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PILOT ACTION REPORT – To improve Energy Savings and the Business Model in REC

Poland

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Partner responsible: Lubelskie Voivodeship - LV

Main Author: Magdalena Rzemieniak

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1. EXECUTIVE SUMMARY

This report presents the results of the pilot project implemented by partner PP8 in Poland (Lubelskie Voivodeship - LV) as part of Work Package 2 of the HERCULES-CE project – "Transborder actions to trigger the contribution to energy transition by Renewable Energy Communities." The objective of the activity was to practically test the assumptions of the HERCULES-CE strategy within the existing Renewable Energy Community (REC) and to develop an action plan aimed at increasing energy efficiency and strengthening the sustainability of the business model.

The existing REC community is the Tomaszów Energy Cluster (TEC). However, its organizational structure and lack of legal personality would have prevented further project implementation, so the project recommended transforming the clusters into an energy cooperative with legal personality.

Objective of the pilot

The pilot had an analytical and implementation-oriented character and focused on:

- assessment of the REC business model,
- analysis of energy efficiency,
- identification of regulatory, financial, and technical barriers,
- testing of the REC Manager digital tool,
- development of a realistic implementation plan.

The analysed structure is based on the cooperation between the Tomaszowski Energy Cluster (TEC) and the Roztocze Energy Cooperative "RSE" (REC "RSE"), with the participation of local government units (LGUs) and technical and operational entities.

MAIN ACTIVITIES

As part of the pilot:

• a set of operational and financial data was developed and collected,

• data was entered into the REC Manager tool,

• simulations were carried out (simplified models due to the lack of full 15-minute intervals data),

• an analysis of the business model and financial scenarios (min/mid/max) was conducted,

• a gap analysis was performed (data, technical, organizational, and communication aspects),

• an implementation plan and a risk management plan were developed.

The applied methodology combined quantitative analysis (digital tool), qualitative analysis (organizational and financial assessment), and participatory elements (coaching sessions and stakeholder consultations).

KEY FINDINGS

1. **The greatest potential for improvement lies in increasing self-consumption.**

Simulations showed that the use of energy storage systems and load optimization could increase self-consumption by 15–25%, directly improving the profitability of the model.

0. **Data is a prerequisite for further development.**

The lack of detailed consumption profiles (15-minute intervals) limits the full use of the REC Manager tool and the ability to plan investments precisely.

0. **The business model is sensitive to energy prices.**

Scenario-based financial planning is necessary, along with the gradual reduction of exposure to the wholesale market through the development of local balancing mechanisms.

0. **Phased implementation of investments reduces risk.**

The recommended model includes:

• first, digitalization and optimization of consumption,

• then the expansion of renewable energy capacity,

• subsequently, the deployment of energy storage systems and the scaling up of the community.

0. **Professionalization of management is necessary.**

The need to establish an REC "RSE" office and to standardize reporting was identified.

MAIN RECOMMENDATIONS

In the short term (1-12 months) the priorities are:

- Implementation of smart metering and an EMS system,
- Data standardization,
- Development of a comprehensive financial model,
- Energy consumption optimization.

In the medium- and long-term perspective (12–36 months):

- installation of energy storage systems,

- phased expansion of PV installations,
- thermal retrofitting of local government buildings,
- extension of the model to new members and additional municipalities.

The pilot confirmed that the development of an REC requires parallel action in three areas:

1. **Data and digitalization** – a prerequisite for optimization and scaling.
2. **Financial model** – based on self-consumption and scenario-based planning.
3. **Management and community communication** – ensuring organizational stability and local acceptance.

Action 2.1. (D.2.1.1: Pilot Action Report to improve energy savings and the business model in one REC in Poland – by LV) established a solid foundation for transitioning from the diagnostic phase to the investment phase, as well as for replicating the model in other renewable energy communities in the region.

1.2. Abbreviations

Abbreviation	Definition
LV	Lubelskie Voivodeship
KOWR	National Support Centre for Agriculture
KRS	National Court Register
MW	megawatt
MWh	Megawatt-hour
PV	photovoltaic
REC “RSE”	Roztocze Energy Cooperative “RSE”
RES	renewable energy sources

TEC	Tomaszowski Energy Cluster

2. ACTIVITY 2.1

2.1. Status of the REC

MAIN GOAL AND STRATEGIC ASSUMPTIONS OF THE REC – TOMASZÓW ENERGY CLUSTER (TEC)

The main goal of the Tomaszów Energy Cluster was to create a local, integrated energy system based on the cooperation of public and private entities, enabling the balancing of energy supply and demand and the development of distributed energy.

