.

Municipality, trough VCE, acts as financial agent, channeling EU resources, procuring works and services, and retaining legal ownership of the assets for the first five years, in line with Spanish public-investment rules. During this period VCE will also shepherd both RECs through subsequent funding rounds, targeting regional instruments such as IVACE and national programs administered by IDAE, while promoting private donations under the “general-interest” designation available to non-profit associations.

It must be highlighted that the EnerCmed subsidy carries two principal conditions: (i) the installations must prioritize vulnerable households and advance a just energy transition; (ii) operational control may pass to the RECs only if they preserve non-profit status and democratic governance. Aside from these stipulations, all capital resources are secured and no further municipal funding is required to complete the works. The financial framework will be formalized in a tripartite collaboration agreement between each REC, VCE and the City of Valencia.

Operational costs

Recurring expenditure for the two pilot schemes falls into four clusters: routine maintenance of modules and inverters; monitoring, metering and data administration; legal compliance (insurance, filings, grid-code renewals); and communication or social-dynamisation activities. During the first five years VCE bears all operating and management costs, bundling them into its central service contracts to capture economies of scale. These outlays are expected to remain broadly stable, subject only to inflation and minor variations in service rates; any incremental cost arising from REC membership growth will be offset by additional contributions from new beneficiaries.

VCE retains legal ownership of both arrays for the first five years, assuming insurance and preventive-maintenance obligations to de-risk the ramp-up phase and guarantee compliance with EnerCmed deliverables. Table 9 represents the breakdown of these costs for CEIP Ballester Fandos pilot case, which are expected to amount to a total annual OPEX of €850.

Plant operational cost	Unitary cost	Units	€/year
Ordinary maintenance	450 €	1	450 €
Insurance	400 €	1	400 €
Total			**850 €**

Table 9. CEIP Ballester Fandos pilot operational costs

From year six onward the burden of OPEX transfers to the REC associations—Coensoma at Ballester Fandos and the newly created Nazaret REC at Ausiàs March. NGOs can contribute a proportional share to the operational costs based on their allocated energy quota. On the contrary, fragile households are exempt from cost contributions, ensuring social equity.

The only currently indeterminate items are long-term O&M expenditures, which will depend on panel-performance decay, inflation and the eventual size of the beneficiary pool.

Revenue stream and savings

The photovoltaic schemes at CEIP Ballester Fandos and CEIP Ausiàs March generate economic value through three complementary channels:

1. Electricity bill savings obtained by on-site or virtually allocated self-consumption.
2. Monetary compensation for surplus energy exported to the grid under Spain's simplified compensation regime.
3. Indirect social returns arising from the alleviation of energy poverty among vulnerable households.

All revenues are treated as non-profit benefits in keeping with the legal status of the Renewable-Energy Communities (RECs).

For both installations, the bulk of the financial benefit derives **from self-consumed energy** that are consumed locally-physically at the host schools and virtually by NGO facilities or registered low-income households. The value of each self-consumed unit equals the avoided retail tariff (energy term, tolls and taxes) and therefore scales with market prices. At Ballester Fandos the existing 100 kWp array serves a well-defined daytime load, maximizing the self-consumption ratio and delivering the largest absolute saving within the pilot portfolio. At Ausiàs March a 64 kWp system feeds a more variable demand profile; the Energy-Sharing Agreement will allow any midday surplus to be reallocated to nearby municipal buildings or to households with flexible consumption patterns, preserving a high utilization factor.

Energy not absorbed on-site is settled monthly through the **simplified compensation mechanism** of Royal Decree 244/2019. Exported kWh are remunerated at a market-indexed rate capped by the retailer, generating a second, smaller revenue stream for each REC. Because exports at Ballester Fandos are already modest, remuneration acts mainly as a balancing item; at Ausiàs March it will offset the lower self-consumption expected in holiday periods. The ultimate financial yield is sensitive to PV production levels, hourly allocation coefficients and the evolution of wholesale prices; the RECs will therefore review sharing rules annually to sustain optimal value capture.

By cutting **household energy bills**, the pilots free disposable income for vulnerable families and reduce the municipality's expenditure on emergency utility assistance. Although these gains are not booked as cash inflows to the RECs, they constitute a measurable socio-economic benefit aligned with EnerCmed objectives and Valencia's Climate-Neutral City Mission.

EnerCmed Interreg Euro-MED Co-funded by the European Union

For the CEIP Ballester Fandos pilot project, the estimated annual revenue and savings are projected to reach €6,655 at the pilot level, factoring in costs distributed among the various REC members as outlined in Table 10. The data provided indicates that the selected design prioritizes energy sharing among REC members, alongside the benefits of physical self-consumption.

Revenues	Amount		Price		Value	
Physical self-consumption	6.628	kWh/year	0,22	€/kWh	1.458	€/year
Energy shared	21.210	kWh/year	0,22	€/kWh	4.666	€/year
Energy surplus not shared	5.302	kWh/year	0,10	€/kWh	530	€/year
Total					**6.655**	**€/year**

Table 10. CEIP Ballester Fandos pilot Revenues

Operational sustainability

A preliminary financial appraisal has been completed for the CEIP Ballester Fandos pilot, whereas no conclusive assessment is yet possible for CEIP Ausiàs March because the definitive site, scope and budget remain contingent on the ongoing structural audit.

For Ballester Fandos the analysis was conducted under a reference case that treats the full capital outlay—equipment, installation, grid connection and REC-related administrative costs—as if it were borne entirely by the community, without recourse to grants. Projected electricity-bill savings for the school, the participating NGOs and the vulnerable households, together with the monetary compensation for residual exports, are sufficient to repay the initial investment within approximately four to five years while covering routine operating expenditure. Sensitivity checks on retail-price trajectories and module degradation do not materially alter this result; the project remains comfortably cash-positive throughout the analysis horizon.

In the real financing configuration, where EnerCmed covers the upfront expenditure and the municipality assumes five years of O&M, payback becomes effectively instantaneous and the subsequent cash flow can be channeled into social initiatives decided by the REC assembly. Conversely, an evaluation that excluded member savings would fail to capture the purpose of the scheme—which is to redistribute economic value rather than to generate a return for municipal accounts. Should the model be replicated without grant support, the energy-sharing coefficients would need to allocate a sufficient fraction of production to the capital sponsor, or the investment cost would have to be apportioned among all participants.

For Ausiàs March the investment envelope cannot be fixed until the audit confirms whether the array can be placed on the school roof or must be relocated to the Avifauna facility. Without reliable figures for capital cost, PV yield and any required civil works, an economic-sustainability calculation would be speculative and has therefore been deferred. A full cost–benefit profile will be produced once the engineering solution is validated.

A more granular life-cycle costing, including environmental and social externalities, will be delivered under Activity A2.6, thereby completing the economic-sustainability appraisal for both Valencia pilots.

Croatian pilots

Croatia's pilot actions illustrate two divergent pathways for deploying rooftop PV initiatives in a national context where the legal architecture for Renewable-Energy Communities remains only partially codified.

Novigrad has elected to pursue a fully-fledged ZOIE, registering a non-profit association that will pool generation and consumption across a cluster of several public buildings in Istria County. The pilot's activity focus on the Home for Elderly People, whose continuous 258 MWh annual demand justifies an initial 50 kWp installation—scalable to 132 kWp as additional capital becomes available. Within the ZOIE framework, surplus energy can be reallocated to neighbouring municipal assets, and members share governance through a flat, participatory structure that embeds transparency and long-term social licence.

Pula, by contrast, has opted for a streamlined self-consumption scheme outside any community construct. A 19 kWp array on the Children's Creative Centre supplies the building directly; savings realised under Croatia's net-metering regime are earmarked by the municipality for its homeless shelter. This centralised model dispenses with the administrative overhead of forming a REC, enabling rapid deployment and direct fiscal control while still delivering a targeted social dividend.

Together, the two pilots demonstrate how Croatian municipalities can navigate an evolving legal landscape to achieve both energy and social objectives through context-specific business models.

