POWERUP
The catalyst for social innovation in the energy market

Energy services alleviating energy poverty

Financial and commercial business cases of 4 pilot areas

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Executive summary

The POWER UP project promotes the emergence of local energy market players with a socioecological agenda. By providing energy services at the local level in four pilots cities in Spain, Czech Republic, Italy, Belgium, the project explores ways to fight energy poverty.

This document analyses the four POWER UP pilots' financial and commercial business cases. This pioneering work in Spain, Belgium, Czech Republic and Italy may be useful to other local authorities wanting to launch renewable energy services for vulnerable people.

The analysis includes the description of the selected models, their elaboration, and the assessment of the potential impacts. After the main description, each pilot's stakeholder analysis is carried out to explain their complexity and the different interactions. From the economic point of view, investment costs, operational costs and revenues are evaluated under different possible scenarios.

The business cases are further assessed by representing monetary flows among each stakeholder and are represented graphically. Several opportunities for generating benefits have been considered. In addition to energy savings, households will benefit from the sharing of incentives, the sale of energy and the purchase of energy at an advantageous price.

Simulations have shown that the net annual impacts per household can vary from 20 € to 170€. The wide difference us due to the differences in activities promoted by the municipalities. These have been designed based on the possibilities that the different regulatory frameworks allow in the four analysed pilots.

Finally, a comprehensive comparison is carried out to represent the strengths and weaknesses of the different approaches implemented by the pilots.

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01

Introduction

This report describes the financial and commercial business model developed for the POWER UP pilots. The models have been discussed with the different stakeholders, with the participation of the involved residents in particular.

Chapter 3 describes the steps taken to develop the business cases, starting from the theoretical business models. In particular, the different basic ideas are shown.

Chapter 4 describes in detail the business cases of each pilot, defining the preliminary calculations sustaining the model. Relevance is given to estimating investments, financial costs and benefits for all the relevant stakeholders.

Chapter 5 provides a final comparison between the different use cases, providing an easy tool to compare their impacts and replicability.

Regarding the pilot areas covered, please note that - as explained in the previous deliverable D3.2 "Report on the governance of the POWER UP pilots" - Heerlen, the pilot in The Netherlands, has been discontinued due to local legal and governance challenges. Thus, this deliverable does not include information about this pilot. Nevertheless, the details about the preliminary model explored in Heerlen can be found in deliverable 4.1 "Guidelines on renewable energy production business case: How to do it, what to take into account".

02

From business models to business cases

As a first step to guide the municipalities towards the definition of their pilot project, a business model was developed, organising their initial ideas into more structured categories and concepts. The business models were developed based on the "business model canvas", a widely used tool to conceptualise and organise the ideas around the final objective.

The long-term business models, deeply described and analysed in Deliverable D2.3, can be summarised as follows:

- Valencia will seize the opportunities coming from the new regulation for Renewable Energy Communities, which can involve vulnerable households as members and/or as beneficiaries of the produced and shared energy and related economic value created. In the Valencia case, the already applied "Valencia model" has been moved to the new shared self-consumption model, which will be objective of the analysis;
- In a similar way, UCSA will work within the Italian Renewable Energy Community concept, which is mainly based on distributing incentives generated through virtual energy sharing; the shared energy will be generated by PV plants owned by the municipality and conferred to the energy community;
- Eeklo will directly invest money in a wind turbine, purchasing the shares of the local energy cooperative Ecopower and lending them to selected vulnerable households, making them benefit from competitive energy tariffs.
- Roznov will set up its own one-stop-shop, aiming at supporting the citizens in taking action for energy savings and energy efficiency; at the same time, the city will invest in the renovation of a public social housing building, it will include the installation of a PV plant, benefiting the vulnerable households living inside;

As a common factor to all pilots, though each business model has its own features and each pilot plans a different set of activities, all are focused on the involvement of vulnerable households with the final aim of fighting energy poverty without burdening the households.

After the definition of the Business Models, obtained starting from the different aspects of the project that the Municipalities are developing and from their discussion with the citizens, it was possible to start working on quantitative aspects. Once the concrete action(s) had been identified, business cases could be developed to assess, in principle, the sustainability of the pilot projects. For this purpose, economic and financial data relating to the investment, such as costs and revenues, both financial and non-financial, were collected.

Business cases aim to assess the convenience of an investment, assess the benefit, cost, and risk of alternative options, and provide motivation for the preferred solution. The business cases are thus developed by analysing the several aspects of the project affecting its sustainability, as will be shown in depth in the following chapter 3:

- Stakeholders: all the subjects that play a role in the project, directly or indirectly. Stakeholders are grouped according to their level in relation to the Energy Community;
- Investment costs: the initial up-front cost to start the project. This could be the cost of installing new renewable energy sources (e.g., PV plants) or buying shares of existing ones (e.g., the shares of the existing wind turbine in Eeeklo). Regardless of the way it's financed, it's the value that needs to be paid back by the revenues, savings and, in general, financial benefits generated by the production, consumption and sharing of renewable energy;
- Revenues/savings: the (annual) financial benefits generated by the project, obtained as proceeds from the sale of electricity, as savings on the energy bill and/or from public incentives available. The business case considers, in the first analysis, all financial inflows generated by the project, regardless of the sharing mechanism that will be chosen;
- Cost/expenditure: the (annual) financial costs and expenditures related to the management of the project, including, for example, the operation and maintenance cost of the renewable energy source, administrative costs, tax, etc. The business case considers, in the first analysis, all financial outflows related to the project, regardless of the subject who finally pays for them;
- Monetary flows for the stakeholders: a calculation of the monetary (financial) costs and benefits for each subject involved in the scheme. This depends on the mechanism to determine "who pays for what" and "who gets what" in the project. Considering that the business models developed within PowerUP! aim at benefitting vulnerable households, the business cases follow the same logic foreseeing different ways to make the vulnerable households benefit from the measures;
- Costs and benefits for the stakeholders: the monetary and non-monetary costs and benefits that are generated by the project for each subject involved in the scheme. This

is done with a wider overview on the project, considering the additional and qualitative benefits generated for the final beneficiaries of the measures, focusing on vulnerable households.

This information is then described and compared to easily represent the main differences within the different pilots.

03

Business Cases

This chapter presents a detailed analysis of the four pilots' business cases.

3.1

Campania (UCSA), involving 4 municipalities in South Italy

The Campania (UCSA) pilot led by San Giuseppe di Vesuviano is centred on the concept of the Italian Energy Community (EC). It represents a comprehensive approach to energy management and community involvement.

> The pilot in a nutshell:
>
> The implementation of this Italian pilot involves the installation of photovoltaic plants on public rooftops, a choice that uses existing infrastructure for renewable energy production. The generated energy is then matched with the consumption patterns of local companies, creating a close relationship between production and consumption. The resulting energy sharing is quantified and remunerated by "Gestore dei Servizi Energetici" (GSE) for each kWh shared, creating an economic incentive that underpins the project's sustainability.
>
> A key aspect of the UCSA Pilot is its focus on social inclusivity. Vulnerable households within the community are identified and targeted to receive a relevant portion of the incentives generated from energy sharing.

At the heart of this initiative lies the collaborative effort of different key players. The project promoters are the municipalities. They finance the installation of photovoltaic (PV) plants on public buildings, thus laying the foundation for renewable energy production within the community. Their role extends beyond funding; they actively manage the project with guidance and support from UCSA. The energy sharing will take place with the participation of local companies. Local companies are selected as a crucial part of the consumers as their energy consumption allows the Energy Community to share the majority of the produced renewable energy with more predictable consumption compared to the households' consumption. These companies' energy consumption patterns are closely monitored to facilitate energy sharing. The energy sharing mechanism is central to the project's financial model, wherein the energy services manager GSE provides economic incentives based on the quantity of energy shared among community members. A key aspect of the UCSA Pilot is its focus on social inclusivity. Vulnerable households within the community are identified and targeted to receive a relevant portion of the incentives generated from energy sharing. This initiative aims to alleviate energy bills for these households, thereby contributing to social welfare. These households are not required to install devices since they can participate by subscribing to an agreement facilitated by municipal social services. This model also allows for flexibility, permitting periodic changes in the beneficiary households as their circumstances evolve.

A notable feature of this project is the equitable distribution of the financial incentives derived from energy sharing. While a portion of these incentives directly aids vulnerable households in reducing their energy costs, another fraction is allocated to the municipalities. This allocation covers operational costs and supplements the revenue generated from energy sales, ensuring the financial viability and sustainability of the project.

A visual representation of the UCSA scheme and its players is shown in the following chart:

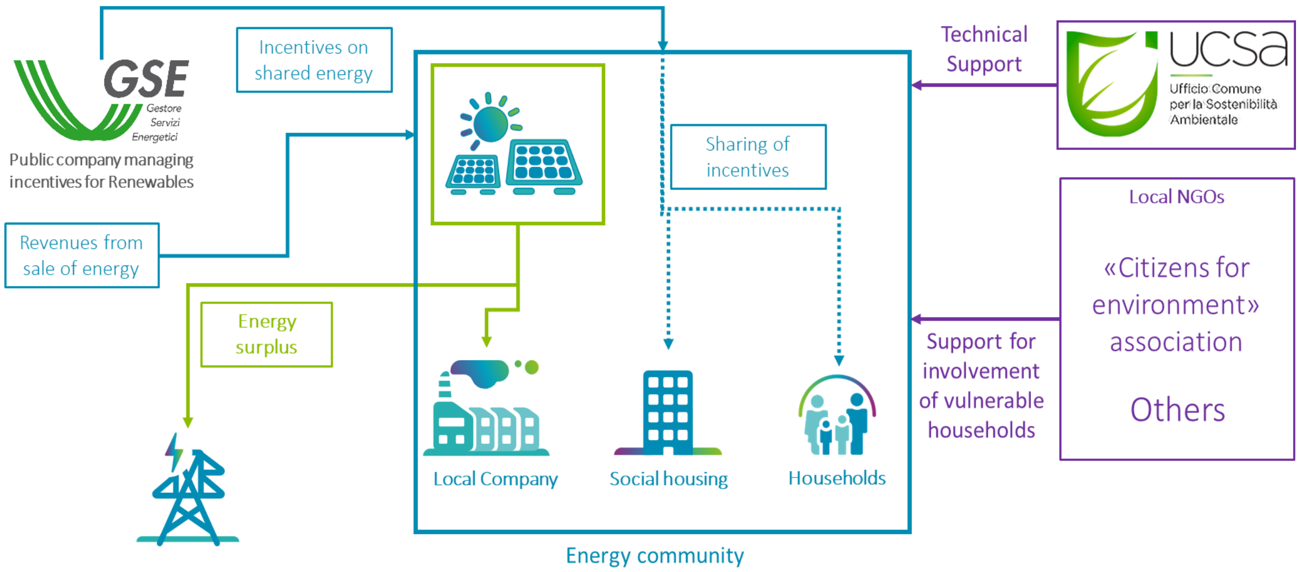

Figure 1: UCSA Conceptual scheme

3.1.1 Stakeholders involved

The stakeholders involved in Campania (UCSA) pilot are:

Level	Stakeholders type	Entity	Description
Macro	DSO	E-Distribuzione	The DSO manages the distribution grid, monitors the flow of electricity, carries out maintenance and manages interconnections with customers and energy producers.
	Authority	GSE	The public company in charge of recognising the status of REC and assigning the incentives
Intracommunity	Municipalities	Palma Campania, San Gennaro Vesuviano, San Giuseppe Vesuviano, Striano	UCSA office cover the geographical area of four distinct municipalities
	Intermediary organisations/ Third parties	UCSA (Common Office for Sustainability and Environment)	UCSA has the objective of facilitating and strengthening the management in the fields of the environment, energy and adaptation to climate change of the four participating Municipalities
		AESS	AESS has the objective of supporting UCSA and the four participating Municipalities with technical studies regarding the RE plants, REC schemes and energy savings interventions, facilitating and strengthening the participatory and co-design processes with the local actors.
		Social Services	Local Social Services from UCSA municipalities help EC managers to identify energy poor households
Intercommunity	Power plants owner	Municipalities	Municipalities' plants produce energy to share with local actors, business, and citizens

	Energy consumer	Local Business	Local energy consuming companies act as energy consumer to generate "shared" energy
	Incentives taker	Households	Specific households are selected to receive economic incentives obtained from the energy sharing

Table 1: UCSA stakeholders

3.1.2 Investment costs

The energy community model undertaken by UCSA is based on the use of photovoltaic systems spread over the public buildings of the four municipalities that are members of the UCSA entity.