Strategic goals included:

- increasing the region's energy security,
- developing renewable energy sources (RES),
- rationalizing energy consumption and reducing its costs,
- increasing the district's energy self-sufficiency,
- reducing pollutant emissions and improving air quality,
- developing the local economy through the use of local resources.

In accordance with the Development Concept (Application Form), the cluster's activities focus on analysing the potential of renewable energy sources, preparing investments (PV, biogas, energy storage), implementing energy management systems, and conducting educational and organizational activities.

DEVIATION FROM THE ORIGINAL ASSUMPTIONS OF TEC

A noticeable shift in approach compared to the initial plans is evident – instead of rapidly implementing large investments, the emphasis has been placed on pre-investment activities (analyses, documentation, building competencies and IT systems). This is primarily due to:

- • infrastructure constraints (e.g., lack of connection capacity),
- • the need for better project preparation,
- • changing regulatory and market conditions.

LEGAL FRAMEWORK FOR THE FUNCTIONING OF THE TEC

The Tomaszów Energy Cluster operates under Polish regulations, in particular:

• the Energy Law,
• the Renewable Energy Sources Act (RES).

An energy cluster is a form of cooperation based on a civil law agreement, covering the generation, distribution, and trade of energy within a limited area (up to one district or five municipalities).

The cluster does not have legal personality – its operation relies on the cooperation of its participants and the role of a coordinator, who manages the cluster's activities and represents it externally.

YEAR OF FOUNDATION AND ORGANIZATIONAL FORM OF THE TEC

The Tomaszów Energy Cluster was established on September 6, 2017.

Organizational form:

- Energy cluster – civil law agreement (**without legal personality**),
- Coordinator: commercial law company (TermoSystemy Sp. z o.o.).

FOUNDING PARTNERS AND ORGANIZATIONAL STRUCTURE OF TEC

The cluster's founders were:

- Tomaszów County and all municipalities within the county,
- research institutions (Lublin University of Technology, Institute of Soil Science and Plant Cultivation),
- regional development institutions,
- renewable energy entrepreneurs and investors.

The organizational structure includes:

- Cluster Partners Assembly,
- Cluster Council,
- Coordinator (TermoSystemy Sp. z o.o.).

KEY STAKEHOLDERS AND MEMBERS OF TEC

The cluster's stakeholders include:

- local government units (13 district municipalities),
- businesses (SMEs and energy companies),
- public institutions (schools, municipal infrastructure),
- research and educational institutions,
- residents (as energy consumers).

Currently, the cluster has approximately 22 active institutional members, but more broadly, it collaborates with a larger group of partners (up to approximately 40 entities in various stages of development):

- TermoSystemy Sp. z o.o. – Cluster coordinator;
- City of Tomaszów Lubelski;
- PGKiM Sp. z o.o. in Tomaszów Lubelski;
- Łaszczów; Tyszowce; Lubycza Królewska; Bełżec; Jarczów; Rachanie; Telatyn and Tarnawatka municipalities;
- BOSCH Car Service;
- Klussenbedrijf;
- PPHU JackeR;
- "ARKADIA" Restaurant;
- ERA Innovation; • PHU D.Z.;
- FH KALIMERA;
- Czysta Energia ADK Sp. z o.o.;
- ANTEX II Sp. z o.o.;
- EKOEN Sp. z o.o.;
- Energy Security Agency.

POTENTIAL NEW MEMBERS / TEC TARGET GROUPS

The planned development of the cluster assumed the inclusion of additional groups:

- households (prosumers),
- housing communities,
- farms,
- schools and public buildings,
- local businesses.

The documents also indicated the development of a model encompassing direct and indirect members, enabling the inclusion of a larger number of energy consumers.

VULNERABLE TEC GROUPS

The cluster project indirectly addresses the problem of energy poverty, particularly in rural areas.

Potential vulnerable groups include:

- low-income households,
- rural residents with limited access to infrastructure,
- users of municipal buildings.

The cluster's activities (development of renewable energy sources, improved energy efficiency, and lower energy costs) can contribute to reducing this phenomenon and improving the quality of life of residents.

PILOT 2.1. PP08 T- TRANSFORMATION OF THE TOMASZÓW ENERGY CLUSTER (TEC) INTO THE ROZTOCZEŃSKA ENERGY COOPERATIVE "RSE" (REC "RSE")

The main goal of the developing energy community is to transform the Tomaszów Energy Cluster into an operational model of the Roztocze Energy Cooperative based on local energy balancing, increasing self-consumption, and improving the energy security of community members. The REC's strategic objectives include reducing energy costs, reducing dependence on the wholesale market, increasing the share of renewable energy in the local energy mix, reducing CO_2 emissions, and building a model that can be scaled to other municipalities in the region.