Renewable Energy Communities and Self-Consumption Configurations

Croatian law offers pathways for establishing Renewable Energy Communities (REC), although the concept is not fully defined, making projects challenging. Currently, RECs are implemented as cooperatives, but large-scale projects are still rare. These pathways aim to promote renewable energy, improve efficiency, and encourage community collaboration in energy production. The main options are Energy Communities of Citizens (EZG), Renewable Energy Communities (ZOIE), and Joint Prosumers at Building-level (self-supply), each with unique characteristics and legal frameworks (European Commission, 2025).

Energy Communities of Citizens (EZG)

Energy Communities of Citizens are established under the Law on the Electricity Market (Official Gazette 111/2021 and 83/2023). An EZG is a legal entity that must be registered with the Croatian Energy Regulatory Agency (HERA) to perform one or more energy-related activities. These communities are controlled by their members or shareholders, who may include natural persons, local government units (LGUs), and micro or small enterprises, provided they are residents or legally established in Croatia. EZGs are authorized to carry out a wide range of activities, such as energy production, consumption, supply, aggregation, storage, as well as the provision of energy efficiency services and electric vehicle charging infrastructure. They operate at the national level, meaning that participation is not limited by geographic proximity; members can be located anywhere within the Croatian territory. Governance is based on a democratic model, ensuring that all members have a say in key decisions, in line with the principle of community ownership and control.

Renewable Energy Communities (ZOIE)

Renewable Energy Communities (ZOIE) are regulated by the Law on Renewable Energy Sources and High-Efficiency Cogeneration (Official Gazette 138/2021 and 83/2023). ZOIEs focus specifically on the collective production and use of renewable energy. They can adopt a variety of legal forms, including associations, cooperatives, foundations, or limited liability companies. Their operational scope includes generation, storage, sale, and sharing of renewable electricity, with an emphasis on local energy self-sufficiency and sustainability. Participation in ZOIEs is limited to natural persons, SMEs, and LGUs that are located near the renewable energy plant. This geographical restriction is defined by the requirement for members to be connected within the same medium-voltage (MV) or low-voltage (LV) substation area, thereby ensuring that the benefits of renewable energy remain within the local community.

Joint Prosumers (Building-level self-supply)

The model of Joint Prosumers represents a specific application of community energy under the ZOIE framework, tailored for co-owners of residential or mixed-use buildings. This option allows individuals sharing ownership of a building and connected to the same low-voltage feeder to collectively produce, consume, and store renewable energy. Activities are confined to the building level, and membership is restricted to legal co-owners of the premises. This setup simplifies energy management, promotes self-consumption, and facilitates the deployment of rooftop photovoltaic systems, particularly in urban settings

A brief comparison is provided in the following table:

Parameter	**Energy Community of Citizens (EZG)**	**Renewable Energy Community (ZOIE)**	**Joint Prosumers (Building level self supply)**
Legal basis	Electricity Market Act (OG 111/2021; 83/2023)	RES & CHP Act (OG 138/2021; 83/2023)	RES & CHP Act Art. 6770
Eligible members	Natural persons, SMEs, LGUs having address in HR	Natural persons, SMEs, LGUs located “in the vicinity” of the RES plant	Coowners of same building connected to same LV feeder

Geographic perimeter	National	Same MV/LV substation	Same building / complex
Permitted activities	Generation, storage, sale & sharing of RES electricity	Generation, storage, sale & sharing of RES electricity	Netmetering & internal allocation of surplus
Needed contrctualization	EZG accreditation trought HERA	EZG accreditation trought HERA	Owners' resolution
Typical incentives	Priority grid access; exemption from some network fees; planned national grants	FIT/FIP for <500 kW; priority dispatch	Netbilling; VAT exemption on selfsupplied kWh
Complexity & cost	Hight	Modderate	Low

Table 11. Croatian models configuration

In Croatia, two distinct pilot models have been selected to respond to the specific energy, social, and administrative needs of their respective local contexts, each operating within the regulatory frameworks defined by the Croatian Law on the Electricity Market and the Law on Renewable Energy Sources and High-Efficiency Cogeneration.

The Municipality of Pula has opted to implement a simplified self-consumption scheme outside the formal structure of a Renewable Energy Community. This decision is based on the intention to deploy a rapid, administratively efficient intervention focused on a single public-use facility: the Children's Creative Center. The installation of a 19 kWp photovoltaic system on the roof of the center is designed to reduce the facility's electricity costs. The savings generated through the net metering mechanism will be reinvested to support the city's homeless shelter, creating a socially inclusive energy model without the need to establish a separate legal entity or engage in the governance obligations associated with ZOIEs. This choice allows the Municipality to retain full ownership and operational control of the system while delivering tangible social impact, consistent with public sector priorities and in full alignment with national net metering provisions for public institutions.

Conversely, the pilot in Novigrad seeks to activate a Renewable Energy Community (ZOIE) at the national level, in line with the objectives of broader citizen and stakeholder engagement. In this case, the Municipality has chosen to involve the "Home for Elderly People," a residential care facility, as the primary beneficiary. The goal is to reduce operational energy costs and enhance the quality of life for elderly residents through the use of locally generated, renewable energy. Participation in a ZOIE provides the structural and regulatory framework necessary for shared energy production and use, and opens access to potential financial incentives and support mechanisms specific to energy communities. Moreover, the community-based governance model inherent in ZOIEs reinforces transparency, inclusiveness, and long-term sustainability.

Novigrad pilot

The Novigrad pilot adopts the Renewable Energy Communities (ZOIE) model, as defined under Croatian legislation, to promote decentralized renewable energy production and participatory energy governance. ZOIEs are designed to enhance energy self-sufficiency, transparency, and stakeholder involvement, particularly at the local level. This model allows multiple stakeholders—including municipalities, public institutions, SMEs, and citizens—to jointly produce, consume, and manage renewable electricity within a defined distribution grid area. The Novigrad pilot will be embedded within a wider, regional-level ZOIE that includes approximately 17 buildings across Istria County.

This regional structure enables energy transfer among participants, such as reallocating surplus energy from schools (typically overproducing in summer) to healthcare facilities like the Home for Elderly People in Novigrad. The Home for Elderly People will act as the main beneficiary of the local pilot. The Municipality's decision to integrate into the national-level ZOIE structure aligns with strategic goals for reducing public sector energy costs, improving the resilience of social institutions, and accessing future financial incentives for energy communities.

Legal options and contractual agreements in Novigrad pilot

Under Croatian law, ZOIEs may adopt flexible legal forms, including associations, cooperatives, limited liability companies, or foundations. For the Novigrad pilot, the stakeholders opted for an association structure due to its non-profit orientation, administrative simplicity, and capacity to facilitate inclusive governance. The association model is the most practical solution for aligning the diverse interests of municipal authorities, institutional beneficiaries, and citizen members.

The association will be formally registered, and its statute will outline the participation rules, voting rights, and revenue redistribution mechanisms. A key contractual requirement is the registration of energy activity with the Croatian Energy Regulatory Agency (HERA), without which the REC cannot legally operate. The association will also sign internal participation agreements with member institutions, including the Municipality of Novigrad, Istria County, and the Home for Elderly People. These agreements will define energy allocations, cost-sharing mechanisms, and responsibilities for maintenance and reporting.

Stakeholders map and relational scheme

The Novigrad pilot operates through a multi-actor governance framework embedded in the ZOIE model.

Municipality of Novigrad

Responsible for the overall coordination and implementation of the pilot project.

Home for Elderly People institute

It partially owns the building part of the action. The institute is the primary beneficiary of the self-consumption, aiming to reduce energy costs and improve the welfare of the elderly. Additionally, the institute holds the energy contract and It pays the energy bills directly to the provider.

Other Municipalities

Member of the ZOIE: These municipalities collaborate with Novigrad to install additional PV power over public buildings and increase energy sharing.

Istria County

In collaboration with the City of Novigrad and the Home for Elderly People, Istria County shares ownership of the building where the PV plant will be installed (Home for the Elderly).

Local Community

Includes residents and local organizations who may benefit indirectly from improved energy efficiency and climate resilience.

Institution residents

Residents of the buildings pay the institution for their stay in the facility; they do not have individual contracts with energy suppliers.

Relational scheme

The Municipality of Novigrad is the initiating entity and acts as the project coordinator. It facilitates cooperation with the regional partners and ensures alignment with the national ZOIE legal framework. The Renewable Energy Community will be formally established as an association, with legal registration and statutes regulating its functioning.