An important characteristic of this case is that some of the installations identified are already partially installed or installed but not connected to the electricity grid. Therefore, initial investment costs are significantly reduced, and the municipalities will not need to spend a large amount of money.

UCSA mapped around 200 KWP of photovoltaic potential that had already been installed but was not being exploited and was not connected to the grid. An average cost of 111 €/kWp has been estimated to complete the installations and make the necessary connections. The total estimated cost is, therefore 22.200 €, an expenditure to be distributed among the four municipalities of the territory. The low investment required allows municipalities to start the project without having to obtain any form of loan or debt, making the project easier to implement. It is important to highlight how, considering the actual market, the value of the activated plants is equal to 300.000 €. This is the amount that UCSA would have to finance to realise 200 kWp of new photovoltaic if there were not already plants to capitalise on.

INVESTMENT COSTS						
	Unitary cost		Estimate power		Total cost	
Investment costs	111	€/kWp	200	kWp	22 200	€

Table 2: UCSA investment costs

3.1.3 Costs/Expenditure

Given the simplicity of photovoltaic systems in the pilot project undertaken by the UCSA municipalities, a constant average operating cost of 20 €/kWp is estimated. According to market investigations, this value can cover the various expenses related to the maintenance and management of the plants. In addition, within the proposed value, the extension of the insurance from the building supporting the PV system can be included to protect the plant itself.

As shown in the table below, considering 200 kWp installed, the annual operating cost is estimated at 4.000 €. The profits of the UCSA consortium generated by the plants are reported in the specific chapter; in any case, these profits are clearly higher than the costs and any increase in costs would not affect the project.

Operational costs						
	Unitary cost		Estimate power		Total cost	
Operational costs	20	€/kWp	200	kWp	4.000	€

Table 3: UCSA operational costs

3.1.4 Revenues/Savings and incentives

Starting from mapping the buildings and plants available for integration, an installable power target of 200 kWp has emerged. The optimal solar radiation typical of the territory of southern Italy will allow the plants to reach a total annual production of 288.770 kWh.

The distribution of the plants on different buildings implies the identification of different self-consumption levels for the different plants. From specific simulations, an average self-consumption value equal to 54% has been defined, it corresponds to 155.936 kWh/year. The remaining energy is fed into the electricity grid to be available for sharing, while at the same time is remunerated from the national energy service manager. It is assumed that not all the energy is shared with other users, but that only 70% of the total would be shared. This value represents the natural misalignment between photovoltaic production and energy consumption by the users involved. The saturation of the potential sharing can be improved by selecting different types of users, to spread the consumption throughout the production curve of the PV plants.

TECHNICAL ASSUMPTIONS		
Power	200	kWp
Average production	1.443	kWh/kWp
Annual production	288.770	kWh/year
Self-consumption index	54	% of total production
Shared index	70	% of fed energy

Table 4: UCSA technical assumptions

Several comparative simulations were carried out to analyse the impact of the consumption index and the sharing index. The following table shows the different values of shared energy obtainable by changing the two indices within plausible ranges.

ANNUAL ENERGY SHARING ACCORDING TO DIFFERENT ENERGY SETTINGS [kWh/year]								
		Self-consumption index						
		24%	34%	44%	54%	64%	74%	84%
Shared energy input	50%	109.733	95.294	80.856	66.417	51.979	37.540	23.102
	60%	131.679	114.353	97.027	79.701	62.374	45.048	27.722
	70%	153.626	133.412	113.198	92.984	72.770	52.556	32.342
	80%	175.572	152.471	129.369	106.267	83.166	60.064	36.963
	90%	197.519	171.529	145.540	119.551	93.561	67.572	41.583
	100%	219.465	190.588	161.711	132.834	103.957	75.080	46.203

Table 5: UCSA energy sharing analysis

Starting from the calculated reference value for self-consumption of 54%, the amount of self-consumed energy is equal to 155.936 kWh/year. Considering a unit savings value of 0,22 €/kWh, the total savings for the municipalities of the UCSA Consortium generated by self-consumption is equal to 34.306 €/year. The remaining 132.834 kWh/year of produced energy will be fed into the grid and, assuming a remuneration of 0,15 €/kWh, the profit of the municipalities obtained from the sale is equal to 19.925 €/year.

As already mentioned, it is assumed that 70% of the energy fed into the grid is virtually shared within the energy community, this share amounts to 92.984 kW/year. The foundation of the Italian energy community concept is the economic incentive for the energy virtually shared between producers and consumers. The incentive is given by the manager of energy services (GSE) and replaces the real cost savings in the bill, which in this case is not present for consumer members. According to the most recent Italian regulations an incentive provided by the GSE of 0,11 € per kWh of shared energy. This value considers a renewable energy selling value of 0,15 €/kWh and the presence of PV plants of less than 200 kWp. In addition to the incentive provided by the GSE must be considered the refund of network charges of 0,009 €/kWh provided by the "Regulatory Authority for Energy Networks and Environment" (AREA). In this specific case, the total value of the incentive amounts to 0,119 €/kWh of shared energy. Considering this incentive value, energy sharing within the energy community is remunerated for 11.065 €/year.

PROFITS AND COST SAVINGS						
	Energy amount		Unitary value		Annual value	
Energy cost saving	155.936	kWh/year	0,22	€/kWh	34.306	€/year
Energy selling to the grid	132.834	kWh/year	0,15	€/kWh	19.925	€/year
Incentives on shared energy	92.984	kWh/year	0,119	€/kWh	11.065	€/year

Table 6: UCSA profits

While the incentives will be used for the social purposes of the energy community, the savings generated by self-consumption and the sale of energy fed into the grid are accounted as profits for the Municipalities of the consortium. The following chart shows how the profits of the municipalities vary according to different levels of self-consumption and different energy prices. The values are represented after deducting the operating costs of 4.000 € /year already presented.

For each level of auto-consumption, the graph compares three different scenarios:

i. Reduced energy price scenario with energy selling price of 0,10 €/kWh and self-consumption savings value of 0,17 €/kWh;
ii. Reference energy price scenario with energy selling price of 0,15 €/kWh and self-consumption savings value of 0,22 €/kWh;
iii. Scenario at increased energy price with energy selling price of 0,20 €/kWh and self-consumption savings value of 0,27 €/kWh.

Within the reference scenario, for a value of self-consumption of 54% the total profit for the municipalities of 50.231 €/year was obtained and considered as reference value.

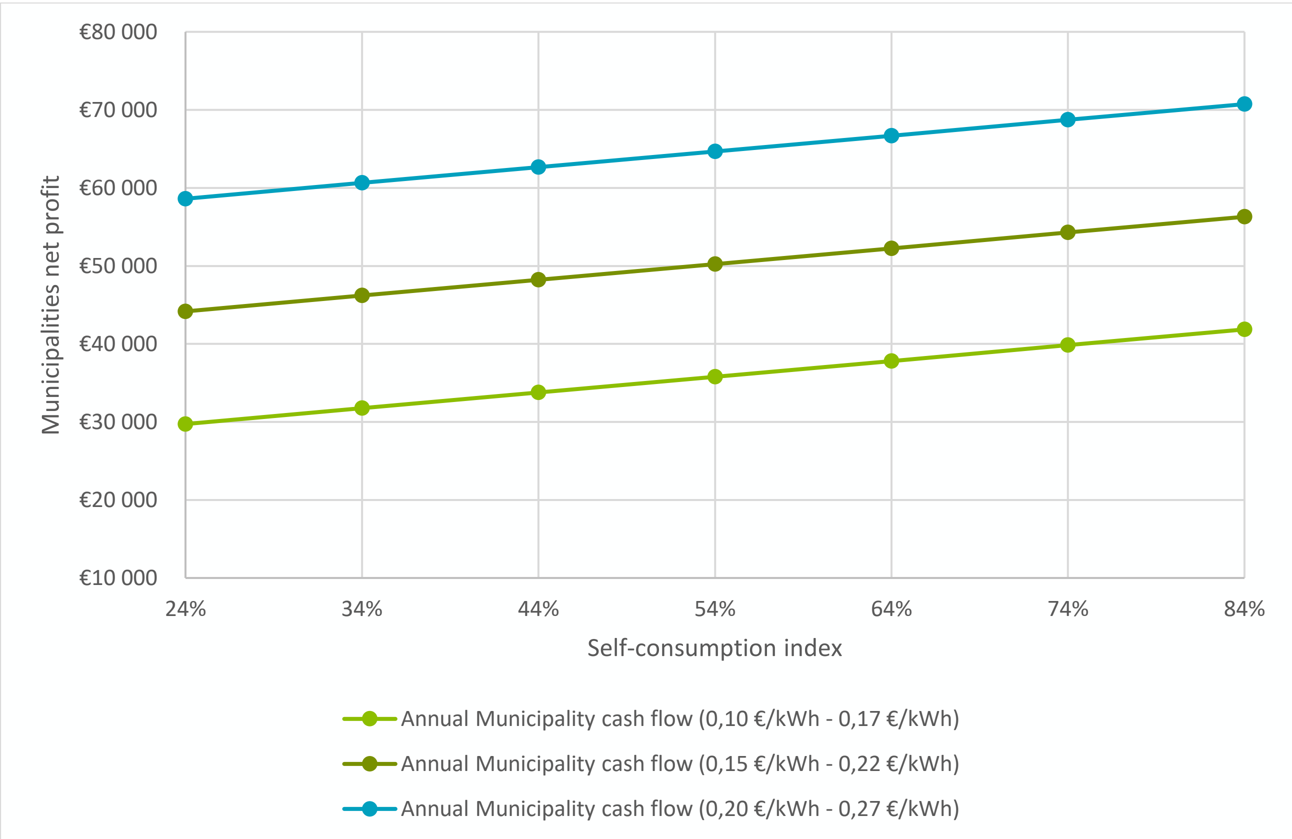

Figure 2: UCSA municipalities profit according to different self-consumption index

3.1.5 Monetary flows

The monetary flows established between the different actors have already been introduced in the previous chapters and can be summarised as follows.

Investment flow: The four municipalities of the UCSA Consortium invest in the implementation of photovoltaic systems for an estimated total amount of 22.200 €. This makes it possible to activate plants for a market value of 300.000€.

Sales and energy saving: Municipalities benefit from the energy savings obtained through the self-consumption of renewable energy generated and from selling the energy surplus. Profit generated through energy consumption and the sale of energy surpluses to the grid is estimated to be 50.231 €/year net of maintenance costs.

Incentives for sharing: The virtual sharing of energy with local companies is remunerated by the GSE and ARERA through the provision of an economic incentive directly to the energy community. The annual amount is equal to 11.065 € and will be used for social purposes through the division between the families involved.