The pilot project confirmed that the key success factor is not only increasing renewable energy capacity, but above all increasing self-consumption, implementing smart metering, energy storage, and energy consumption optimization (DSR). Some adjustments were made to the original assumptions of the application form – instead of a rapid expansion of renewable energy capacity, a phased model was adopted:

- Stage 1 – core stabilization (data, metering, optimization),
- Stage 2 – renewable energy expansion,
- Stage 3 – model scaling.

This change was due to data gaps, connection constraints and the need to reduce investment risk.

BRIEF DESCRIPTION OF THE NATIONAL LEGAL FRAMEWORK OF THE ENERGY CLUSTER AND ENERGY COOPERATIVE

Legislative differences: energy cluster vs. energy cooperative

1. Legal Basis

- **Energy Cluster**
  - Defined in the Renewable Energy Act – Article 2, point 15a, and Articles 38aa–38af, 184k–184m.
  - Special provisions regarding the cluster agreement, coordinator, and support mechanism (fee relief).
- **Energy Cooperative**
  - Defined in Article 2, point 33a, and Articles 38c–38m.
  - Subject to the provisions of the Cooperative Law/Act on Farmer Cooperatives.

2. Legal Status and Form

- **Cluster**
  - Civil law agreement – not a separate legal entity.
  - Represented by a "cluster coordinator" (company, association, foundation, or local government unit/local government partnership).
- **Energy Cooperative**
  - Legal entity – a cooperative entered in the National Court Register (KRS). o It has cooperative bodies (general meeting, council, management board); it may conduct business activities.

3. Members and Area of Operation

- **Energy Cluster**
  - Members: individuals, legal entities, local government units, universities, institutes, etc.
  - Area: maximum 1 district or 5 municipalities, within the distribution network <110 kV of the same DSO.
  - Following amendments – participation of at least one local government unit or local government company required.
- **Energy Cooperative**
  - Members: minimum 10 individuals or 3 legal entities (e.g., municipalities, companies).
  - Area: generally, up to 3 rural/urban-rural municipalities within a single DSO (after 2023, somewhat more flexible definition, but still strongly localized).

4. Scope of Operations and Energy Carriers

- **Cluster**
  - Generation, storage, distribution, and trade of electricity, heat, or fuels (not only renewable energy sources), balancing supply and demand.
  - The goal is economic, social, and environmental benefits, as well as the flexibility of the power system.
- **Energy cooperative**
  - Only renewable energy sources: electricity, heat, biogas, agricultural biogas, biomethane.
  - Operates exclusively for the cooperative and its members – energy is primarily consumed locally.

5. Power Limits and Balancing Requirements

- **Cluster**
  - No general limit on installation capacity in regulations (limitations primarily stem from the grid and connection conditions).
  - Requirement of a common DSO and voltage <110 kV.
- **Energy Cooperative**

- Total capacity of RES installations: up to 10 MW (electricity) and up to 30 MW (heat), biogas up to 40 million m^3 per year.
- Electricity must cover at least 70% of the annual demand of the cooperative and its members (for cooperatives registered by December 31, 2025 – preferential 40%).

6. Support and Settlement System

- **Energy Cluster**
  - From July 2, 2024 – support mechanism (Articles 184k–184m): including Reductions in the renewable energy and cogeneration fee for renewable energy consumed within the cluster, and special rules for calculating a portion of the distribution fee.
  - Reporting obligations of the cluster coordinator (Article 38ad).
- **Energy cooperative**
  1. Dedicated settlement system with DSOs and a "prosumer" mechanism (settlement based on the amount of energy introduced/consumed within the cooperative).
  2. Record-keeping and reporting requirements (to the National Support Center for Energy Conservation and the Energy Regulatory Office).

The cluster is a flexible agreement between multiple entities, encompassing a broad range of energy sources, lacking legal personality, and growing regulatory support.

The cooperative has a formal legal entity, strictly defined capacity limits and area, and a strong focus on self-consumption and local needs.

REC operates and develops within the framework of Polish regulations concerning:

- energy cooperatives (Renewable Energy Sources Act),
- energy clusters,
- energy law and regulations concerning distribution system operators,
- regulations concerning collective prosumers and local energy balancing.

The Roztocze Energy Cooperative has been registered with the National Court Register (KRS) and is awaiting registration with the National Agricultural Support Centre (KOWR), which is a formal requirement for the full operationalization of the energy cooperative model. The pilot project also confirmed the importance of continuous legislative monitoring given the dynamic regulatory changes.