The Home for Elderly People plays a central role as the local energy consumer. It manages the facility where the PV installation will be placed and maintains the energy contract. Istria County supports the initiative both administratively and as a co-owner of the facility. Other municipalities in the regional ZOIE structure contribute to the diversification of energy production and consumption points, enabling dynamic energy redistribution.

Institutional participants will sign membership agreements with the association. The REC will handle energy balancing, invoicing (where applicable), and reporting. A flat governance structure will ensure participatory decision-making, while cost and benefit allocations will follow pre-agreed quotas based on energy use and investment share. Transparency will be ensured via regular reporting and stakeholder consultation. The model facilitates not only technical and economic efficiency but also institutional legitimacy and social inclusiveness.

Technical Configuration

The Novigrad pilot targets the Home for Elderly People in the Bikokere district—a 6,256 m² facility accommodating 173 residents whose annual electricity demand reaches 258 MWh against a total site energy load of roughly 1.5 GWh. The load profile is flat and predictable, making the building an optimal host for a high-self-consumption photovoltaic scheme. Engineering studies confirm a technical ceiling of 136 kWp; the deployment will be phased, with EnerCmed resources underwriting the first 50 kWp and the Municipality of Novigrad together with Istria County financing the remaining 86 kWp. Project design has therefore been dimensioned for the full-scale configuration to ensure seamless expansion once co-funding is mobilized.

A preliminary structural survey has detected localized roof-deck water ingress, necessitating remediation before module installation. Detailed inspections are scheduled for June 2025; should extensive works be required, the project will switch to a pre-approved contingency: a ground-mounted photovoltaic carport of equivalent capacity. In either scenario the array will connect at low voltage, avoiding substation upgrades and simplifying permitting.

Surplus production, expected to be modest given the facility's continuous occupancy, will be exported to the regional ZOIE and allocated among sixteen additional public buildings, SMEs and household members, in accordance with Croatian net-sharing rules. The Renewable-Energy Community's business plan anticipates incremental PV capacity – with a first batch of 15 PV plants —and optional EV-charging services, with operating and maintenance costs covered by energy-sharing revenues and prospective charging fees. This modular approach aligns with Novigrad's objectives of lowering public-sector energy expenditure, enhancing social care resilience and establishing a scalable template for community-owned renewables across Istria County.

Business model

The Novigrad pilot adopts Croatia's Zajednica Obnovljive Izvori Energije (ZOIE) framework to establish a REC focused on safeguarding energy affordability for a municipally owned Home for Elderly People. The Municipality of Novigrad leads the initiative at local level, coordinating together with neighbouring municipalities and Istria County to form a non-profit association that will form the national level ZOIE.

The Home for Elderly People provides the host rooftop, manages the electricity contract and captures the first-tier benefit of avoided retail purchases. Surplus generation is redistributed virtually across the ZOIE network pursuant to Croatian net-sharing rules, enabling broader municipal self-consumption without additional grid reinforcements.

Financially, the model combines EnerCmed grant finance, prospective regional co-funding for roof renovation and future equity injections from REC members to reach full scale. Operating costs—maintenance, insurance and administrative reporting—remain low thanks to the association's flat governance structure. Revenue streams arise principally from electricity-bill savings at the elderly home, supplemented by remuneration for any residual exports, delivering both budget relief for public social services and long-term protection against utility-price escalation for the 173 resident seniors.

Here is a concise overview of the **Business Model Canvas** for the Novigrad pilot RECs:

Value Proposition

- Avoiding utilities costs increase over the time for elderly tenants trough renewable energy intervention
- Improved environmental performance and carbon footprint.

Key Partners

- Home for Elderly People institute: partial ownership of the building where the PV plant will be installed.
- Istria County: partial ownership of the building where the PV plant will be installed.
- Other Municipalities member of the ZOIE: collaborate with Novigrad to install additional PV power.

Key Activities

- Installation and commissioning of rooftop PV plant.
- REC establishment with other Municipality.

- Energy sharing with REC participants.
- Administrative reporting.

Key Resources

- Home for Elderly People building.
- PV plants and technical infrastructure.
- Municipality's technical and financial departments.
- Monitoring devices and interfaces.

Customer Segments

- Home for Elderly People institute: primary beneficiary of the self-consumption.
- Institution residents: In the long term, they are the final beneficiaries of the avoided increase in utility costs.

Channels

- Internal energy management and accounting.
- DSO metering.

Cost Structure

- CAPEX: investment in PV systems, legal constitution of the RECs.
- Additional CAPEX: Roof renovation and insulation.
- OPEX: maintenance, administrative management, and insurance.

Revenue Streams

- Avoided costs on purchased electricity for Home for Elderly People institute
- Revenues for any residual energy fed into the grid not matched under REC.

Economic sustainability assessment of Novigrad pilot

Investment costs

The investment costs for the Novigrad pilot can be categorized into two main components: those associated with infrastructure and plant development, and those required for the establishment of the REC legal entity.

The first category, infrastructure and 136 kWp plant investment, amounts to a total of €113,200. This encompasses various technical and installation-related expenses necessary for the photovoltaic system and its integration. Among the most significant cost items are the purchase of PV cells, which is estimated at €25,585, and inverters, valued at €4,400. Additional plant-related costs, including design and engineering account for €2,700.

Design and monitoring systems cost an estimated €16,000. Maintenance, support, safety systems, and measuring equipment add another €63,015. Grid connection costs are €500, varying by system size and site location. Table 12preset a detailed breakdown of investment costs.

Investment costs	**Unitary cost**	**Units**	**€**
Design and engineering	2.700 €	1	2.700 €
PV plant purchase			
PV cells	85 €	301	25.585 €
Inverters	2.200 €	2	4.400 €
Other plant costs	16.000 €	1	16.000 €
Monitoringor devices	1.000 €	1	1.000 €
Connection costs	500 €	1	500 €
Measuring and system security	63.015 €	1	63.015 €
TOTAL			**113.200 €**

Table 12. Novigrad pilot Investment costs

As mentioned in the technical description, a significant roof renovation may be necessary. If confirmed, an additional capital cost of approximately 500,000 € will be required to consolidate the building roof and ensure proper insulation. However, this amount is not included in the evaluation of the project sustainability as it represents a building-related cost external to the REC activation.

The second category pertains to the establishment of the REC legal entity, with total costs amounting to €1,018. It is important to note that this estimation covers the activation of the entire Istria level REC, not just the Novigrad pilot. The activation of the REC serves as a catalyst for the initiation of numerous other local installations across Istria County. The indicated costs include fixed administrative expenses such as legal entity formation, which is valued at €13, and REC authorization, estimated at €995. Other minor legal and administrative costs account for the remaining €10. Although these costs are relatively modest compared to infrastructure expenses, they are crucial for ensuring regulatory compliance and the operational viability of the REC. The mentioned administrative costs are better represented in Table 13.

Legal constitution costs	**€**
Legal entity constitution (association, cooperative)	13 €
REC model autorization or recognition	995 €
Other legal or administrative costs (please describe)	10 €
TOTAL	**1.018 €**

Table 13. Novigrad pilot legal constitution costs

Financing strategy

The investment package for the Novigrad pilot combines programme, regional and municipal capital. EnerCmed has earmarked € 65,000. The balance will be covered by the City of Novigrad and Istria County through off-budget allocations; discussions are also under way to redirect a fraction of the uncommitted EnerCmed envelope originally assigned to the Pula pilot, subject to Steering Committee approval[4].

Additional financing options—regional climate-action grants, earmarked county funds and potential corporate sponsorship—are being examined to ensure full coverage of the expanded 136 kWp design. Each source carries specific conditions on administrative clearance, public-procurement compliance and expenditure eligibility; these requirements will be integrated into the project's financial management plan and monitored through the REC's governance structure.

Operational costs

Similar to the investment costs, the operational expenses for the Novigrad pilot can be categorized into two primary groups: those associated with the PV system and those related to the administration of the REC.

As detailed in Table 14, the operational costs associated with the PV system total €7,482 annually. The primary components within this category include ordinary maintenance, which represents €6,132 annually, extraordinary maintenance estimated at €1,000 annually, and insurance costs of €350 per year. While maintenance and insurance expenses are generally stable, they may vary depending on the selected provider or changes in policy terms.