The following image represents the described cash flows:

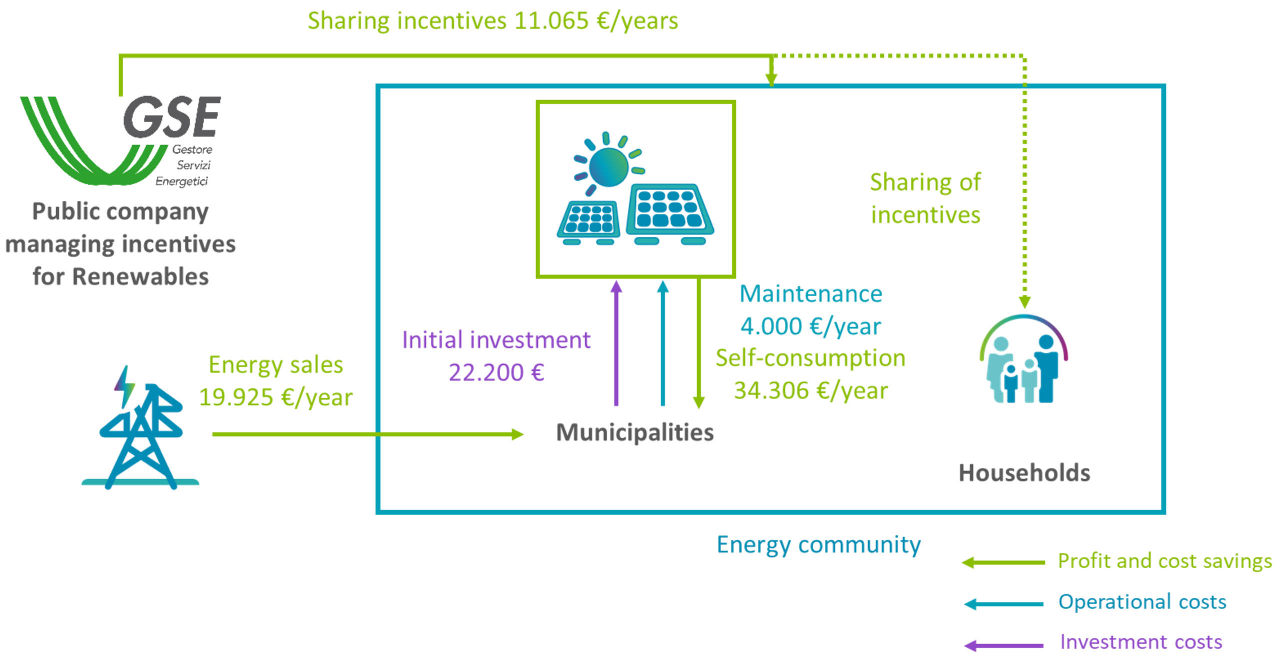

Figure 3: UCSA monetary flows

3.1.6 Costs and benefits for the stakeholders

As previously discussed, the beneficiaries of the project are the Consortium of Municipalities and citizens participating in the sharing of incentives. After dealing with the investment costs and annual maintenance costs, the municipalities will benefit from a total annual profit of 50.231 €.

Citizens who participate in the sharing of incentives, selected among the most fragile residents, will get a share of the 11.065 €/year of incentives without having to face any cost.

The amount recognised for each individual household depends on several factors. Firstly, it is a function of the number of citizens involved in the allocation of incentives. The larger the number of citizens involved, the lower the amount allocated per family. To provide a more complete view, the following table shows this variation as a function of different energy sharing indices (the reference sharing index is 70%).

VARIATION OF THE INDIVIDUAL BENEFIT FOR DIFFERENT SHARING RATES [€/year]								
		Households number						
		40	50	60	70	80	90	100
Shared energy input	50%	227 €	182 €	152 €	130 €	114 €	101 €	91 €
	60%	273 €	218 €	182 €	156 €	136 €	121 €	109 €
	70%	318 €	255 €	212 €	182 €	159 €	142 €	127 €
	80%	364 €	291 €	243 €	208 €	182 €	162 €	146 €
	90%	409 €	328 €	273 €	234 €	205 €	182 €	164 €
	100%	455 €	364 €	303 €	260 €	227 €	202 €	182 €

Table 7: UCSA individual benefit analysis A

The proposed simulation assumes that companies participating in energy sharing will not receive any form of economic remuneration for their contribution to the project. This is plausible as companies will not face any expenses and could participate exclusively for social responsibility. If this is not the case, and companies require a contribution, it will correspond to a percentage of the incentives generated. The following table shows the amount of incentives that can be allocated to each household according to different proportions of incentives retained and therefore not allocated to households. The values are obtained by fixing the sharing index to 70% (the reference retained percentage is 0%).

VARIATION OF THE INDIVIDUAL BENEFIT IN CASE OF DIFFERENT INCENTIVE ALLOCATION [€/year]								
		Households number						
		40	50	60	70	80	90	100
Incentives not allocated to households	0%	318 €	255 €	212 €	182 €	159 €	142 €	127 €
	10%	287 €	229 €	191 €	164 €	143 €	127 €	115 €
	20%	255 €	204 €	170 €	146 €	127 €	113 €	102 €
	30%	223 €	178 €	149 €	127 €	111 €	99 €	89 €
	40%	191 €	153 €	127 €	109 €	96 €	85 €	76 €
	50%	159 €	127 €	106 €	91 €	80 €	71 €	64 €

Table 8: UCSA individual benefit analysis B

3.1.7 Action plan and next steps

A public call was released after holding the first series of co-design workshops between October and November 2023. This was to identify the founding partners of the REC, and these, together with representatives from UCSA's municipalities, will establish the local working group (LWG) for the constitution of the REC entity (association) in the first part of 2024.

With the formal constitution of the REC association, the relation among the stakeholders will be formalised and the REC should absorb the majority of the working group's activities, helping the implementation of the POWER UP project.

In 2024, 5 public meetings are foreseen with citizens and householders in energy poverty conditions, especially with the one already engaged in the REC's activation/co-design group (selected in the meeting cycle held between October and November 2023 in the municipalities of Palma Campania and San Giuseppe Vesuviano). The public meetings will be held to promote energy efficiency measures and engage the householders in the energy community initiative. They are foreseen to be held between February and August 2024.

Meanwhile, the UCSA consortium, with the support of the sustainability agency AESS and local technicians, will proceed with checking the status of the mapped PV plants and completing the installation. In addition, the municipalities of the consortium are moving on with identifying additional photovoltaic potential and planning further installations.

3.2

Valencia

The Valencia Pilot is based on the Spanish concept of collective self-consumption.

Basically, the energy produced by the PV plant is virtually shared and consumed by the households that are members of the scheme. Each household can consume the energy produced by the PV plant in proportion to the number of shares it holds. The consumption of renewable energy produced by the PV plant directory reduces households' energy bills.

Within the energy community framework, participating households can consume the renewable energy generated by the photovoltaic plants based on the number of shares they hold. This virtual energy-sharing mechanism allows households to reduce their energy bills using locally generated renewable energy directly. Embracing this model, the Valencia Municipality effectively promotes the democratisation of access to renewable energy sources and addresses energy poverty.

The Valencia pilot in a nutshell:

The Municipality of Valencia, through its public agency Valencia Clima I Energia, plans to install five photovoltaic systems for a total power of 2,8 MWp. These municipal plants will provide energy directly to the Municipality and the citizens involved, which can be divided into two categories: citizens in a vulnerable energy situation and citizens or small and medium size enterprises within the energy sharing radius. The direct investment of the Municipality allows vulnerable households to obtain shared energy quotas without investing an initial amount of money, making the energy community model accessible even to those who do not have capital to invest in the plant. Others pay a participation fee.

The Valencia Municipality already incubated an energy community project, utilising its resources to catalyse renewable energy development and offering effective measures to address energy poverty within the region. The Municipality adopted a strategic approach, whereby it does not directly invest financial resources into the energy communities but leverages its budget to foster their development. By providing public roofs, the Municipality facilitates the implementation of renewable energy community projects, particularly those to alleviate energy poverty. Specifically, the Municipality provided an available area via free concession to install the energy community's photovoltaic plant. Citizens, as members of the energy community, had the opportunity to participate in the investment by purchasing 0.5 kWp plant shares at a cost of 600€ each. Through an initial investment, citizens could obtain a constant share of free renewable energy over the years. Thanks to the collective self-consumption scheme, shared renewable energy directly reduces the citizens' bills and improves their social condition.

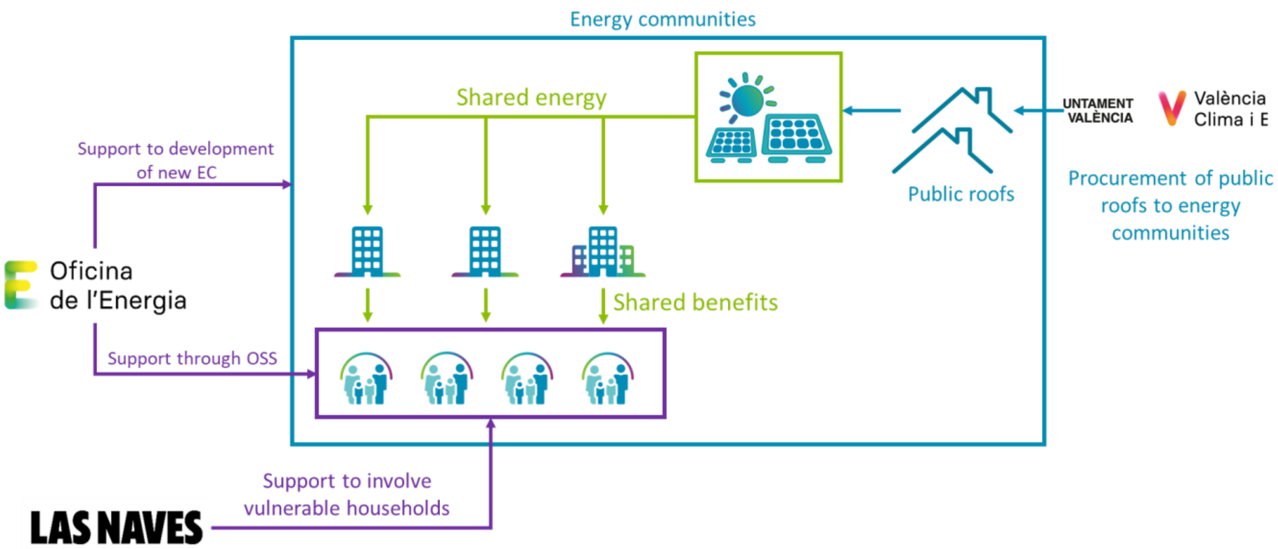

Figure 4: Valencia Model conceptual scheme

Based on this experience, the City of Valencia decided to develop a more complex model based on the concept of public service of self-consumption of renewable energy. This new model is described in detail in the following chapters.

3.2.1 Renewable energy self-consumption - public service setup

In the scheme of shared self-consumption implemented by the Municipality of Valencia, it is planned to install 5 photovoltaic systems for a total power of 2,8 MWp. These plants will provide energy directly to the Municipality and the citizens involved, which can be divided into two categories:

- Energy vulnerable households
    - Vulnerable persons and non-profit entities better defined in D3.3;
    - Are involved from the start of the project and are not required to pay participation fees.
- Citizenship (non-vulnerable households)
    - Citizens or small and medium size enterprises within the energy sharing radius;
    - Will be involved following the full activation of administrative procedures and will be required to pay the participation fee.