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BRIEF DESCRIPTION OF THE NATIONAL LEGAL FRAMEWORK OF THE ENERGY CLUSTER AND ENERGY COOPERATIVE

Legislative differences: energy cluster vs. energy cooperative

	ENERGY CLUSTER	ENERGY COOPERATIVE
1 Legal Basis	• Defined in the Renewable Energy Act – Article 2, point 15a, and Articles 38aa–38af, 184k–184m. • Special provisions regarding the cluster agreement, coordinator, and support mechanism (fee relief).	• Defined in Article 2, point 33a, and Articles 38c–38m. • Subject to the provisions of the Cooperative Law/Act on Farmer Cooperatives.
2 Legal Status and Form	• Civil law agreement – not a separate legal entity. • Represented by a "cluster coordinator" (company, association, foundation, or local government unit/local government partnership).	• Legal entity – a cooperative entered in the National Court Register (KRS). • It has cooperative bodies (general meeting, council, management board); it may conduct business activities.
3 Members and Area of Operation	• Members: individuals, legal entities, local government units, universities, institutes, etc. • Area: maximum 1 district or 5 municipalities, within the distribution network <110 kV of the same DSO. • Following amendments – participation of at least one local government unit or local government company required.	• Members: minimum 10 individuals or 3 legal entities (e.g., municipalities, companies). • Area: generally up to 3 rural/urban-rural municipalities within a single DSO (after 2023, somewhat more flexible definition, but still strongly localized).
4 Scope of Operations and Energy Carriers	• Generation, storage, distribution, and trade of electricity, heat, or fuels (not only renewable energy sources), balancing supply and demand. • The goal is economic, social, and environmental benefits, as well as the flexibility of the power system.	• Only renewable energy sources: electricity, heat, biogas, agricultural biogas, biomethane. • Operates exclusively for the cooperative and its members – energy is primarily consumed locally.
5 Power Limits and Balancing Requirements	• No general limit on installation capacity in regulations (limitations primarily stem from the grid and connection conditions). • Requirement of a common DSO and voltage <110 kV.	• Total capacity of RES installations: up to 10 MW (electricity) and up to 30 MW (heat), biogas up to 40 million m^3 per year. • Electricity must cover at least 70% of the annual demand of the cooperative and its members (for cooperatives registered by December 31, 2025 – preferential 40%).
6 Support and Settlement System	• From July 2, 2024 – support mechanism (Articles 184k–184m): including: – Reductions in the renewable energy and cogeneration fee for renewable energy consumed within the cluster, – and special rules for calculating a portion of the distribution fee. • Reporting obligations of the cluster coordinator (Article 38ad).	1. Dedicated settlement system with DSOs and a "prosumer" mechanism (settlement based on the amount of energy introduced/consumed within the cooperative). 2. Record-keeping and reporting requirements (to the National Support Center for Energy Conservation and the Energy Regulatory Office).

Local cooperation. Clean energy. Strong communities.
Together for a sustainable energy future.

Figure 1 Brief description of the national legal framework of energy cluster and energy cooperative

YEAR OF FOUNDATION AND LEGAL/INSTITUTIONAL FORM OF REC "RSE"

The process of creating a REC began as an energy cluster, while the formal transformation to an energy cooperative model was completed with the registration of REC "RSE" with the National Court Register (KRS) on March 18, 2026, and on April 27, 2026, REC "RSE" was registered with the National Agricultural Support Center (KOWR). Currently, REC "RSE" is in the process of signing an agreement with the Distribution System Operator (DSO).

The institutional model is hybrid in nature and combines:

- an energy cluster (a strategic cooperation platform),
- an energy cooperative (an operational and settlement model).

This formula enables both investment cooperation and future local energy balancing.

FOUNDING PARTNERS AND CURRENT ORGANIZATIONAL STRUCTURE OF REC "RSE"

The founding members of REC are:

- TermoSystemy Sp. z o.o.
- TANEW-AGRO Sp. z o.o.
- TANEW Group of Grain and Rapeseed Producers Sp. z o.o.
- City and Municipality of Narol
- Municipality of Bełżec
- Roman Catholic Parish in Bełżec
- Energy Security Agency – Szymon Malinowski
- Grocery Store – Joanna Mańczak
- BOSCH Car Service – Jacek Zabandżała
- Arkadia Restaurant – Janusz Zieliński

The organizational structure of the RSE:

- general meeting of RSE cooperative members,
- RSE supervisory board,
- RSE management board,
- RSE members.

KEY STAKEHOLDERS AND MEMBERS OF REC "RSE"

Key stakeholders:

Members of the RSE Cooperative, RSE shareholders, RSE Supervisory Board, RSE committees, External stakeholders (Bełżec municipality, Narol town and municipality, Tomaszów Lubelski municipality, entrepreneurs operating in the region, OSD, ABE, URE, KRS, Banks and institutions financing renewable energy sources, Technology and construction companies, Regulatory and legal stakeholders (Ministry of Climate and Environment, audit companies) Market stakeholders (energy sellers, other energy clusters, etc).