Plant operational cost	Unitary cost	Units	€/year
Ordinary maintenance	6.132 €	1	6.132 €
Extraordinary mantainance	1.000 €	1	1.000 €
Insurance	350 €	1	350 €
Total			**7.482 €**

Table 14. Novigrad pilot PV plant related operational cost

Administrative overheads for the Istria-wide REC are expected to rise progressively as membership expands, with personnel costs showing the greatest elasticity to scale. For the current operating year the REC's budget allocates €12,995 to management activities: €9,600 for staff remuneration, €1,800 for monitoring and IT support, and €600 for routine

[4] In any case not exceeding 80% of the eligible costs.

secretarial and compliance services (see Table 15). While ICT and general-administration outlays are largely fixed, staffing requirements will increase in proportion to the volume of member services—energy-sharing settlement, invoicing, stakeholder engagement—necessitating periodic budget revisions as the community grows.

REC administration costs	Unitary cost	Units	€/year
REC management and administrative costs	50 €	12	600 €
Additional personnel costs	800 €	12	9.600 €
Informatic or monitoring service costs	150 €	12	1.800 €
Fee and costs owed to the DSO or othe institutions	995 €	1	995 €
Total			**12.995 €**

Table 15. Novigrad pilot REC administration costs

These operational costs are expected to be directly covered by the REC through its revenue streams, which may derive from energy sales or savings through self-consumption. This financial model ensures that the REC remains sustainable without relying on external funding sources.

Revenue stream and savings

The Novigrad pilot project aims to generate a total annual value of €27,272 through three distinct revenue streams: physical self-consumption, energy injected into the grid and shared with other REC members, and energy injected into the grid but not shared. Each of these streams contributes to the financial sustainability of the initiative.

Physical self-consumption represents the largest portion of the value generated, amounting to €19,955 per year. This is achieved by utilizing the solar energy produced on-site to directly meet the electricity needs of the building. The high self-consumption rate of approximately 75% ensures a significant reduction in electricity expenses. These savings directly benefit the Home for the Elderly by maintaining stable accommodation costs for residents despite rising energy prices, thus providing both financial and social advantages.

The second revenue stream is expected to arise from surplus electricity exported to the grid and virtually allocated to other REC participants. Preliminary modelling indicates that roughly 80 % of total exports will qualify as “shared energy,” which—if remunerated at current wholesale prices—could translate into annual proceeds of about €5,321. This projection must, however, be regarded as illustrative. Croatian secondary legislation has not yet established either the valuation basis or the settlement procedure for energy shared within a REC. Until the regulator clarifies whether compensation will be linked to spot prices, a dedicated feed-in premium, or another tariff mechanism, the realisable income from this stream remains highly uncertain and subject to material revision.

The third revenue stream involves energy injected into the grid but not shared with REC members. This energy is compensated at the grid injection price, contributing an estimated €1,197 annually. Although this represents the smallest portion of the total value, it nonetheless provides a supplementary financial benefit to the project. However, like shared energy, the precise valuation of this stream is subject to regulatory uncertainties within Croatia. Table 5 presents detailed descriptions of the revenue values and the assumptions behind them.

Revenues	Amount		Price		Value	
Physical self-consumption	106.713	kWh/year	0,187	€/kWh	19.955	€/year
Energy shared or virtually consumed	28.457	kWh/year	0,187	€/kWh	5.321	
Energy surplus not shared or virtually consumed	7.114	kWh/year	0,168	€/kWh	1.197	€/year
Total					**26.474**	**€/year**

Table 16. Novigrad pilot revenues

Operational sustainability

The Novigrad scheme is embedded in the emergent Istria-wide Renewable-Energy Community association. While the regional REC will ultimately pool administrative services and distribute overheads among all participating municipalities, the final membership base—and therefore each member's cost share—remains indeterminate. To avoid overstating local burdens, the present assessment excludes the association's central management budget and focuses on the costs and benefits strictly attributable to the Novigrad installation at the Home for Elderly People.

Capital expenditure is dominated by the PV plant itself—modules, inverters, mounting structures, monitoring hardware and grid connection—supplemented by design and permitting services. Operating expenditure consists chiefly of preventive and corrective maintenance, insurance and periodic performance verification. When assessed on a stand-alone basis these technical OPEX items are modest relative to the annual value of electricity-bill savings generated through a high self-consumption ratio and the remuneration expected for residual exports.

Under the reference scenario—financed entirely from local and regional sources with no capital subsidy—the projected cash flow returns the investment in roughly six years, a horizon well within municipal asset-management norms and consistent with social-purpose infrastructure. In the real scenario, which applies the EnerCmed grant to part-fund the initial deployment, the payback period is effectively halved to around three years, freeing earlier surplus for reinvestment in elderly-care services or further PV expansion.

Material uncertainties remain. Croatian secondary legislation has not yet fixed the tariff methodology for energy shared within a ZOIE, creating upside potential once a clear remuneration mechanism is enacted. In addition, a final roof survey will determine whether limited waterproofing works suffice or whether the contingency option—a ground-mounted carport—must be activated; either outcome is already embedded in sensitivity tests and does not threaten baseline viability.

Overall, the Novigrad pilot demonstrates robust economic resilience, with swift capital recovery under both unsubsidised and grant-supported configurations and a pathway to long-term cost stability as the regional REC matures.

EnerCmed Interreg Euro-MED Co-funded by the European Union

Pula pilot

The City of Pula has opted for a direct self-consumption model, avoiding the formation of a formal Renewable Energy Community. This choice aligns with the Municipality's objectives for administrative simplicity, rapid deployment, and focused social impact. The model leverages existing regulatory provisions for public institutions to self-generate and consume renewable electricity, with excess production sold to the grid.

The intervention targets the Children's Creative Center in the Monte Zaro district—a socio-economically sensitive area characterized by high population density and limited green infrastructure. The decision to exclude the building from the ZOIE framework allows the city to maintain full control of the project, simplifying legal, financial, and operational management. The cost savings from the PV system will be directly allocated to support the city's homeless shelter, promoting social inclusion and energy justice without the complexity of a shared governance model.

Legal options and contractual agreements in Pula pilot

No new legal entity is required for the Pula pilot. The Municipality retains full ownership of the PV system and the energy point of delivery. All administrative and regulatory procedures, including grid connection, monitoring, and incentive access, are managed directly by the city administration in coordination with HEP ODS (the national DSO).

This centralized structure eliminates the need for participation agreements or REC registration, streamlining the process and reducing transaction costs. Surplus electricity, if any, will be injected into the grid under standard net metering conditions for public entities, and the revenues will be directly received by the Municipality. Internally, the city commits to reallocating these revenues to support the homeless shelter, in accordance with its social policy objectives.

Stakeholders map and relational scheme

The stakeholder map and relational scheme for the Pula pilot reflect the streamlined nature of its operational model, showcasing a reduced number of stakeholders compared to the Novigrad pilot. This simplicity is a direct result of the Municipality's decision to retain full ownership and management of the PV system, avoiding the complexities of a Renewable Energy Community. By centralizing responsibilities, the Pula model ensures efficient coordination and minimizes administrative burdens.

Municipality of Pula

Acts as the sole institutional operator of the PV system, retaining ownership, managing all technical, financial, and administrative responsibilities, and reallocating energy savings to local social services, particularly the homeless shelter.

Children’s Creative Center

Hosts the PV system on its recently refurbished roof. While not a direct contractual actor, it benefits from reduced energy bills and contributes to energy-saving efforts through daily operations.

Homeless Shelter

Receives indirect financial support from the Municipality through the reinvestment of PV-generated savings, aimed at enhancing services for vulnerable populations and social beneficiaries.

HEP ODS

As Croatia’s national distribution system operator, it oversees the metering of injected surplus energy and ensures the technical compliance of the PV system’s connection to the local grid.

Local Community

Gains long-term benefits in terms of increased climate resilience, improved public infrastructure efficiency, and symbolic alignment with the city's inclusive and sustainable development goals.

Relational Scheme

The Pula pilot project exemplifies a centralized relational model with the Municipality of Pula at its core. The Municipality takes on the legal ownership of the photovoltaic (PV) installation and acts as the contracting authority for the Children's Creative Center. This central role allows the Municipality to manage the entire chain of energy generation, consumption, and redistribution of financial benefits.