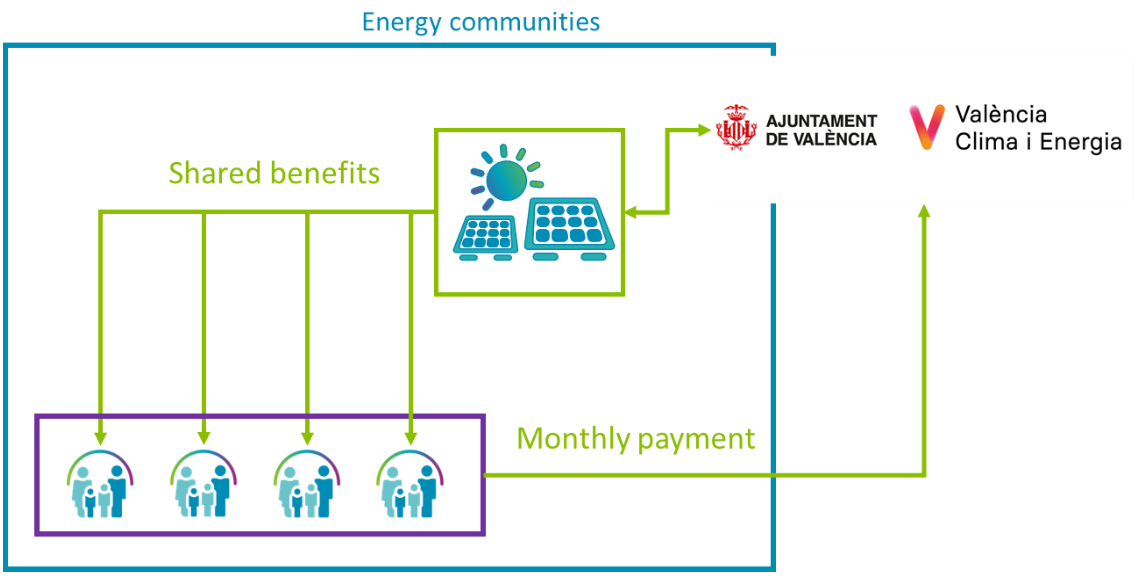

Figure 5: Renewable energy self-consumption public service conceptual scheme

The selection of citizens who can rent the plant is carried out through the definition of a public tender; this allows all vulnerable citizens to become part of the energy community. Compared with the "Valencia model", the "Renewable energy self-consumption public service" introduce some clear benefit:

- The direct investment of the Municipality allows households to obtain shared energy quotas without investing an initial amount of money, making the energy community model accessible even to those who do not have capital to invest in the plant;
- The rental of the quota, combined with its small size, allows the Municipality to request a fee designed to be lower than the cost saving generated by energy sharing, making citizens' participation immediately convenient even for low energy consumption citizens;
- At any time, a citizen can leave the energy community, leaving the available share to other citizens who will take over the rent.

This project serves as a social/charity endeavour, supplying free electricity to vulnerable households in the neighbourhood. This social intervention is achieved by saving a specific number of free shares to be distributed to a selected number of vulnerable households.

To foster collaboration and engagement, the Valencia Municipality actively promotes the formation of a Local Working Group. This group serves as a platform for presenting projects, gathering ideas, and engaging local stakeholders. The municipality provides essential technical and legal assistance to individuals or organisations interested in launching an energy community, specifically emphasising including vulnerable householders in the initiatives.

3.2.2 Stakeholders involved

The stakeholders involved in are:

Level	Stakeholders	Entity	Description
Macro	DSOs	i-DE (Iberdrola Distribución), COELCA Redes (Castellar)	Responsible for distribution grid operation and maintenance, monitoring of energy flows and intermediation with electricity suppliers, including the formal activation, facilitation, and provision

			of billing information to suppliers regarding self-consumption schemes. I-DE is the main DSO in the Valencia region, COELCA is DSO at pilot project of CEL Castellar-L'Oliveral.
	Energy Provider/Suppliers	Multiple	Multiple energy providers can be involved in collective self-consumption schemes, as each prosumer freely chooses its preferred supplier, either in the free or the regulated market. Providers should directly reflect in the individual energy bills the savings related to participation in collective self-consumption installations, according to DSO readings.
	National authorities	Spanish government, Ministry for Ecological Transition, IDAE	The central government, through its dedicated ministry, sets the general legal and regulatory framework for energy communities and collective self-consumption, as well as for energy poverty considerations. IDAE is the national body aimed at facilitating energy transition, providing with detailed guidelines, and supporting programmes, with a special focus on energy communities.
	Regional authorities	Regional government, IVACE	The regional government "channels" different supporting programmes and subsidies (mainly through public body IVACE) and can also contribute with specific legal and regulatory dispositions regarding energy transition issues.
Intracommunity	Municipality	Valencia	Promoter and facilitator of different business models regarding energy sharing, always from a public interest perspective and prioritising the inclusion of vulnerable households on the schemes. Depending on the scheme, the Municipality can act as direct promoter of PV installations or

			facilitate access to municipal roofs and spaces for REC so they can implement their projects. Municipal Social Services play a key role as intermediary, detailly explained below.
	Intermediary organisations/ Third parties	VCE/Las Naves	Pilot partners, responsible for intermediation between parts and direct contact with citizens to successfully implement energy sharing models. VCE collaborates with the Municipality to define the model, offer technical support and help with the identification and support to vulnerable households. VCE also provides with OSS services regarding energy poverty and energy communities. Las Naves will take the lead for knowledge transfer tasks, especially with sister cities.
		Social Services	Sets the eligibility criteria for vulnerable households and plays a key role for the identification and inclusion of vulnerable households on the scheme.
		NGOs, Grassroot organisations	Can help with the identification and referral of potential beneficiaries to social services and can also join or collaborate with energy communities.
	Contractors	PV installers	Via public tendering if the Municipality acts as promoter / selected by energy communities once they have access to a roof.
		Technical assistance for collective self-consumption management	The Municipality may need to contract a technical assistance to manage its collective self-consumption projects, especially regarding tasks of intermediation with utilities, bureaucratic procedures etc..
		Technical assistance for	Subcontracting of supporting services, within POWER UP VCE budget, to

	social implementation of energy sharing	help with the implementation of business models at the neighbourhood level.

Table 9: Valencia stakeholders

3.2.3 Investment costs

The Valencia Municipality has undertaken a strategic initiative to advance sustainable energy practices and address social concerns by installing a 2.831 kWp photovoltaic (PV) plant atop public spaces.

An estimated investment cost of 1.158 € per kWp has been calculated, encompassing various expenses associated with procuring PV panels, installation processes, activation procedures, and other related costs. The comprehensive evaluation of expenses results in a total projected investment of 3.277.252 € initially supported by the Municipality, which will relaunch the investment through the ten-year lease of photovoltaic shares.

INVESTMENT						
	Size		Price		Cost	
PV Plant	2.831	kWp	1.158	€/kWp	3.277.252	€
Total investments					3.277.252	€

Table 10: Valencia investment costs

3.2.4 Operational costs

The operational phase of the PV plant involves dealing with various operational costs that are incurred annually. The costs have been estimated as follows:

<u>PV maintenance:</u> An operational cost of 15 € per kWp has been allocated for the maintenance of the PV system. With a 2.831 kWp capacity, the calculated maintenance expenses amount to 42.464 €. This provision covers routine upkeep, inspections, and necessary repairs to ensure the PV plant's efficient functioning and longevity.

<u>Administrative Costs:</u> Addressing administrative functions associated with the operational phase requires a financial allocation of 10 € per member. This includes administrative tasks

relating to the supervision and management of the operational framework, ensuring compliance with the legislation, and facilitating coordination between stakeholders. The total value of administration costs varies with the number of households involved. As shown below, the number of citizens involved can range from 874 vulnerable households to a maximum of 3.471. The latter scenario considers the possibility that the municipality decides to share the total potential with vulnerable and non-vulnerable households, without reserving any quota for public purpose.

Data Management: The management of data, critical for maintaining accurate records, monitoring energy production and consumption, is estimated to have an annual cost of 18.000€.

The following table summarises possible ranges of operational costs, in the next chapters, specific scenarios will be considered.

ANNUAL COST				
	Unitary value		Total	
PV maintenance	15	€/kWp	42.463	€
Administrative costs	10	€/member	847 - 3.4710	€
Data management			18.000	€
Total costs			**68.934 - 95.174**	**€**

Table 11: Valencia operational costs

3.2.5 Revenues/Savings

The 2.831 kWp mentioned are divided into five plants of different sizes. Due to a different regulation of the sale of energy for plants with a rated power of more than 100 kWn, these plants can be virtually divided into two categories:

- 3 photovoltaic systems have a nominal power of less than 100 kWn for a total power of 246 kWn or 335 kWp
  - these plants offer the opportunity to directly obtain compensation of the energy surplus in the consumer's bill, providing a greater economic impact for the user
  - vulnerable families are the priority users of these plants, reserving the majority of the quota
- 2 photovoltaic systems have a rated power of more than 100 kWn for a total power of 2.070 kWn or 2.496 kWp
  - these plants have access only to the spot energy market, the profit for the sale of surplus energy is provided to the owner of the plant (the Municipality)
  - these shares of these plants can also be allocated to municipalities and vulnerable families.

The detailed dimension and vulnerable households allocation quota for each plant is provided in the following table:

TECHNICAL ASSUMPTIONS				
Installation	Nominal power (kWn)	Peak power (kWp)	Municipal Buildings self-consumption	Allocation for VH
Grau	50	63	0%	100%
Benimamet	96	111	1%	99%
Campanar	100	161	2%	98%
Cabanyal	510	618	2%	20%
General I	1.560	1.878	2%	13%
Total	2.316	2.831	2%	25%

Table 12: Valencia technical assumptions

For each plant, a minimum of energy self-consumption is assumed. The indicated amount of energy is assumed to be directly consumed from the municipal buildings and then provide a reduction in municipal bills. As already mentioned, the remaining quota after municipal building self-consumption and vulnerable households (VHs) allocation can be sold in the spot market from the municipality or shared with non-vulnerable households (NVHs).

The percentage allocation for citizens is transformed into the number of citizens involved by setting a standard power allocated to each participating citizen. The allocation of a fixed individual power also implies the fixed amount of energy that a citizen can consume. The following table analyses a matrix of comparisons between different power thresholds and levels of individual self-consumption. An individual power of 0.8 kWp and an individual consumption quota of 70% are taken as a reference for the following assessments.

INDIVIDUAL SELF-CONSUMPTION FOR HOUSEHOLDS AND VULNERABLE HOUSEHOLDS [kWh]				
		Individual quota [kWp/H]		
Self-consumption		0,6	0,8	1
	40%	302	403	504
	50%	378	504	630
	60%	454	605	756
	70%	529	706	882
	80%	605	806	1.008
	90%	680	907	1.134

Table 13: Valencia individual self-consumption levels comparison

By assuming a producibility index of 1,260 kWh/kwp and the individual power of 0,8 kWp the individual energy quota is 1.008 kWh. The individual self-consumption value of 706 kWh is then obtained as a reference value for energy reduction in citizens' bills.

By setting the individual power, the number of participating citizens is a function of the power shares allocated to the citizens. The two possibilities are addressed in the two respective scenarios:

1. Reference scenario: assumes the initial possibility for the Municipality to share 25% of the total energy with vulnerable households (no fee-payers) while it owns the remaining 75% of the total power and then sells the energy in the spot market
2. Comparison scenario: evaluate different configurations keeping the share of vulnerable families 25% and dividing the shares between municipalities and non-vulnerable families (fee-payers). This scenario will be evaluated for the following configurations.
    a. 25% VH - 50% NVH - 25 % municipality
    b. 25% VH - 40% NVH - 35 % municipality
    c. 25% VH - 30% NVH - 45 % municipality

Reference scenario

This scenario covers the case where only vulnerable households (VH) are involved, to which 25% of the installed capacity is reserved. Assuming a per capita share of 0,8 kWp it is possible to involve 874 VH. These citizens will be able to benefit from the project without paying fees and will be involved as soon as the plants are operational, without needing to wait for the completion of the fee payment scheme.

Due to the Spanish legislation, the economic benefits to which participants can have access vary depending on the power of the plant of which they have a share:

- Total capacity < 100 kWn:
    - Recognition of self-consumption - Reduction of kWh of energy withdrawn from the network: is directly allocated to the owner of the share
    - Remuneration of surplus energy sold on the grid: is granted to the owner of the share through the mechanism of compensation in energy bills;
- Power plant > 100 kWn:
    - Recognition of self-consumption - Reduction of kWh of energy withdrawn from the network: is directly allocated to the owner of the share

- Remuneration for surplus energy sold on the grid: granted to the municipality after sale in the spot market.

The distinction in the management of the surplus energy generates a greater impact in bills for the VHs who hold quotas of power plants < 100 kWn. As shown in the table, their annual cost saving is estimated to be 185 €, while the cost saving for VHs owners of power plants > 100 kWn is estimated at 155 €.