Table 1 Detailed list of founding members of RSE

No.	*Name*	*Type*	*Location*	*Representative*
1	TermoSystemy Sp. z o.o.	Company	Jeziernia	Jacek Sikora
2	TANEW-AGRO Sp. z o.o.	Company	Narol	Elżbieta Kowalczuk
3	TANEW Grain and Rapeseed Producers Group	Company	Narol	Mariusz Kowalczuk
4	City and Municipality of Narol	Local Government	Narol	Arkadiusz Mroczka
5	Municipality of Bełżec	Local Government	Bełżec	Dariusz Malec
6	Roman Catholic Parish in Bełżec	Institution	Bełżec	Rev. Stanisław Szałański
7	Energy Security Agency	Company	Jeziernia	Szymon Malinowski
8	Grocery Store – Joanna Mańczak	Company	Bełżec	Joanna Mańczak

9	BOSCH Car Service – Jacek Zabandżała	Company	Bełżec	Jacek Zabandżała
10	Arkadia Restaurant	Company	Tomaszów Lubelski	Janusz Zieliński

POTENTIAL NEW MEMBERS / TARGET GROUPS OF REC "RSE"

In subsequent stages, the community is planned to expand to include:

- households,
- rural residents,
- schools and other public entities,
- farms,
- local SMEs outside the current structure.

Expanding membership is intended to increase the scale of local energy balancing, improve the economics of the model, and enhance the social dimension of REC.

VULNERABLE/SENSITIVE GROUPS REC "RSE"

Although the pilot project was not dedicated exclusively to combating energy poverty, this topic was indirectly considered as one of the potential social impacts of REC development.

Groups potentially linked to the project:

- households at risk of energy poverty,
- residents of rural areas with high energy costs,
- possible future inclusion of social housing or vulnerable consumers.

In the long term, REC could also serve as a tool for reducing energy costs for vulnerable groups through participation in local energy sharing mechanisms.

The REC being developed in the Roztocze region is a gradually developing energy community based on the cooperation of local government units, businesses, and public entities, with the ambition to scale the model to residents and additional municipalities. The pilot project confirmed the validity of the adopted strategic assumptions, simultaneously leading to their refinement through a greater emphasis on data, self-consumption, investment phasing, and the development of a sustainable organizational model.

2.2. Documented evidences

The key formal evidence confirming the establishment and development of the renewable energy community is the entry of the Roztoczańska Spółdzielnia Energetyczna (RSE) in the National Court Register

(KRS), which confirms the formal establishment of the entity in the legal form of an energy cooperative. The entry in the KRS is the primary document confirming the transition from an energy cluster model to a formally established Renewable Energy Community (REC) and constitutes tangible evidence of the implementation of activities within the pilot scheme.

This document serves as proof of the improvement/establishment of the REC in accordance with the intended outcomes of Activity 2.1 and confirms the implementation of a key element of the organisational and institutional model set out in the application form.

DOCUMENTS CONFIRMING THE ESTABLISHMENT AND DEVELOPMENT OF REC "RSE"

The following evidence is attached:

- 1) TEC Letter of Intent regarding the establishment of "RSE" (May 1, 2025),
- 2) Excerpt from the National Court Register (KRS) – registration of the Roztocze Energy Cooperative "RSE",
- 3) Articles of Association of the "RSE" Energy Cooperative,
- 4) List of founding members of the Roztocze Energy Cooperative "RSE",
- 5) Attendance list of founding members of the Roztocze Energy Cooperative "RSE",
- 6) Agenda of the founding meeting of the Roztocze Energy Cooperative "RSE",
- 7) Minutes of the founding meeting of the Roztocze Energy Cooperative "RSE",
- 8) List of shares of the founding members of the Roztocze Energy Cooperative "RSE",
- 9) List of contact details of the founding members of the Roztocze Energy Cooperative "RSE",
- 10) Resolution 1 on the establishment of the Roztocze Energy Cooperative Energy Cooperative "RSE,"
- 11) Resolution 2 on the adoption of the statute of the Roztocze Energy Cooperative "RSE,"
- 12) Resolution 3 on the recommendation to the Supervisory Board to elect the RSE management board,
- 13) Resolution 4 on the election of the Supervisory Board of the Roztocze Energy Cooperative "RSE,"
- 14) Materials from the organizational process and working meetings supporting the establishment of the REC,
- 15) List of consolidated data of the Roztocze Energy Cooperative "RSE" for the purposes of the KOWR,
- 16) Document confirming the registration of the Roztocze Energy Cooperative "RSE" with the KOWR.