The Children's Creative Center, while not entering into a contractual agreement, operates the PV system. Its responsibilities include facility management and maintaining energy consumption patterns that maximize self-consumption. The Homeless Shelter benefits indirectly from the financial savings generated by the reduced electricity costs. These savings are administratively transferred by the city, rather than being directly linked to the shelter's energy use.

HEP ODS, the national distribution system operator of Croatia, ensures the technical compliance of the PV system's connection to the local grid and oversees the metering of any surplus energy generated. The streamlined arrangement of this model facilitates swift implementation and minimizes bureaucratic hurdles, while also achieving the project's social objectives.

Technical Configuration

The technical configuration involves the installation of a 19 kWp PV system on the flat roof of the Children's Creative Center. The center was recently refurbished and includes approximately 270 m² of usable roof space, allowing for a theoretical installation of up to 45 kWp. However, the EnerCmed-funded deployment is limited to 19 kWp.

The PV system will consist of high-efficiency monocrystalline panels with a total estimated output of 24,000 kWh/year. This output is expected to cover a substantial share of the center's daytime electricity needs. Any excess will be injected into the grid under net metering arrangements.

The system includes smart inverters and monitoring devices for performance tracking. Maintenance will be handled by the Municipality or an external contractor. Revenues generated from grid-injected electricity will be earmarked for the city's homeless shelter. This configuration ensures operational autonomy, cost-effectiveness, and alignment with the city's social policy goals.

Business model

The Pula pilot adopts a streamlined, municipality-led self-consumption model tailored for rapid deployment and minimal administrative burden. A 19 kWp photovoltaic array, installed on the roof of the Children's Creative Center in the Monte Zaro district, supplies the building's daytime demand under Croatia's net-metering regime. The Municipality of Pula retains full ownership of the asset and manages all technical, financial, and regulatory tasks directly with HEP ODS, eliminating the need to constitute a separate Renewable-Energy Community.

Energy flows are simple: electricity produced on site is consumed on site; any surplus is exported to the grid and credited to the municipal account. Financial benefits are twofold. First, the Children's Creative Center sees an immediate reduction in utility expenditure. Second, the Municipality earmarks the resulting savings—and any net-metering revenues—for the city's Homeless Shelter, thereby converting an energy-efficiency intervention into a targeted social-welfare measure.

Key stakeholders include the municipal energy department (system owner and operator), the Children's Creative Center (host facility), HEP ODS (grid interface), and the Homeless Shelter (indirect beneficiary). Capital investment covers PV procurement and installation, while operating costs are limited to routine maintenance and insurance. The absence of new legal entities or governance structures keeps transaction costs low and makes the model readily replicable across other public buildings in Pula.

Following, the building block of the Pula pilot **Business Model Canvas** are presented:

Value Proposition

- Reduction of electricity expenditure for the Children's Creative Center through on-site self-consumption.
- Re-allocation of the resulting savings to the city's Homeless Shelter, delivering direct social impact without additional bureaucracy.
- Improved environmental performance and lower municipal carbon footprint.
- Rapid, low-transaction-cost deployment fully controlled by the Municipality, readily replicable across other public buildings.

Key Partners

- Municipality of Pul: owner, financier and operator of the PV installation.
- Children's Creative Center: host facility and primary energy consumer.
- HEP ODS: national distribution system operator, responsible for grid connection, metering and compliance.
- Homeless Shelter: social beneficiary of re-invested energy savings.
- Local EPC contractor and O&M service providers (installation, maintenance).

Key Activities

- Procurement, installation and commissioning of a 19 kWp rooftop PV plant.
- Operation, monitoring and routine maintenance under municipal management.
- Net-metering administration and any surplus export to grid.
- Internal accounting and transfer of financial savings to the Homeless Shelter.

Key Resources

- PV modules, inverters, mounting structures and monitoring devices.
- Technical and financial staff within the municipal energy department.
- Net-metering interface provided by HEP ODS.

Customer Segments

- Children's Creative Center: direct reduction of utility bills.
- Homeless Shelter: indirect financial beneficiary.
- Wider local community: long-term climate-resilience and social-equity gains.

Channels

- Internal municipal energy-management system and accounting procedures.
- HEP ODS metering and net-metering portal for surplus tracking and settlement.

Cost Structure

- CAPEX: one-off investment for the 19 kWp PV system (design, equipment, installation, commissioning).
- OPEX: preventive maintenance, insurance, periodic performance monitoring and administrative overheads.
- No costs for legal-entity set-up or community governance.

Revenue Streams

- Avoided electricity-purchase costs for the Children's Creative Center (primary financial benefit).
- Net-metering credits / revenue from any surplus electricity exported to the grid, received directly by the Municipality.
- Social return (non-cash) from reallocating monetary savings to support Homeless Shelter operations.

Economic sustainability assessment of Pula pilot

The economic sustainability assessment of the Pula pilot highlights its robust financial framework, underpinned by a total investment of approximately €19,500. A significant portion of this funding is covered by the EnerCmed contribution, ensuring the project's feasibility while minimizing upfront costs for the Municipality of Pula. Operational costs are notably low, with the burden of operating expenses transferring after the 5th year. Revenue generated from surplus energy injected into the grid and bill reduction from energy savings are earmarked to support the city's homeless shelter, fulfilling critical social objectives. This approach not only ensures cost-effectiveness but also aligns with the city's broader commitment improve social activities by reinvesting in infrastructure and services for vulnerable groups.

Investment costs

The total investment related to the Pula pilot is approximately €19,500, covering the design, engineering, and purchase of high-efficiency components for the recently installed 19 kWp PV plant. Design costs encompassed essential reports, such as static roof evaluation and fire safety analysis. While the conceptual design is developed by IRENA internal staff to minimize expenses. The bulk of the budget was allocated to PV plant purchases, including monocrystalline cells and supplementary infrastructure like panel substructures, cable routes, and fireproof sealing for safety compliance. Preparatory civil work also contributed to the expenditure, reflecting the technical rigor required for sustainable installation. Notably, administrative costs were eliminated by opting for a direct self-consumption model, bypassing the complexities of forming a formal Renewable Energy Community. Table 17 presents a detailed breakdown of investment costs.

Investment cost	**Unitary cost**	**Units**	**€**
Design and engineering	2.700 €	1	2.700 €
PV plant purchase			
PV cells	85 €	45	3.825 €
Inverters	2.200 €	1	2.200 €
Other plant costs	3.500 €	1	3.500 €
Monitoringor devices	500 €	1	500 €
Installation	3.200 €	1	3.200 €
Connection costs	446 €	1	446 €
Testing and measures	200 €	1	200 €
Optimizers	65 €	45	2.925 €
TOTAL			**19.496 €**

Table 17. Pula pilot CAPEX

Financing strategy

The Pula pilot Investment is financed through a combination of grant funding and municipal contributions. A significant portion of the investment, 80% of the final investment, is supported by EnerCmed funds as a grant. This funding source comes with specific conditions, including reporting obligations and adherence to time constraints, ensuring accountability and timely implementation. Complementing this, the Municipality of Pula is expected to contribute 20% of the total project cost. Additionally, the Municipality is slated to finance the grid connection, further underlining its active role in the pilot's success.

Operational costs

The annual operational costs are estimated in €550 and can be divided into three primary categories, namely ordinary maintenance, extraordinary maintenance, and insurance. Ordinary maintenance, valued at €250 per year, encompasses regular system inspections, cleaning, and minor repairs, ensuring the continuous and efficient operation of the system. Extraordinary maintenance, estimated at an average value of €150 per year, addresses unforeseen interventions such as component failures or external damage, which may vary depending on the aging of components and exposure to external risks. Insurance, also costing €150 per year, provides coverage against potential risks including fire and storms.

For the first five years, these expenses are covered by IRENA, ensuring financial relief during the initial phase of the project. However, after this period, the responsibility for these costs will transition to the city of Pula, as the photovoltaic plant is installed on municipal property. Over the lifespan of the plant, no specific external funding mechanisms have been identified to cover operational expenditures, leaving energy-related savings and revenues as the primary sources for managing these ongoing costs. Table 18 presents a detailed breakdown of operational costs.