ANNUAL REVENUES AND DIRECT COST SAVINGS			
Energy profit	total	Plants < 100 kWn	Plants > 100 kWn
Profit for Municipality	263.205 €	1.261 €	261.943 €
Total cost saving for VHs	148.162 €	76.600 €	71.562 €
Individual cost saving for VH	170 €	185 €	155 €
Total cost saving for NVH	0 €	0 €	0 €
Individual cost saving for NVH	0 €	0 €	0 €

Table 14: Valencia annual revenues and direct cost savings in benchmark scenario

In this scenario, the VHs will achieve a total cost savings of 148.162 € obtained from 25% of the shares of plants. The municipality obtains an annual profit of 263.205 € obtained exclusively from the sale of energy (already taxed) and the reduced percentages of self-consumption of the Municipality itself. Please note that the energy sold by the Municipality includes the sum of the whole energy sold on the spot market, including the surplus of VHs connected to plants with a power > 100 kNn.

To relieve the burden on citizens, the municipality decided to bear the costs of management and maintenance for an annual amount of 69.204 €, calculated considering the presence of 874 points of consumption to be monitored. Due to the exclusive presence of VHs, the municipality does not receive fees compensation. The following table shows that the net profit of the municipality amounts to 194.000 €/year.

ANNUAL MUNICIPALITY NET PROFIT		
Profit from energy flows	263.205	€
Fee compensation	0	€
Total costs	-69.204	€
Total net profit	194.001	€

Table 15: Annual net profit by Valencia municipality in benchmark scenario

This profit, against an investment of more than 3.200.000 €, allows the municipality to return the expenditure (PBP) in a time of 17.6 years.

Comparison Scenario: In the long term, non-vulnerable households (NVHs) will be involved in the project with the aim of increasing the impacts between the citizenship. As already mentioned, the number of NVHs involved is a function of the share of plants that the municipality decides to withhold exclusively for the sale of energy.

The three cases analysed predict a constant increase in the share of power reserved for the municipality, while the share reserved for VHS remains fixed at 25%:

d. 25 % municipality - 25% VH - 50% NVH: 1.817 NVHs can be involved
e. 35 % municipality - 25% VH - 40% NVH: 1.505 NVHs can be involved
f. 45 % municipality - 25% VH - 30% NVH: 1.193 NVHs can be involved

Unlike VHs, NVHs are required to pay a fee to the municipality to access the economic benefits of their participation. Different thresholds are evaluated to define the necessary fee quota, calculating the fee as a percentage of the net benefit for the NVHs.

An assessment of the investment payback period for the different cases is carried out as done for the reference scenario and shown in the following table:

SIMPLE PAYBACK PERIOD (PBP) FOR DIFFERENT CONFIGURATIONS [year]				
Fee % of NVH cost saving	Municipality quota	25%	35%	45%
	NVH shares	1.817	1.505	1.193
	25%	26	24	22
	35%	21	20	19
	40%	19	19	18

Table 16: Valencia payback periods comparison

In comparison to the reference scenario where the payback period (PBP) was 17.6 years, the limit threshold is 25 years in this case. The table shows how the configuration characterised by the municipality share of 35% and fixed fee to 25% allows the Municipality to return the investment in about 24 years. A faster PBP would be achieved by reducing the number of citizens involved or increasing the fee, thus reducing cost savings for citizens.

The following table shows the generated values assuming 874 VHs and 1.505 NVHs. Note that the cost saving of the VHs remains unchanged, while the annual profit of the Municipality drops to 167.658 € and NVHs faces total cost savings of 233.557 €/year.

ANNUAL REVENUES AND DIRECT COST SAVINGS			
Energy profit	Total	Plants < 100 kWn	Plants > 100 kWn
Profit for municipality	167.658 €	1.261 €	166.397 €
Total cost saving for VH	148.162 €	76.600 €	71.562 €
Individual cost saving for VH	170 €	185 €	155 €
Total cost saving for NVH	233.557 €	0 €	233.557 €
Individual cost saving for NVH	155 €	0 €	155 €

Table 17:Valencia annual revenues and direct cost savings

Looking at individual values, the cost savings in bills for each individual NVHs is estimated at 155 €/year. Each NVHs must then pay the municipality a 25% fee equal to 39 €/year, generating an annual net savings of 116 €.

INDIVIDUAL NVH'S NET PROFIT		
Energy cost saving	155	€
Fee	39	€
Net cost saving	116	€

Table 18: Valencia Individual NVS's net profit

As mentioned higher up, the fees are collected exclusively for NVHs, generating an annual flow to the municipality of 58,389 €.

ANNUAL FEE						
	Unitary value		Members		Total	
VH fee	0	€/member	874	n	0	€
NVH fee	39	€/member	1505	n	58.389	€
Total costs					58.389	€

Table 19: Valencia annual fee collection

The fees collected by the municipality add to the profits obtained from the sale of energy. After deduction of the new costs, the total annual profit of the municipality is calculated at about 141.800 €/year. The costs shown in the following table are calculated for a total of 2.379 consumption points to be monitored.

ANNUAL MUNICIPALITY NET PROFIT		
Profit from energy flows	167.658	€
Fee compensation	58.389	€
Total costs	-84.249	€
Total net profit	141.798	€

Table 20: Annual municipality net profit

3.2.6 Monetary flows

The monetary flows established between the different subjects have already been introduced in the previous chapters and in case of complete participation can be summarised as:

Investment flow: The municipality invests in the installation of the PV system, incurring initial expenses such as purchasing PV panels, installation costs, and administrative charges for a total estimated amount of 3.277.252 €.

Energy sale and savings: Users benefit from energy savings achieved through shared self-consumption of the generated renewable energy. Savings are made both through self-consumed energy (at a higher value of 0,22 €/kWh) and the sale of surplus energy (at 0,10 €/kWh). These total savings are estimated to have an average value of 170 €/year per VHs and 155 €/year per NVHs.

Annual fee flow: The participants pay an annual fee to the municipality. This fee serves as repayment for the investment made in installing the PV system. The fee is required only to NVHs and amounts to 39 €/year each.

The following image graphically represents the cash flows described:

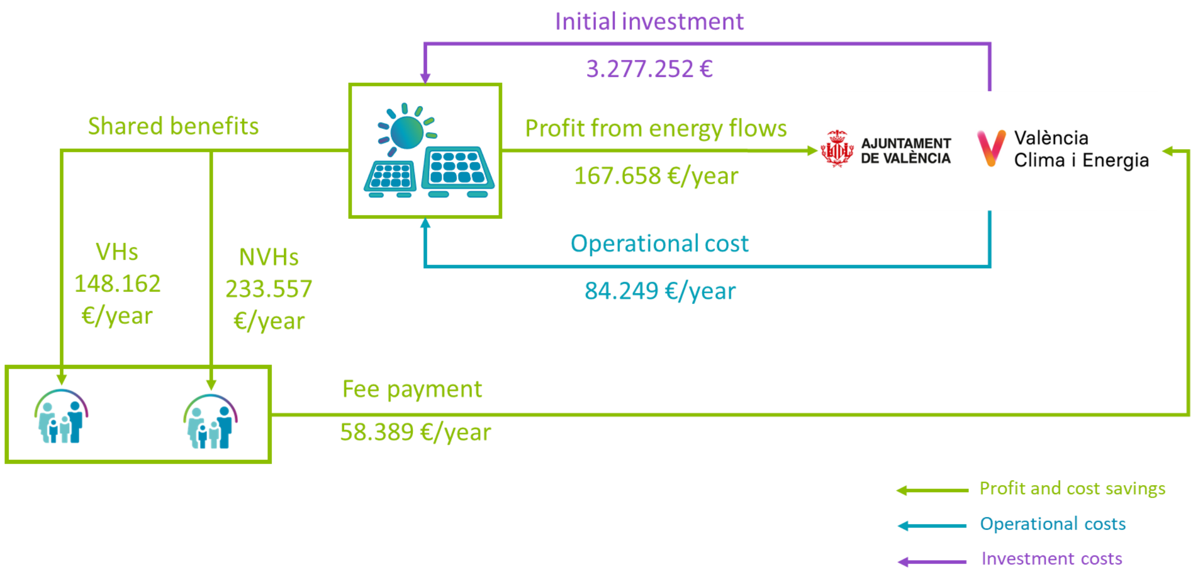

Figure 6: Collective self-consumption model monetary flows

3.2.7 Costs and benefits for the stakeholders

From the municipality point of view, the initial investment costs of 3.277.252 € incurred by the City of Valencia would then be recovered in 24 years through the energy revenues and the collection of fees for an annual net profit of 141.798 €.

Regarding individual citizens participating in the projects, a distinction can be made between vulnerable households (VHs) and non-vulnerable households (NVHs). For VHs there is no requirement to pay the participation fee and their average benefit is 170 €/year while the average benefit for NVHs becomes 116 €/year after fee detraction.

No other stakeholders are involved in the project. However, it is important to remember that the subjects involved are not only families but can also be non-profit entities in the case of vulnerable groups and small and medium-sized enterprises in the case of vulnerable subjects.

3.2.8 Action plan and next steps

An action plan is designed for the next phase of the Valencia pilot. It will focus on integrating vulnerable households into the renewable energy community.

This plan begins by co-defining protocols with the municipality's Social Services to effectively identify and engage these households. Legal procedures will also be prioritised, including the validation of informed consent forms, ensuring participants are well-informed and protected legally.

Furthermore, the municipality will oversee the effective installation and legalisation of photovoltaic (PV) plants, which are essential for the project's infrastructure. Informal sessions will be organised with social workers at neighbourhood social services premises to foster community engagement. This step will facilitate clear communication and transparency about the project's benefits and participation process.

Additionally, there will be a focus on contracting the necessary supporting services for implementing and managing the public collective self-consumption model. Finally, a pre-test of the model with a small initial installation will be conducted to ensure its viability before it is rolled out on a larger scale.

3.3

Eeklo

The Municipality of Eeklo, in collaboration with the cooperative Ecopower, launched an initiative focused on reducing energy costs for vulnerable households through access to renewable energy provided by Ecopower.

The Eeklo pilot in a nutshell

The Municipality intends to invest 25.000 € to secure 100 shares in a cooperative wind turbine project, allowing households to benefit from favourable energy prices. The city pre-finances cooperative shares and lends these to people who would not be able to pay this upfront cost on their own. Over several years, these beneficiaries will then pay the share back through a small monthly fee.

As of day one, though, the shareholders will be full members of the Ecopower cooperative including all rights that come with it such as getting renewable energy at a fair price or having a voice at Ecopower's decision-making. This rolling fund of pre-financed social energy shares makes local renewable energy accessible for all.

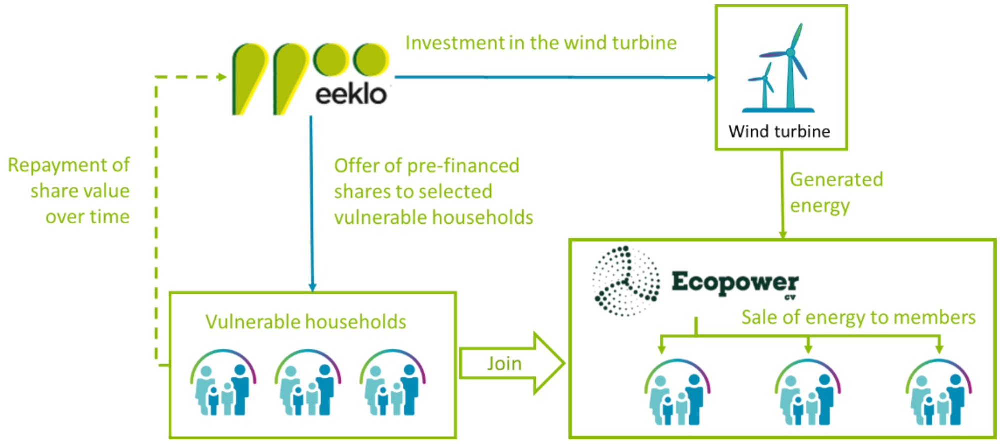

Figure 7: Eeklo model conceptual scheme

The Municipality intends to invest 25.000 € to secure 100 shares in a wind turbine project, allowing households to benefit from favourable energy prices. The aim is to create a self-sustaining model that will allow in time to recover the initial capital and use it again to increase new shares for other future members.