2.3. Pilot description

TECHNICAL PROFILE

OVERVIEW OF INSTALLED TEC SYSTEMS

The Tomaszów Energy Cluster operates as an electricity generation system with elements of district heating solutions (a mixed model in the development phase), based primarily on renewable energy sources.

The technological structure includes:

- photovoltaic installations (dominant technology),
- wind farms,
- biogas installations (limited share),
- hydropower plants (marginal share),
- planned: energy storage, biogas plants, and district heating systems.

At the district level (cluster area), at the end of 2024, there were 44 renewable energy installations operating with a total capacity of approximately 109 MW, including:

- 39 PV installations – approximately 31 MW,
- 3 wind farms – approximately 77.1 MW,
- 1 biogas installation – approximately 1 MW,
- 1 hydropower plant – approximately 0.07 MW. Annual electricity consumption in the district is approximately 87 GWh, which serves as a benchmark for the development of local energy balancing.

At the local level (local government buildings and public infrastructure), there are numerous micro-PV installations (e.g., schools, preschools, sports facilities), with capacities ranging from a few to several dozen kW, as well as larger installations (hundreds of kW).

Energy Storage:

- Currently, there are no energy storage facilities within the cluster structure,
- Planned implementation of storage facilities (50–250 kW) as part of investment activities.

Metering Systems and Data:

- Lack of fully integrated smart metering systems (15-minute),
- Available data is mainly annual or estimated,
- Planned implementation of ICT/EMS systems for energy management and consumption prediction.

TEC OPERATING MODEL

The cluster operates as a grid-connected system, cooperating with the distribution system operator (PGE).

Operational characteristics:

- no own distribution network – utilizing DSO infrastructure,
- local energy balancing model (in development),
- cooperation between energy producers and consumers within the cluster,
- possibility of concluding PPAs within the cluster,
- development towards an energy community (REC).

The system is a virtual energy community, where energy flows through the public grid, and balancing is an organizational and billing process.

LEVEL OF SELF-CONSUMPTION AND ENERGY BALANCE TEC

The current level of self-consumption in the Tomaszów Energy Cluster (TKE) is not precisely defined due to the lack of detailed measurement data. However, based on available analyses, it can be concluded that:

- a significant portion of energy produced from renewable energy sources is consumed locally (especially in local government units and public facilities),
- there is surplus energy (especially in PV installations) that is fed into the grid,
- the lack of energy storage facilities limits the possibility of increasing self-consumption,
- the potential for increasing self-consumption through energy storage and demand-side response (DSR).

Ultimately, the model assumes:

- increasing local self-consumption,
- limiting energy export to the grid,
- improving balancing through the integration of energy management systems.

The technical profile of the Tomaszów Energy Cluster is based on a developed, yet still distributed, renewable energy system with a dominant role for photovoltaics. Key challenges include the lack of energy storage facilities, limited availability of measurement data, and the need to implement advanced energy management systems. At the same time, there is significant potential for development towards an efficient, locally balanced energy system based on the principles of an energy community.

OVERVIEW OF INSTALLED REC "RSE" SYSTEMS

The Roztocze Energy Cooperative (RSE) is being developed as an electricity system based primarily on renewable energy sources (an electric model with the potential to develop towards a mixed model).

The current and planned technology mix includes:

- photovoltaic (PV) installations – the primary energy source (existing and planned),

- potential: biogas installations and other renewable energy sources (based on the cluster's experience),
- no significant share of heating systems at this stage (possible future development).

Capacity and Energy Production:

- lack of complete, aggregated data for the RSE (system in the organization and integration phase),
- part of the capacity comes from member installations (local government units, enterprises),
- development of renewable energy capacity is planned in stages, based on an investment model.

Energy Storage:

- currently no energy storage facilities implemented,
- their installation is a key element of the development plan (increasing self-consumption and system stability). Metering systems and data:
- lack of a complete smart metering infrastructure (15-minute measurements),
- available data is partial (often annual or monthly),
- lack of an integrated Energy Management System (EMS),
- planned implementation of a central data collection and analysis system.

REC "RSE" OPERATING MODEL

The RSE operates as a grid-connected system, cooperating with the distribution system operator.

Operational characteristics:

- no own distribution infrastructure – utilizing the DSO network,
- local energy balancing model (in the implementation phase),
- operation as a virtual energy community (virtual REC),
- energy flows physically through the public grid, while billing is organizational and system-based,
- planned implementation of energy management systems (EMS) and consumption optimization.