Plant operational costs	Unitary cost	Units	€/year
Ordinary maintenance	250 €	1	250 €
Extraordinary mantainance	150 €	1	150 €
Insurance	150 €	1	150 €
Total			**550 €**

Table 18. Pula pilot operational costs

Revenue stream and savings

The financial benefits generated through the pilot site's photovoltaic (PV) system, installed at the DKC building, are rooted in two primary mechanisms: the reduction of electricity bills through self-consumption of solar energy and the revenue obtained from surplus energy fed into the grid. These direct profit are credited to the City of Pula, which owns and pays the utility costs for the facility.

Rather than retaining energy savings at the DKC facility, the City of Pula reallocates these resources to the homeless shelter, thereby enabling improvements in infrastructure and services for individuals experiencing homelessness. This strategy represents an internal transfer within the public administration's economic framework, effectively channeling the advantages of renewable energy into targeted social interventions.

Several key factors influence the magnitude and efficiency of this revenue stream. These include the quantity of solar energy produced, which directly correlates with the level of savings generated; the rate of self-consumption of this energy within the pilot site; and the tariffs applied to surplus energy injected into the grid, which determine the financial returns from excess production. The City of Pula has implemented a robust mechanism to ensure that these savings are not only realized but also strategically reinvested to maximize their impact on community welfare.

The PV system, with an installed capacity of 19.0 kWp, generates an annual production of approximately 19,592 kWh. The building itself is estimated to directly consume 31% of this energy, equivalent to 6,006 kWh per year, due to its reduced consumption during the summer, when solar production peaks. Its energy usage profile is similar to that of a school building, operating primarily from 07:00 to 15:00 on weekdays and remaining closed on weekends. The remaining 69% of the generated energy—approximately 13,586 kWh per year—is injected into the grid, creating an additional revenue stream for the administration.

Energy streams are remunerated based on market prices, resulting in an estimated annual benefit of approximately €3,250. Of this amount, €1,072 is attributed to the value of reduced electricity bills through physical self-consumption, while €2,182 comes from the direct revenue generated by energy injections into the grid. This dual mechanism not only optimizes the economic returns from renewable energy production but also ensures a substantial financial contribution to public administration resources. Table 19 presents a detailed breakdown of energy streams repartition, reference prices and revenues streams.

Revenues	Amount		Price		Value	
Physical self-consumption	6.006	kWh/year	0,178	€/kWh	1.072	€/year
Injection in the grid	13.586	kWh/year	0,161	€/kWh	2.182	€/year
Total					**3.254**	**€/year**

Table 19. Pula pilot revenues

Operational sustainability

A preliminary analysis immediately highlights the clear sustainability of the investment. The lack of necessity to establish and manage a dedicated legal entity significantly reduces both costs and complexities, positively impacting CAPEX and OPEX.

Under a reference scenario, assuming the absence of contributions provided by the EnerCmed fund, the revenues—including operational savings—are expected to allow recovery of the initial investment within 7–8 years, considering the identified operating costs.

Conversely, in the real scenario, where the Municipality is required to cover only 20% of the project costs, the return on investment is projected to occur in less than two years.

A more detailed analysis will be provided as part of activity A2.6, “Environmental, economic and social impact assessment associated to the pilots.” This study, employing the Life Cycle Costing (LCC) method, will evaluate not only the sustainability of the photovoltaic component but also the integration of NBS and their impacts on stakeholders, such as the homeless shelter.

Greek pilot of Patras

The Patras pilot showcases a lean, municipality-driven approach to public-sector decarbonisation, capitalising on Greece's mature net-metering framework while sidestepping the governance complexity of a full Renewable-Energy Community. Rather than constituting a new legal entity, the City has chosen to install a 50 kWp rooftop photovoltaic system on the 6th High School and to enrol the plant under net metering. The arrangement that allows kilowatt-hour credits and any surplus remuneration to flow directly into the school's operating budget even though the Municipality retains ownership of the asset.

This strategy exploits two distinct regulatory opportunities. First, public entities may still apply classic net-metering rules despite Greece's 2024 shift toward net billing, ensuring a stable, credit-based settlement that maximises on-site value. Second, virtual metering enables off-balance-sheet reinvestment: all savings and export revenues are earmarked for educational needs, reinforcing the school's financial autonomy and embedding energy literacy in the curriculum.

Administratively, it relies on a single internal agreement that governs how benefits are transferred from the municipal utility account to the school. The chapter that follows details investment requirements, financing structure, operating costs and projected payback, demonstrating how a streamlined, legally simple model can deliver rapid climate-action gains and measurable socio-economic co-benefits.

Renewable Energy Communities and Self-Consumption Configurations

The Greek regulatory framework initially promoted the adoption of renewable energy sources (RES) through the implementation of a net metering scheme, introduced by Ministerial Decision 15084/382 in 2014. This mechanism enabled both natural and legal persons—including non-profit organizations such as local authorities, educational institutions, and agricultural cooperatives—to offset electricity produced by photovoltaic systems against their electricity consumption. The model allowed for self-consumption while feeding any excess energy into the grid, with compensation applied over a rolling three-year period. In cases where energy production exceeded consumption, surpluses were credited to future bills; any remaining surplus at the end of the cycle was annulled (European Commission, 2025).

To enhance flexibility, the scheme was later expanded to include "virtual net metering", allowing eligible entities to install RES systems at off-site locations within the same administrative region. This development proved especially advantageous for public institutions and social service providers, as well as for the emergence of Energy Communities.

Energy Communities were formally integrated into Greek legislation with Law 4513/2018 and further regulated under Law 5037/2023, transposing EU Directives 2018/2001 and

2019/944. The current framework provides for three distinct forms of energy communities:

- Renewable Energy Communities (RECs)
- Citizen Energy Communities (CECs)
- Pre-existing Energy Communities under Law 4513/2018 (established before April 1, 2023)

These community models vary in terms of eligible participants, with RECs being the most inclusive—permitting participation from citizens, local authorities, SMEs, and cooperatives. Notably, RECs and CECs are positioned as innovative tools for collective energy generation and consumption, aligning with EU objectives for decentralization and democratization of energy.

In May 2024, Greece introduced Law 5106/2024, signaling a gradual shift from net metering to net billing. Under this new model, electricity exported to the grid is monetarily compensated rather than offset against consumption. Despite this transition, certain exemptions apply public sector entities, including municipalities, retain the right to adopt net metering for RES installations intended for self-consumption (PV Magazine, 2024).

In this evolving context, the Municipality of Patras has opted to implement a net metering scheme rather than establish a Renewable Energy Community. This decision was driven by the need to adopt a lean and operationally efficient model, minimizing administrative complexity while ensuring that the economic benefits of energy production could be directly allocated to the end beneficiary—in this case, a local public school. The selected approach involves the installation of a 50 kWp photovoltaic system on the school rooftop, under a virtual net metering arrangement. This solution allows the Municipality to avoid the burdens associated with the creation and governance of a new legal entity, while still aligning with national objectives for decarbonization and energy efficiency.

Legal options and contractual agreements

In the case of Patras, the implementation of a net metering scheme for on-site individual self-consumption eliminates the need to establish a separate legal entity, as would be required under a REC model. The Municipality remains the sole legal and administrative owner of the photovoltaic installation and the associated infrastructure, operating fully within the existing public law framework and national energy regulations (Law 5106/2024).

This legal simplicity enables the Municipality to directly manage the project without the creation of an association, cooperative, or company, thereby avoiding the governance and compliance obligations typically associated with REC structures. The only formal legal acts required concern the grid connection request, the technical and administrative documentation for the photovoltaic installation, and the formal application to the grid operator for enrollment under the net metering regime.

To ensure that the economic benefits generated through net metering are meaningfully reinvested at the local level, the Municipality of Patras opts to establish an internal agreement with the beneficiary institution—namely, the 6th High School of Patras. This agreement stipulates that all financial gains derived from the operation of the photovoltaic system—including direct savings on electricity bills and compensation for surplus energy injected into the grid—are allocated to the school's operational budget.

Although the Municipality retains ownership of the system, this internal arrangement ensures that the school's administrative committee directly benefits from the installation, reinforcing the educational institution's financial autonomy and promoting a culture of energy responsibility among students and staff. The agreement outlines the specific modalities for transferring the savings and any other compensatory credits, in compliance with applicable national and municipal accounting procedures.