3.3.1 Stakeholders involved

The stakeholders involved in are:

Level	Stakeholders	Entity	Description
Macro	Energy provider and distributor	Fluvius	The DSO manages the distribution grid, monitors the flow of electricity, carries out maintenance and manages interconnections with customers and energy producers.
	Authority	VEKA	Public agency in charge of the implementation of the sustainable energy policy of the Flemish government
Intracommunity	Authority	VREG	Flemish energy regulator, in charge of registering REC's and CECs
	Energy community and energy supplier Municipality Social Services	Ecopower	Power Up pilot partner and cooperative supplier, welcomes vulnerable households with pre-financed shares as members and clients

		City of Eeklo	Power Up pilot, responsible for pre-financing and assign social shares via participation in the cooperative wind turbine 'Huysmanhoeve'
		OCMW Eeklo	Social department of the city of Eeklo in charge of contacting, advising and follow up of vulnerable households in the Power Up pilot scheme in Eeklo
	Intermediary organisations/ Third parties	Veneco	Regional energy house
Intercommunity	Intermediary organisations/ Third parties	SHM	Social housing company, promoting Power Up pilot scheme in target group
	Power plants owner	Ecopower	Citizen owned cooperative wind turbine 'Huysmanhoeve' located on public ground
	Energy sharing and consumption	citizens	vulnerable households that match the social criteria and are willing to participate in the pilot scheme

Table 21: Eeklo stakeholders

3.3.2 Investment costs

The Municipality of Eeklo, in collaboration with Ecopower, has undertaken an ambitious initiative to promote energy cost reduction through a model of acquiring and lending shares in a wind turbine project. The Municipality is actively involved in empowering vulnerable households with an investment of 25.000 €. This investment enables the acquisition of 100 social shares in a wind turbine project, which will be used to engage as many households in the process of accessing energy at a favourable price.

TECHNICAL ASSUMPTIONS		
Vulnerable households	100	n
Per household investment	250	€/VH
Total investment	25.000	€

Table 22: Eeklo technical assumption

3.3.3 Revenues/Savings

The Municipality of Eeklo, in collaboration with Ecopower, has established a model that allows the 100 participating members to access favourably priced energy produced by wind turbines through shares provided by the municipality.

The entire cost savings for citizens participating in the pilot is based on the assumption that the renewable energy provided by Ecopower has a lower final price than the average energy market price. The difference between the two prices is precisely the sum that the citizen will be able to save. This assumption may come undone if the acquired renewable power plants cannot meet demand due to particular weather conditions and Ecopower is forced to purchase power from other producers.

Energy flows and cost savings per member:

a) Average energy consumption: Following local averages, each participant is assumed to consume an average of 2.000 kWh of energy per year.
b) Average energy cost: Starting from the values reported in vreg.be, a standard tariff of 0,44 €/kWh is considered; therefore, the annual energy cost for a member is 880€ (value at July 2023).
c) Member's energy cost: Due to the share of wind turbines provided by Ecopower, the member has access to Ecopower's advantageous tariff, which can be estimated at 0,36 €/kWh. As a result, the annual energy cost for a member is reduced to 720 € (value at July 2023).

The difference between the average energy cost and the cost reduced by the wind turbine tariff equals a saving of 0,08 €/kWh. An annual consumption of 2.000 kWh translates into a substantial savings of 160 euros per household participating in the Eeklo pilot. It is important to highlight that cost saving is closely linked to the difference between the two energy prices and that small gaps lead to reduced savings.

ANNUAL COST SAVING PER VULNEABLE HOUSEHOLD						
	Energy		Unitary values		Total	
Everage energy cost	2.000	kWh	0,44	€/kWh	880	€
Member's energy cost	2.000	kWh	0,36	€/kWh	720	€
Energy cost savings	2.000	kWh	0,08	€/kWh	160	€

Table 23: Eeklo individual cost saving

Extrapolating these individual savings to a collective scale of 100 participating households, the cumulative energy cost savings from wind turbine shares reach a remarkable total of 16.000 €/year. This considerable aggregate amount highlights the cumulative impact of renewable energy initiatives, showing a significant financial benefit and illustrating the practical benefits of community-driven renewable energy ownership.

In order to make the intervention sustainable, the municipality outlined a payback plan for the initial investment of 25.000 €. The goal is to return the initial capital in a commensurate time by setting an annual fee for each participant who benefits from reduced energy costs.

The constraints in setting the fee are the following:

a) the fee should not have an excessive impact on the member, ideally it should be less than 30% of the savings gained from participation in the project;
b) the fee must be enough to allow the municipality to return the initial investment in an appropriate time;
c) In the long run, fee collection must allow the project to evolve by financing the acquisition of new shares and thus the participation of additional members in the project.

Therefore, a sustainable repayment strategy has been elaborated to meet these constraints. Each participating household will repay the Municipality investment by paying 3,5 €/month (42 €/year) to Ecopower over the monthly bill for a period of 6 years. Ecopower will transfer the amount of 250€ directly to the Municipality at the end of this period. This annual fee allows the Municipality to systematically recover its investment, enabling households to gradually fulfill their commitments without incurring excessive financial burdens.

At the individual level, paying a fee of 42 €/year brings the net savings to the value of 118 €/year per household, equal to the 74% of the initial cost saving. This shows that households continue to benefit significantly from the reduction in energy prices, exceeding the repayment commitment.

The restitution of the capital initially invested by the municipality allows it to be repeated every six years. In this way, maintaining the same allocation of resources, the number of subjects involved in the project can go up to 200 in the sixth year, to the twelfth year 300, and so on, creating a sustainable growth model over time.

3.3.4 Costs/Expenditure

The model proposed by the municipality of Eeklo does not include additional costs for the municipality other than the purchase of shares. As already described, the municipality can allocate an initial fee of 25.000 € and use the profit generated by the collection of fees to buy future shares. Therefore, no additional financial support is required in addition to the initial allocation.

Operating costs of management or maintenance are not considered in the scheme. This is due to the fact that the management of the plants is entirely in charge of Ecopower which also considers these costs in the definition of the energy tariff.

3.3.5 Monetary flows

The monetary flows established between the different subjects have already been introduced in the previous chapters and can be summarised as:

Shares purchase: The municipality of Eeklo invests 25.000 € in the acquisition of 100 social shares in a wind turbine project through the collaboration with Ecopower. In the years to follow, the municipality will continue to acquire additional shares financing them with fees collected by members.

Energy purchasing and cost saving: Ecopower offers participating citizens access to wind turbine shares at a reduced energy price of 0,36 €/kWh instead of the average market rate of 0,44 €/kWh. Each citizen thus experiences an annual cost savings of 160 € due to reduced energy prices.

Annual fee flow: Each participating family reimburses an annual fee of 42 € to the municipality of Eeklo for a period of 6 years. This will cover the initial investment in wind turbine shares.

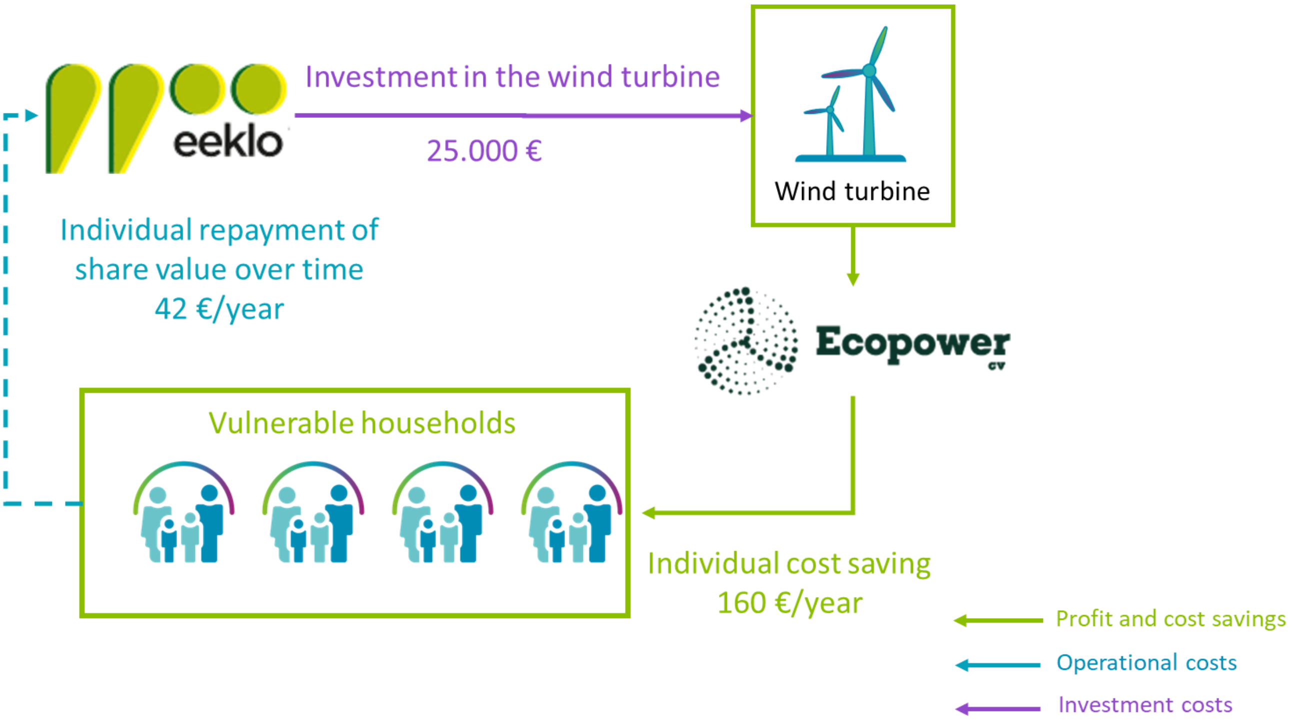

Figure 8: Eeklo monetary flows

3.3.6 Costs and benefits for the stakeholders

The costs and benefits for the citizens participating in the project have been widely discussed in the previous chapters and can be summarised in benefits given by the purchase of energy at an advantageous price and annual costs to repay the initial investment of the municipality. At the very end, the annual cost saving per household amounts to 118 €.

Based on the proposed model, costs or benefits for other stakeholders are not expected as the relational scheme of the plan is particularly simple and does not see ulterior relations.

3.3.7 Action plan and next steps

During the upcoming months, the city of Eeklo and Ecopower will focus on reaching out to potential participants of the scheme to reach the target of 50 vulnerable households by the end of the project. The social services of the city of Eeklo have a crucial role in this endeavour and will be supported by additional communication actions by the municipality and Ecopower.

Next, the project partners will investigate ways to make the model more robust to changes in the energy market. As mentioned above, the benefit vulnerable households can realise by participating in the scheme is strongly dependent on electricity prices. In the current context of decreasing prices, the incentive to switch to the cooperative supplier diminishes. Ecopower and the city of Eeklo want to find ways to keep the model attractive even in times of a more relaxed situation on the electricity market.

3.4

Rožnov

The Municipality of Rožnov is implementing a path to reduce the energy poverty of residents of a social housing structure through the sharing of self-produced solar energy.

The Roznov pilot in a nutshell:

To alleviate energy poverty in social housing, the municipality install photovoltaic on a selected social housing building. The energy produced by the plant will benefit the residents of the building, with the aim of reducing their electricity cost through collective self-consumption of renewable energy produced. The municipality is doing upfront investment. The households benefitting from this electricity will contribute by paying a slight monthly rent supplement. In parallel, the municipality wants to help residents navigate through the complexity of energy efficiency by setting up a One-Stop-Shop.