SELF-CONSUMPTION LEVEL AND ENERGY BALANCE REC "RSE"

At this stage, accurate, quantitative data on the level of self-consumption is not available due to the lack of comprehensive measurement data. However, based on analyses and simulations, it can be indicated:

- Self-consumption of energy exists, but is limited by the lack of energy storage facilities and management systems,
- There are surpluses of energy (especially from PV installations) that are fed into the grid,

- The financial and energy model of the Energy and Power Grid is sensitive to the level of self-consumption,
- The potential for self-consumption growth is approximately 15–25 % after the implementation of energy storage facilities and load optimization (according to simulation results),
- Increasing self-consumption directly translates into improved economic efficiency of the community.

The technical profile of the Energy and Power Grid indicates a system in transition – from distributed renewable energy installations to an integrated energy community. Key challenges include the lack of high-resolution data, the lack of energy storage facilities, and limited digitalization. At the same time, there is significant development potential through:

- implementing smart metering and EMS,
- installing energy storage,
- increasing self-consumption,
- developing local energy balancing.

These actions will transform the RSE into an efficient, modern energy community with a high level of self-sufficiency.

FINANCIAL PERFORMANCE

CURRENT TEC COST STRUCTURE

The cost structure of the Tomaszów Energy Cluster stems from its nature as an operational agreement and the evolving energy system. The main cost categories include:

- maintenance and operation costs of renewable energy installations (e.g., PV system maintenance and energy infrastructure),
- cluster management and coordination costs (coordinator activities – TermoSystemy Sp. z o.o., organizational, expert, and administrative support),
- investment preparation costs (technical analyses, energy audits, project documentation),
- costs related to IT infrastructure and energy management systems (planned implementation of EMS and predictive systems),
- network and distribution fees (use of the distribution system operator's infrastructure),
- costs of information and educational activities (meetings, campaigns, local competency building).

It is worth emphasizing that some costs are preparatory (pre-investment), meaning that the cluster's financial model is still in the development phase.

TEC'S REVENUE SOURCES

Current and future sources of cluster revenue include:

- sales of electricity from renewable energy sources (e.g., PV installations and wind farms),
- internal energy settlements between cluster members (ultimately in the REC model),
- cost savings resulting from self-consumption of energy,
- public funds and subsidies (national and EU programs supporting renewable energy sources and energy efficiency),
- contributions and investments by cluster members,
- potentially:Power Purchase Agreements (PPAs),
- revenues from energy services (energy management, consulting, balancing).

The revenue model is hybrid – it combines direct financial revenues with economic benefits in the form of reduced energy costs.

PROFITABILITY (CURRENT SITUATION) OF TEC

Due to the nature of the cluster as an agreement (rather than an independent economic entity), there is no single, shared income statement for the entire cluster.

Currently:

- the cluster as a whole does not generate direct financial profits,
- economic benefits are dispersed and realized at the level of individual members,
- some activities are still in the preparatory phase (analyses, investment planning).

At the same time, the implemented renewable energy installations are already generating:

- energy cost savings for local government units and businesses,
- partial revenues from selling surplus energy to the grid.

PROJECTED FINANCIAL BENEFITS OF TEC

According to the cluster's analyses and development strategy, the expected economic effects include:

1. Reduction in energy costs:

- Reduction in energy purchase costs through self-consumption,
- Long-term cost stabilization (reduced dependence on the wholesale market).

2. Increased revenues:

- Increased energy production from renewable energy sources and sale of surplus energy,
- Development of local power purchase agreements (PPAs),
- Utilization of support mechanisms (subsidies, EU funds).

3. Improved investment efficiency:

- Better utilization of local resources (e.g., solar radiation, biomass),
- Optimization of energy consumption through energy management systems (EMS).

4. Return on investment (ROI):

- Investments in PV and renewable energy installations are characterized by a medium payback period,
- Shortening the payback period is possible through increased self-consumption and the implementation of energy storage facilities.

5. Indirect effects:

- Development of the local economy and entrepreneurship,
- Increased value of energy infrastructure,
- Reduction of environmental costs (CO_2 emissions). The Tomaszów Energy Cluster's financial model is in a transitional phase – from a model based on collaboration and analysis to an investment-operational model. Currently, preparatory and organizational costs dominate, but in the medium and long term, the cluster has the potential to generate significant economic benefits through the development of renewable energy sources, increased self-consumption, and optimization of the local energy system.

CURRENT COST STRUCTURE OF THE REC "RSE"

At the current stage of RSE development (organizational and pilot phases), the cost structure is primarily preparatory and operational. Key categories include:

- management and operational costs of the cooperative (administration, coordination of activities, legal and organizational support),
- investment preparation costs (technical and financial analyses, design documentation, feasibility studies),
- data and IT costs (implementation of tools such as REC Manager, planned EMS systems, and smart metering),
- operating costs of existing renewable energy installations (borne by members – service and maintenance),
- network and distribution fees (related to the use of DSO infrastructure),
- communication and organizational costs (meetings, workshops, development of cooperation structures).