Technical Configuration

The Patras pilot centers on a 50 kWp rooftop photovoltaic installation at the 6th High School, complemented by courtyard upgrades that improve micro-climate resilience and provide an outdoor learning space.

The plant will employ high-efficiency mono-PERC modules rated at ~550 Wp (±10 %) and ≥20 % conversion efficiency. Three three inverters, each nominally 17 kVA, provide grid compatibility and string-level redundancy. Annual output is forecast at roughly 74 MWh, covering more than two-thirds of the school's electricity demand. Connection to the local low-voltage grid will be carried out in coordination with the public electricity supplier and grid operator.

Energy settlement is governed by a virtual net-metering agreement: the Municipality of Patras retains ownership and regulatory responsibility, while all kWh credits and grid injection revenues are assigned to the school's budget.

The system is sized to favor on-site consumption, with additional surplus exports remunerated, thus aligning with national decarbonization policy while maximizing economic benefit for the school.

Overall, the technical configuration delivers robust energy autonomy, reduces operating costs, and serves as a practical demonstration of Greece's energy-transition strategy within the public-education sector.

Business model

The energy produced will directly offset the school's electricity consumption, generating operational savings for the school administration. Because ownership, grid liaison and regulatory compliance remain with the Municipality, the model avoids the governance complexity of a Renewable-Energy Community yet still delivers measurable economic relief and an educational showcase for energy transition. Upgrades to the surrounding courtyard further enhance climate resilience and provide a practical learning environment for students.

Following, the building blocks of the Patras pilot **Business Model Canvas** are presented:

Value Proposition

- Annual reduction of the 6th High School's electricity expenditure through self-consumption.
- Additional income from grid injection remuneration of surplus exports.
- Educational platform for renewable-energy awareness among students and staff.
- Simplified, low-transaction-cost model fully controlled by the Municipality and readily replicable across other public schools.

Key Partners

- 6th High School of Patras – host facility and sole financial beneficiary.
- HEDNO – distribution system operator, responsible for interconnection, metering and net-metering settlement.
- DEI – electricity retailer issuing bills and applying net-metering credits.
- EPC contractor and O&M service providers (installation, two-year guaranteed maintenance).

Key Activities

- Procurement, installation and commissioning of a 50 kWp rooftop PV system.
- Two-year preventive maintenance and defect replacement by the contractor; routine monitoring thereafter.
- Administration of net-metering settlement and allocation of monetary savings to the school.
- Reporting and compliance with national procurement and municipal-finance regulations.

Key Resources

- PV modules, inverters, mounting structures, monitoring devices.
- Municipal technical and financial staff.
- Net-metering contract with HEDNO/DEI.
- Upgraded courtyard infrastructure supporting educational use.

Customer Segments

- 6th High School of Patras administration: direct budgetary savings for operational and educational needs.
- Student body and teaching staff: experiential learning on renewable energy.
- Municipal education department: pilot template for wider school fleet.

Channels

- Municipal internal accounting and budgeting procedures.
- HEDNO metering portal and DEI billing interface for credit reconciliation.

Cost Structure

- CAPEX: design, equipment, installation and grid connection.
- OPEX: ordinary and extraordinary maintenance, insurance and monitoring.

Revenue Streams

- Avoided electricity-purchase costs for the school.
- Remuneration for surplus exports at per kWh.
- Intangible educational and climate-resilience benefits for the wider community.

Economic sustainability assessment

The pilot project in Patras represents a streamlined and cost-effective model for deploying renewable energy infrastructure within a municipal setting. Designed around a single public building, the intervention focuses on the installation of a rooftop photovoltaic system with minimal administrative complexity and clear financial transparency. The Municipality of Patras is the sole project promoter and directly manages all procurement, contracting, and financial flows.

The implementation and financial management of the project adhere to the following regulatory provisions:

- Law 4412/2016 (Official Gazette A 147), on public procurement;
- Law 3463/2006 (Official Gazette A 114), the Municipal and Community Code;

- Law 3852/2010 (Official Gazette A 87), on the architecture of local government (Kallikratis Program).

This chapter provides a comprehensive overview of the investment costs, financing strategy, operational expenditure, revenue streams, and the overall economic sustainability of the initiative. It outlines the technical and administrative capital expenditures incurred for project implementation, details the mechanisms by which the installation is financed, and presents the projected operational savings and grid-injection revenues that will sustain the pilot over its lifecycle.

Investment costs

The investment costs associated with the pilot project in Patras are primarily technical, amounting to approximately €42.500. The remaining costs are linked to the design and project management activities, while administrative costs, such as connection fees, are minimal. The cost distribution is shown in Table 20.

Investment cost	**Unitary cost**	**Units**	**€**
Design and engineering	2.000 €	1	2.000 €
PV plant purchase			
PV cells	200 €	90	18.000 €
Inverters	1.333 €	3	4.000 €
Other plant costs	11.000 €	1	11.000 €
Monitoringor devices	2.000 €	1	2.000 €
Installation	5.000 €	1	5.000 €
Connection costs	500 €	1	500 €
TOTAL			**42.500 €**

Table 20. Patras pilot investment costs

All listed expenditures are fixed costs, relating solely to the initial setup and deployment of the project's technical infrastructure, as a result of a completed tender process, with the relevant contract already awarded. All costs will be directly covered by the Municipality of Patras, which is responsible for conducting tender procedures and executing contracts with suppliers.

Financing strategy

The entire project is financed through public funds, with 80% of the costs covered by EnerCmed funds, and the remaining 20 percent financed by National fund.

These resources are fully secured, and the Municipality will not need to mobilize additional financial resources to complete the project.

Operational costs

After the execution of the supply, a guaranteed operation period of 2 years is defined. During this period, the contractor of the supply shall carry out preventive maintenance and replace any defective materials in order to ensure the proper functioning of the photovoltaic system.

Periodic maintenance will involve several key tasks, including cleaning the photovoltaic panel surfaces at least twice a year. Additionally, biannual inspections will check electrical connections of cables, converters, grounding, grounding triangle, and measure grounding values. Maintenance will also cover inspection of photovoltaic panel support bases, ensuring proper screw connections, and examining the support points for electrical conductors (cables). Finally, the process will include checks for all materials and micromaterials that are integral to the photovoltaic system, guaranteeing comprehensive functionality and reliability.

The replacement of defective material shall be carried out by the contractor after written notification of the monitoring committee or receipt of the supply within 20 days after excluding reasons of the above violence.

The annual estimated costs for maintenance and monitoring amount to €1,800, as detailed in Table 21.

Plant operational cost	Unitary cost	Units	€/year
Ordinary maintenance	750 €	1	750 €
Extraordinary mantainance	300 €	1	300 €
Insurance	450 €	1	450 €
Other plant operational costs	300 €	1	300 €
Total			**1.800 €**

Table 21. Patras pilot operational costs

The above-mentioned costs will be covered by the contractor of the supply, as it is one of his obligations according to his contract.

Revenue stream and savings

The economic viability of the Patras pilot is primarily supported by two sources of financial benefit: direct energy savings from self-consumption and revenues from the sale of surplus electricity to the grid. These financial flows contribute to improving the economic sustainability of the public-school infrastructure, while remaining fully aligned with the applicable legal and procedural framework for municipal energy management in Greece. Although the scheme does not include dedicated incentive tariffs for shared energy, the combination of avoided energy purchases and surplus injection revenues provides a stable and predictable financial return throughout the system's operational lifetime.

The primary economic benefit of the Patras pilot is derived from operational savings generated through the self-consumption of electricity produced by the photovoltaic systems. These savings, in accordance with applicable national regulations, are retained within the school community's budget, directly reducing the institution's energy expenditure. Based on current electricity tariffs applied by the Municipality of Patras for public-sector supply, the annual cost reduction is estimated at approximately €6,248.

In addition to self-consumption savings, the installation generates revenue through the sale of surplus energy to the grid. Exported energy is remunerated at a fixed tariff of €90 per MWh, resulting in an expected annual income of around €3,651.

There are no internal revenue transfers between institutions within the pilot. All revenues remain assigned to the host site, and their utilization follows national rules governing public financial management.