Through this solar roof installation, the municipality will spread collective self-consumption and then apply its strategy of reducing energy poverty. To reimburse the initial investment, the municipality charges families a slight supplement in the monthly rent. The correct quantification of the supplement will allow the municipality to define a sustainable model that can repay the investment relatively quickly. The development of an economically sustainable model is the basis of the study model, which aims at the replicability of the project at local level and the drafting of guidelines useful for the proliferation at national level.

As a second action, the city of Rožnov aims to create a One Stop Shop (OSS) for energy renovation. The OSS will tackle two dissemination goals:

- The OSS will promote the reduction of energy poverty through collective self-consumption as in the residential buildings promoted by this project, with particular involvement of fragile citizens;
- The OSS will inform and advise the public on energy efficiency measures, renewable energy issues, funding available for energy-related interventions, and providing experts.

By its nature, the OSS will inform and support any citizen, but will provide special attention to vulnerable people over time.

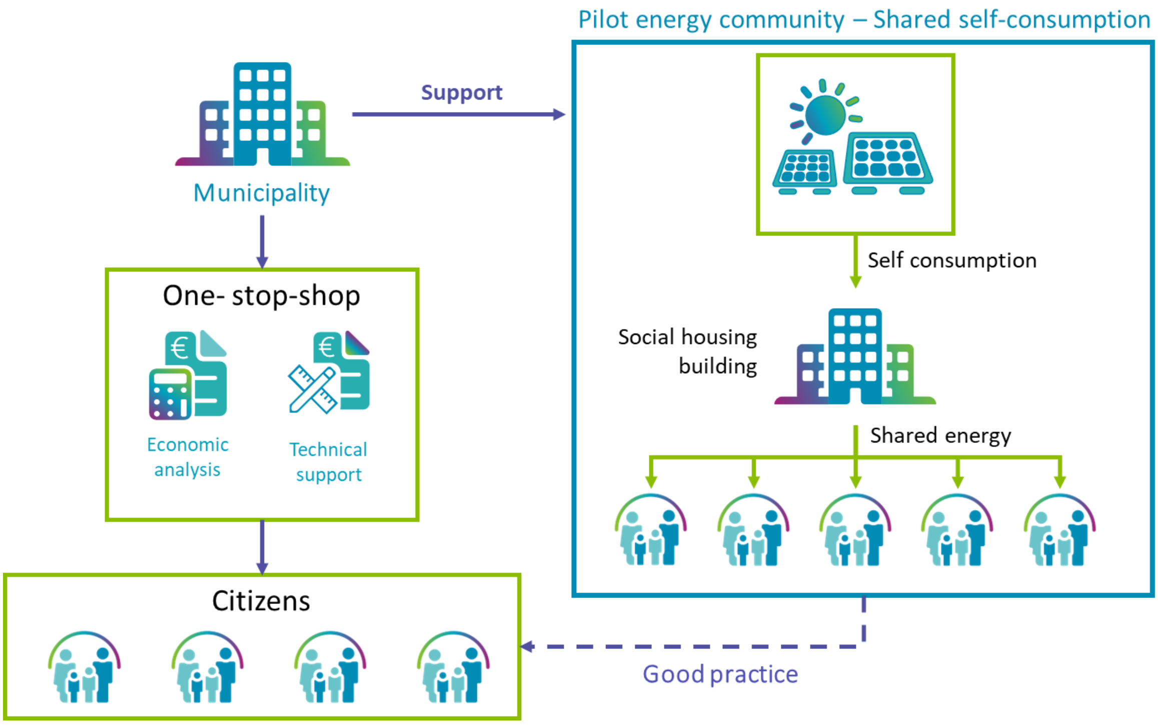

Figure 9: Roznov model conceptual scheme

3.4.1 Stakeholders involved

The stakeholders involved in are:

Level	Stakeholders	Entity	Description
Macro	Energy provider and distributor	CEZ	The electricity provider directly supplies electricity to the municipality-owned building, where Municipality owns the energy contract.
Intracommunity	Municipality	Roznov Municipality	The Pilot building is under the ownership of the Municipality of Roznov, which entails various responsibilities. As the owner, the Municipality is tasked with the overall management of the building, including the installation of photovoltaic (PV) systems. Additionally, it bears the responsibility of maintaining positive relations with the building's residents, who pay a monthly rent and a PV fee (5€/month/household) to the municipality. Furthermore, the Municipality assumes the financial burden of covering all operational and maintenance costs associated with the PV installation.
	Social Services	Dpt. of social services, Rožnov municipality	The municipality's social services are aware of vulnerable households located in the public housing building. All households that express their interest can then benefit from the renewable energy produced.
	Intermediary organisations/ Third parties	One Stop Shop of Rožnov municipality	OSS is an integral part of the Municipality as it consists of municipal staff experienced in energy and climate measures.

	Contractors/ Engineering Office	PV installation company	Will be tendered in accordance with the Public Procurement Act
Intercommunity	Power plants owner	Roznov Municipality	The municipality's owned PV plant generates electricity, supplying power to both the common areas within the building and all the households. Furthermore, any surplus energy not used within the building is carefully managed and sold by the municipality. It is anticipated that all consumption sites, or metering points, will be merged into a single entity overseen by the City. The city will handle the procurement of electricity for the entire building, and individual households will subsequently receive bills for their energy consumption based on this centralised set up.
	Energy consumer	Households	Households of the selected property have access to direct consumption that allows them to reduce their costs in electricity bills.

Table 24: Roznov stakeholders

3.4.2 Investment costs

The Municipality of Roznov intends to install a photovoltaic system on the roof of a public residence building. To facilitate the self-consumption of energy by residents, the system will be connected to the electricity grid of the building.

To match the energy demand of the members, but considering the limits imposed by the available surface, the municipality will install a PV plant with a power of 39,1 kWp. The PV system will be completed by a system of batteries. This will significantly increase the levels of self-consumption of renewable energy, combining daytime PV production and evening consumption, both typical for residential buildings. Moreover, combining the metering points in a single meter charged to the municipality is necessary, which will also be combined with the photovoltaic system. This last intervention is quantified at a cost of 33.353 €. Globally, the overall required investment amounts to 133.988 €.

In order to lighten the investment required by the municipality, a public funding opportunity worth 93.792 € has been identified. This financing support will reduce the initial investment to 40.196 €, making the expenditure easier to be addressed by the Municipality.

The following table illustrates the main values regarding the Roznov municipality investment:

INVESTMENT COST						
Voice	Size		Unitary cost		Cost	
PV power	39,1	kWp	1.424	€/kWp	55.714	€
battery sistem	19,3	kWh	2.327	€/kWh	44.921	€
Meter merging cost					33.353	€
Total investment cost					133.988	€
Public subsidy					93.792	€
Final investment costs					40.196	€

Table 25: Roznov investment costs

3.4.3 Revenues/Savings

A photovoltaic system characterises the project with a capacity of 39,1 kWp. Each year this system is expected to produce about 39.100 kWh of electricity, obtained from a production of 1.000 kWh/kWp, indicative of the territory's characteristics. Given the presence of the storage battery, it is assumed that 70% of the electricity generated by the photovoltaic system is consumed by residents themselves.

TECHNICAL ASSUMPTION		
PV power	39,1	kWp
PV production	1.000	kWh/kWp
Annual production	39.100	kWh/year
Share of electricity consumed in the building	70	%
Saved electricity in the building - Self consumption	27.370	kWh/year
Energy sold to the grid	11.730	kWh/year

Table 26: Roznov technical assumptions

The self-consumption of renewable energy amounts to 27.370 kWh/year. Using this self-produced energy, the building significantly reduces its dependence on external energy sources. With a reference electricity price of 0.26 €/kWh, the total annual savings obtained through self-consumption is about 7.070 €. This saving is a direct financial benefit for residents, facilitating their energy expenses.

In addition, the remaining 30% of the electricity generated, which is equivalent to 11.730 kWh/year, is sold to the grid. The sale of excess energy generates revenues from the municipality, which will support the return of the investment in an acceptable time. At a selling price of energy of 0,12 €/kWh, this sale translates into an annual revenue of about 1.457 €. This revenue stream improves the project's economic sustainability and can be reinvested in further community development initiatives or in the maintenance and expansion of the system photovoltaic.

ENERGY COST SAVING AND REVENUE						
	Energy amount		Unitary value		Annual value	
Saved electricity in the building	27.370	kWh/year	0,26	€/kWh	7.070	€/year
Energy sold to the grid	11.730	kWh/year	0,12	€/kWh	1.457	€/year

Table 27: Roznov energy cost saving revenues

The analysis shows that energy consumption levels have an important impact on the distribution of profit among different stakeholders. As reported in the following chart, as the level of self-consumption increases, trends in financial benefits for both parties diverge. For the municipality, there is a significant downward trend in profit derived from lower energy sales. This is because increased self-consumption implies that less excess energy is fed into the grid, reducing revenue from such sales. For high values of self-consumption, the municipality benefits exclusively from the increase in rent defined as a fee. On the contrary, residents experience an upward trend of savings as the self-consumption of energy produced increases. At lower levels of self-consumption, savings are minimal, and for a value of less than 35% the positive impacts of residents are covered by the presence of the fee.

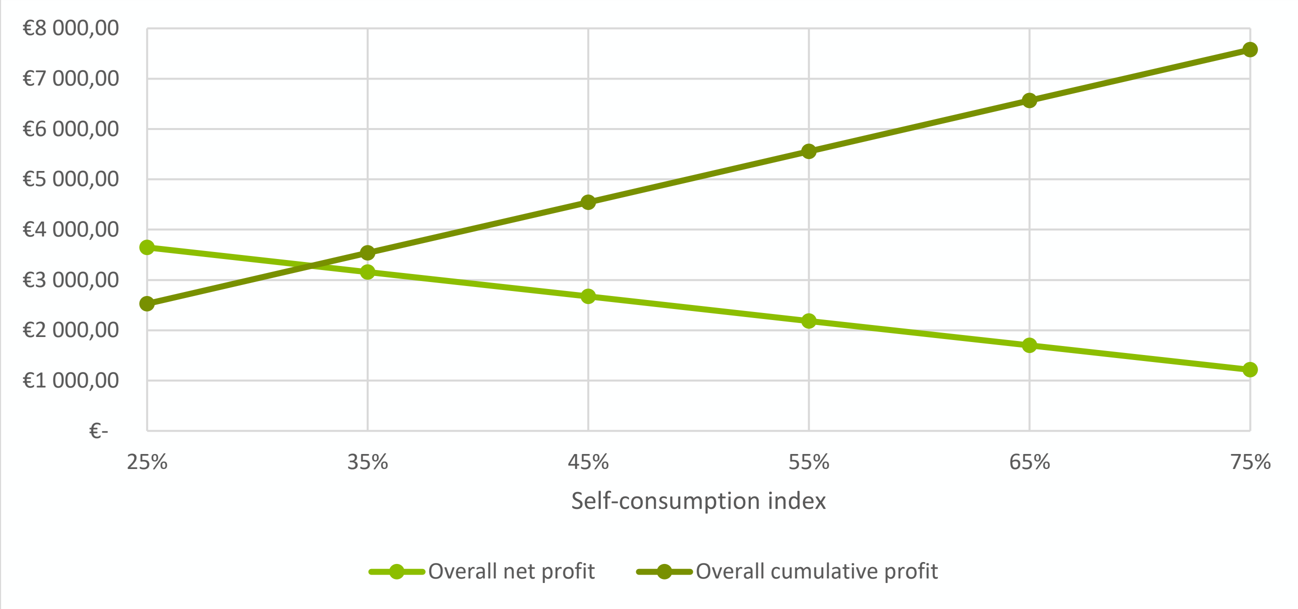

Figure 10: Breakdown of the value generated

For the reference value of the self-consumption defined at 70%, an increase in the rent to residents of 60 €/year per household was assumed. This fee weighs for 5.100 €/year in the profits of the Municipality.

FEE		
Number of households	85	n
Fee for PV/household/year	60	€/year
Total fee cost	5.100	€/year

Table 28: Roznov fee collection

It is desirable that if levels of consumption are identified significantly lower than the expected, the fee is reduced in view of the shift in the distribution of profits in favour of the Municipality.

As shown in the following table, maintaining the reference fee, and reducing the cost savings generated by self-consumption of energy among 85 households, an individual net savings of 23€/year is estimated.

INDIVIDUAL COST SAVING		
Individual cost saving	83	€/year
Individual fee	60	€/year
Individual net cost saving	23	€/year

Table 29: Roznov individual cost saving

3.4.4 Costs/Expenditure

The ownership of the facilities by the municipality of Roznov brings with it a set of operating costs that the Municipality itself will face to ensure the efficiency and safety of the project. It is estimated that each year, the Municipality will have to allocate 205 € specifically for the plant's insurance. An additional 82 € is dedicated annually to the system revision necessary to ensure the correct function of the plant and its safety. Equally important is the allocation of another 82 € for maintenance and operational control, ensuring that the photovoltaic system operates at its maximum performance during its life cycle. Monitoring the production metrics and energy performance of the system is managed with an annual investment of 98 €. Finally, it is estimated that an additional 1.583 € is spent annually to manage the contracts and reporting of energy bills for 85 individual households. The municipality must manage this important effort as it purchases energy from the energy supplier for all households.

Overall, the municipality will face an annual expenditure of 2.050€ to ensure the plant's correct operation and continuity in the project.

OPERATING COST		
Insurance	205	€/year
Revision	82	€/year
Maintenance, operation control	82	€/year
Monitoring	98	€/year
Bills management	1.583	€/year
Total operating cost	2.050	€/year

Table 30: Roznov operating cost

An important second chapter of relevant costs is the mid-life revamping of the plant. In the tenth year, the municipality is expected to invest a sum of 6.150 € to bring the operation of the plant back to the initial levels. This will compensate for the plant's natural decline, allowing it to maintain high energy flows throughout the extended life cycle of the project.

3.4.5 Monetary flows

In the Roznov pilot project, monetary flows describe a complete economic interaction between the municipality and the households benefiting from the installed PV plant. Here is an overview of the different cash flows described in detail above:

Municipal investment and operating costs: The Municipality of Roznov has made a strategic investment in a photovoltaic plant. This investment includes initial installation costs of € 40.196 (already reduced by the public contribution) and annual operating expenses such as insurance, system revisions, maintenance, operational control, and bills management, which add up to 2.050 €/year. To these must be added the investment necessary for revamping the tenth year of 6.150 €.

Household energy savings: Residents of social housing benefit from the photovoltaic system through energy savings, which reduces the energy bill. Using the energy produced by photovoltaic panels, the estimated savings for each citizen is 83 €/year, equal to 7.070 €/year total.

Payment fee to the city: To support the sustainability of the photovoltaic system, families pay a fee to the municipality through their monthly rent, notably 60 €/year per household (5.100 €/year total). This fee is meant to ensure that residents enjoy reduced energy costs and contribute to the repayment of the municipality's sustained investment.

Municipal revenue from the sale of energy: any surplus energy not consumed by households is sold to the grid. It is estimated that this sale provides an additional income stream for the municipality of 1.457 €/year, which, if taken into account with fees collected by residents, helps to offset the initial investment and operating costs of the photovoltaic system.

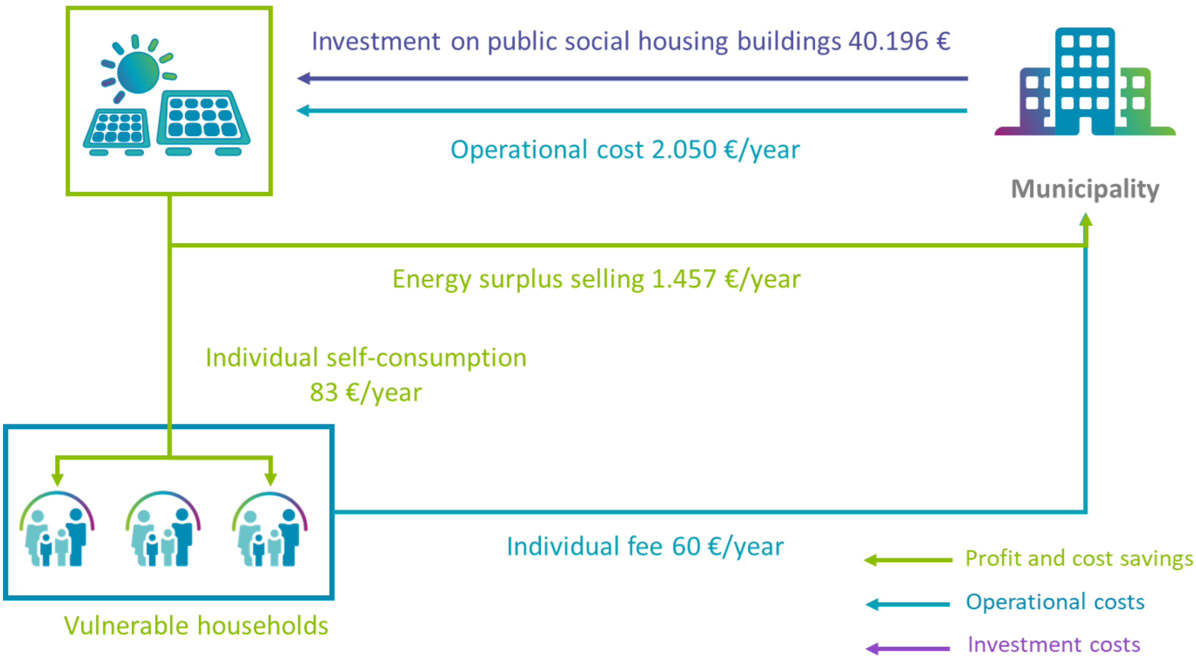

Figure 11: Roznov monetary flows

3.4.6 Costs and benefits for the stakeholders

The costs and benefits for the municipality and for the building residents concerned by the photovoltaic plant have been extensively described in previous chapters. Over the two subjects cited, it is not forecasted that the project will carry an economic impact on other stakeholders. From an environmental point of view, it can be said that the use of renewable energy instead of fossil energy will lead to a reduction in emissions with a widespread impact on the territory.

3.4.7 Action plan and next steps

The process to get the pilot fully operational still involves several actions that must be taken. Among the most important is the need to proceed with the installation of photovoltaic and battery storage.

Before this, all consumption and monitoring points of residents must be collected in a single meter owned by the municipality. This implies that the electricity supply contracts of the residents are closed and the municipality creates a new single contract. In addition, the system of allocating expenditures among residents must be implemented through the installation of new systems for monitoring individual consumption.

04

Conclusion

These four pilot projects from Italy, Spain, Belgium and Czech Republic show different approaches to integrating renewable energy solutions while addressing energy poverty. Each pilot project has a unique relational pattern defined by the stakeholders involved, their roles and the interaction between them. In the Campania (UCSA) pilot project, key stakeholders include municipalities, local businesses and vulnerable citizens. Municipalities invest in photovoltaic systems that have already been partially developed on public buildings, sharing energy with companies to donate the incentives to local families. Roznov's model takes a slightly different approach: Here the Municipality invests in a photovoltaic system for a social housing building, aiming to reduce residents' energy costs through collective self-consumption directly generated by the tenants. The Valencia model is based on a photovoltaic system in which citizens can participate by renting shares of the system and thus accessing self-consumption. The Eeklo model introduces the municipal collaboration with energy cooperatives to increase community involvement. The project focuses on wind energy, with the municipality investing in shares of a wind turbine to give vulnerable citizens access to energy at a subsidised price. These relational dynamics highlight the different strategies employed to engage communities in renewable energy initiatives.

The approaches for the return of the investment in these pilots reflect different stakeholder strategies and roles. In the Campania (UCSA), Roznov and Valencia pilots, investments come from municipalities. They invest in photovoltaic systems on public buildings. UCSA's investment will be repaid exclusively with the sale of surplus energy, while the municipalities of Roznov and Valencia will ask for a fee for participation. The investments of the Municipality of Eeklo are focused on purchasing shares of wind turbines. This approach does not require the Municipality to ask citizens to repay the fees over time as it is not intended to recover the investment.

The following table provides a detailed comparison of the pilots, focusing on the individual cost savings generated and the investment made by municipalities per participating citizen. Specifically, the UCSA project exhibits a relatively low investment per capita, benefiting from partially pre-installed photovoltaic systems. This approach has effectively minimised initial costs, offering economic advantages for the community involved. Conversely, Valencia's project shows a higher per capita investment. This is due to some of the installed photovoltaic systems not being directly allocated to citizens but remaining under municipal ownership. Roznov extends beyond just installing photovoltaic panels by incorporating a storage battery and undertaking additional activities. Lastly, Eeklo stands out for having the lowest per capita investment among the projects reviewed. Eeklo's approach involves purchasing participation shares in an energy cooperative for everyone, facilitating access to renewable energy for community members.

MAIN ECONOMIC ASPECTS		
	Per capita investment (€)	VH annual economic saving (€)
UCSA	269	165
Valencia	1.378	170
Roznov	473	23
Eeklo	250	120

Table 31: Individual investments and cost savings comparison

The different approaches used by the pilots also lead to substantial differences between the impacts generated per each involved citizen. In the pilots of Valencia and Roznov the savings are generated by the self-consumption of renewable energy produced by the public plant.

The net savings for a household in Roznov is estimated at 23€/year, while in the pilot of Valencia it rises to approx. 170€/year per vulnerable household (116 €/year for non vulnerable[1]) as citizens also hold the share related to the sale of energy. A relevant difference is evident for the fragile citizens of Valencia, who double their cost saving as they are not required to provide the fee to the municipality.

The families engaged in the Campania (UCSA) pilot benefit from the repartition of economic incentives generated by energy sharing between the Municipality and local companies. In this way, it is possible to involve a different number of citizens according to the objective impact. Depending on the households involved the individual value can vary between 130 €/year and 200 €/year.

Finally, in the Eeklo pilot benefit is given by the lower price of energy provided by the energy cooperative. This difference leads to an average household savings of 120 €/year.

[1] Value after 25% fee.

The following table provides a qualitative comparison of the main profit sources:

PROFIT GENERATION SOURCES				
	Incentives sharing	Energy saving	Energy selling	Lower energy price
UCSA	x			
Valencia		x	x	
Roznov		x		
Eeklo				x

Table 32: Profit generation comparison

Given the different setups and sources of benefit, each model is also distinguished by different levels of replicability, engagement, and participation of households and different levels of cost reduction.

Thanks to the diffusion of energy cooperatives, especially in northern Europe, the model applied in the Eeklo pilot appears to be that of maximum replicability, if the prices provided by the energy cooperative remains lower compared to other local providers. On the contrary, the other three pilots are in a similar situation characterised by their innovation.

Cost savings for residents was widely discussed earlier, in the previous table was compared in detail its origin in different cases.

A different situation is that of cost savings for the municipality. The UCSA model maximises the impact for the municipality, retaining all proceeds from the sale of energy. In other cases, the city has no particular profits.

Regarding the engagement and participation of households, the situation presents some diversification factors. The model that UCSA applies is designed for the lowest possible level of household participation, requiring minimal household effort. In contrast, the models implemented in Valencia and Roznov require households to change their habits to maximise renewable energy consumption. This requires an elaborate level of awareness and activity from project members. Finally, in the case of Eeklo, households are required to sign a new energy supply contract, requiring a minimum commitment through an initial fee.

The table below summarises the key qualitative aspects of each pilot:

MAIN ASPECTS				
	Replicability	Cost saving per households	Cost saving per municipality	Engagement
UCSA	++	+++	+++	-
Valencia	++	+++	-	++
Roznov	++	+	-	++
Eeklo	+++	+++	-	+

Table 33: Main aspects comparison

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