Due to the involvement of public funding, no incentive tariff is applied to shared energy under the current regulatory framework, and there are currently no mechanisms in place to reinvest the savings into broader social or energy-related initiatives. The estimated breakdown of revenue by energy category is presented in Table 22**.**

Revenues	**Amount**		**Price**		**Value**	
Phisical self-consumption	40.575	kWh/year	0,154	€/kWh	6.248	€/year
Energy shared or virtually consumed	40.575	kWh/year	0,090	€/kWh	3.651	€/year
Total					**9.899**	**€/year**

Table 22. Patras pilot revenues

Operational sustainability

A preliminary assessment confirms the economic feasibility of the Patras pilot, supported by a streamlined implementation model that does not require the creation or management of a separate legal entity. This approach significantly simplifies administrative processes and reduces both capital and operational expenditure, contributing to the project's overall financial viability.

In a reference scenario that assumes no grant support from the EnerCmed programme, the combination of self-consumption savings and gid injection revenue would allow for full recovery of the initial investment within approximately 5 to 6 years, factoring in routine operating costs. This payback horizon demonstrates the potential for replication even under self-financed conditions.

In the actual scenario, however, the entire investment is publicly funded through the EnerCmed project. As a result, the concept of return on investment becomes non-applicable in traditional terms, since no upfront expenditure is incurred by the Municipality.

A comprehensive evaluation of the project's economic, social, and environmental performance will be delivered under Activity A2.6, "Environmental, economic and social impact assessment associated to the pilots." This assessment will apply the Life Cycle Costing (LCC) methodology, extending the analysis to include long-term impacts and potential co-benefits related to Nature-Based Solutions (NBS) and local stakeholder engagement.

EnerCmed Interreg Euro-MED Co-funded by the European Union

Conclusion

This deliverable set out to examine how the five EnerCmed lighthouse pilots translated national regulatory opportunities into workable Renewable-Energy Community (REC) or self-consumption schemes and to provide an initial appraisal of their economic sustainability. The assessment was developed through iterative exchanges with the local pilot leaders, who supplied technical, legal and financial inputs over several consultation rounds. On this basis, tailored business models were constructed for each site, reflecting both statutory frameworks and local social priorities. Solutions range from Genoa's remote individual self-consumption configuration—chosen to deliver immediate municipal savings without additional governance layers—to Valencia's dual REC approach, where autonomous associations mobilize citizens and NGOs to route solar benefits to vulnerable households. Pula follows a municipality-led on-site self-consumption model targeting a children's center, while Novigrad activates the Istria-level national REC to protect elderly tenants from rising utility costs. Patras deploys virtual net metering to offset the electricity bill of a public high school, with the Municipality retaining ownership and regulatory liabilities.

Figure 1 compares capital outlays with payback periods under a reference scenario that excludes grant support and captures the full economic value—bill savings and export remuneration—available to each community. Payback ranges from roughly 4.5 to 9.5 years, a horizon that is fully acceptable for socially oriented public investments. Novigrad exhibits two variants: with (Novigrad) and without (Novigrad*) the share of national REC administrative costs, the latter being spread across an as-yet undetermined set of member municipalities. Key drivers of financial viability include declining photovoltaic equipment prices and, in the cases of Genoa, Pula and Patras, the virtual absence of recurring administrative overheads.

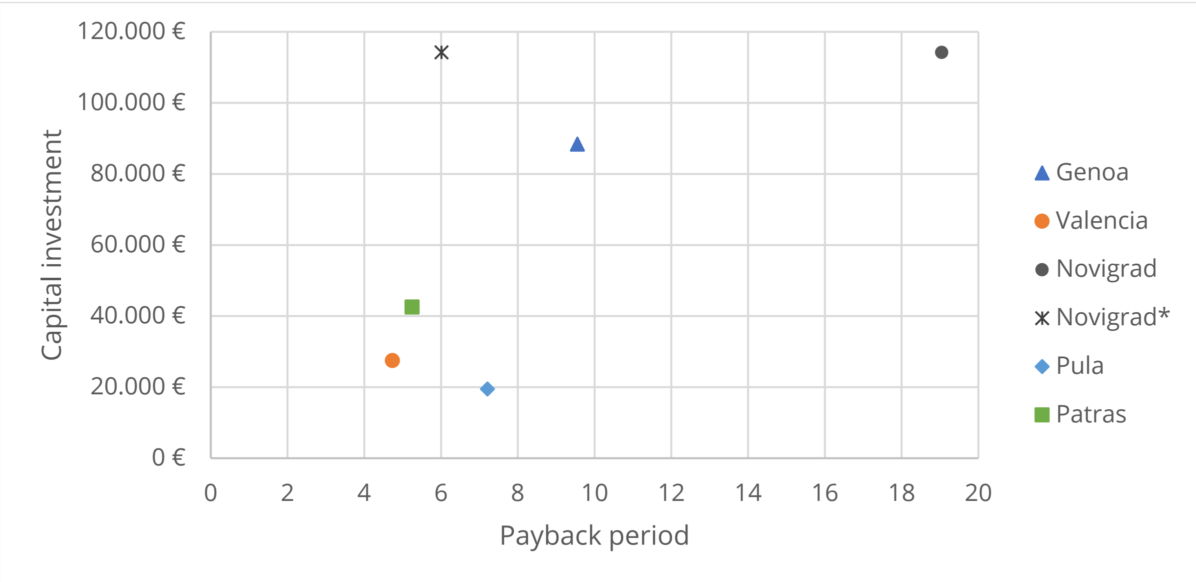

Figure 1. Payback period and capital investment comparison across pilots.

The analysis underscores that rooftop suitability cannot be presumed. Structural investigations at Novigrad and CEIP Ausiàs March reveal either the need for reinforcement works or relocation to alternative buildings if EnerCmed timelines are to be met. These findings highlight the importance of early engineering diligence in community-energy planning to avoid critical hidden costs.

Despite differing governance models and site conditions, all pilots demonstrate economic robustness within a self-financed framework and deliver clear social co-benefits—whether through lower public-sector operating costs, protection of vulnerable consumers, or enhanced educational value. The streamlined municipal models confirm that meaningful impact can be achieved even without the administrative complexity of a full REC, while the Valencia and Novigrad cases show the added social reach that community governance can unlock.

A holistic evaluation of economic, social and environmental performance will follow under Activity A2.6. Using Life-Cycle Costing (LCC) and impact-assessment methodologies, that study will quantify long-term costs, Nature-Based Solution co-benefits and stakeholder value creation, providing the final decision basis for replication and policy recommendations.

In conclusion, the pilot portfolio proves that, when aligned with local regulatory contexts and social objectives, photovoltaic-centred energy communities and self-consumption schemes are both technically feasible and financially sustainable, offering scalable pathways toward the Mediterranean port cities' energy-transition goals.

Bibliografia

European Commission. (2025). *Clean energy for EU islands*. Retrieved from clean-energy-islands.ec.europa.eu: https://clean-energy-islands.ec.europa.eu/countries/croatia/legal/community-energy-policies/energy-communities-energy-cooperatives-energy

European Commission. (2025). *Net-Metering / Net-Billing (Net-metering and virtual net-metering)*. Retrieved from clean-energy-islands.ec.europa.eu/: https://clean-energy-islands.ec.europa.eu/countries/greece/legal/res-electricity/net-metering-net-billing-net-metering-and-virtual-net

GSE. (2025). *CONFIGURAZIONI PER L'AUTOCONSUMO DIFFUSO*. Retrieved from www.gse.it: https://www.gse.it/servizi-per-te/autoconsumo/gruppi-di-autoconsumatori-e-comunita-di-energia-rinnovabile

Il Sole 24 ore. (2024). *Autoconsumo Individuale a Distanza e Comunità di Energia Rinnovabile*. Retrieved from www.ilsole24ore.com: https://i2.res.24o.it/pdf2010/S24/Documenti/2024/05/21/AllegatiPDF/dominel.pdf

PV Magazine. (2024). *pv-magazine.com*. Retrieved from Greece shuns net metering: https://www.pv-magazine.com/2024/06/18/greece-shuns-net-metering/

Column 1	Column 2

Table 23. EnerCmed sample table

Figure 2. EnerCmed logo