Due to the lack of full system integration and financial data, costs are not yet aggregated at the cooperative level.

REC "RSE" REVENUE SOURCES

The RSE revenue model is hybrid and relies on both financial flows and cost effects. The main sources include:

- sales of electricity from renewable energy installations (both to the grid and ultimately within the community),
- internal energy settlements between members (a key element of the REC model – currently under development),
- membership fees and investment contributions,
- public funds and grants (e.g., national programs, the National Fund for Environmental Protection and Water Management, local government funds, EU funds – e.g., EFfICE - **European Funds for Infrastructure, Climate, Environment**),
- potentially:
- revenues from PPAs,
- energy management and energy consulting services.

At this stage, some revenues are indirect (energy cost savings for members).

PROFITABILITY (CURRENT SITUATION) REC "RSE"

The RSE is in its early stages of development, which is why:

- there is a lack of comprehensive financial data and KPIs,
- the cooperative does not yet generate stable financial results as a whole,
- economic benefits are primarily at the level of individual members (e.g., energy savings),
- data limitations (lack of complete datasets, lack of system integration) make it difficult to accurately assess profitability.

Therefore, it can be concluded that the RSE is currently in the investment and preparation phase, not the profit-generating operational phase.

PROJECTED FINANCIAL BENEFITS OF REC "RSE"

Based on the analyses and simulations conducted during the pilot project, the following anticipated economic effects can be identified:

1. Reduction in energy costs:

- Reduction in energy purchase costs through increased self-consumption,
- Reduction in exposure to wholesale energy price volatility.

2. Improved investment efficiency (ROI):
    - Increased investment profitability with increased self-consumption,
    - Possibility of improving ROI through the implementation of energy storage and consumption optimization,
    - Need to phase investments to reduce financial risk.
3. Increased revenues:
    - Increased energy production from renewable energy sources and the sale of surplus energy,
    - Development of local settlement mechanisms (RECs),
    - Access to public financing and support instruments.
4. Systemic and long-term effects:
    - Improved financial stability of members,
    - Increased value of energy infrastructure,
    - Development of the local economy and new business models.

The financial profile of the RSE indicates an organization in a transition phase – from a preparatory to an operational model. Currently, organizational and investment costs and limited availability of financial data dominate. At the same time, pilot analyses confirm the high potential for improving economic efficiency, particularly through increased self-consumption, the implementation of energy storage facilities, and the development of a local energy billing model. In the medium and long term, RSE has the potential to achieve a stable and sustainable financial model.

BUSINESS MODEL

TEC BUSINESS MODEL

The Tomaszów Energy Cluster's business model is based on the collaboration of local entities for the joint generation, distribution, balancing, and use of energy, primarily from renewable sources. The cluster functions as a platform coordinating the activities of multiple stakeholders (local government units, businesses, and public institutions), striving to increase energy self-consumption, improve energy efficiency, and reduce energy costs in the region. Below, a simplified version of the business model, inspired by the GENO Canvas approach, is presented:

1. VALUE PROPOSITION

- Reducing energy costs for cluster members,
- Increasing the region's energy security,
- Access to renewable energy and stable supply sources,
- Possibility to participate in joint energy investments,
- Reducing CO_2 emissions and improving environmental quality.

2. CUSTOMER SEGMENTS

- local government units (municipalities, districts),
- enterprises (SMEs, energy companies),
- public entities (schools, institutions),
- residents (ultimately as prosumers).

3. KEY ACTIVITIES

- Development and operation of renewable energy installations (PV, wind, biogas),
- Local energy balancing (supply-demand),
- Preparation and implementation of energy investments,
- Energy management and implementation of ICT/EMS systems,
- Educational and informational activities.

4. KEY RESOURCES

- renewable energy infrastructure (PV installations, wind farms),
- local energy grid (in cooperation with the DSO),
- energy data and energy management systems,
- financial capital and public support,
- technical and organizational competences of cluster members.

5. KEY PARTNERS

- local government units,
- energy and technology companies,
- research institutions and universities,
- distribution system operators (DSOs),
- financing institutions and public administration.

6. REVENUE STREAMS

- electricity sales (to the grid or in an internal model),
- savings resulting from self-consumption,
- funds from subsidies and support programs,
- potential revenues from PPAs and energy services.

7. COST STRUCTURE

- Investment costs (RES, infrastructure, IT systems),
- Operating and maintenance costs,
- Cluster management and coordination costs,
- Network and distribution fees,
- Costs of analysis, documentation, and project preparation.

8. CHANNELS

- direct cooperation between cluster members,
- local energy billing,
- use of the DSO network as transmission infrastructure,
- information and educational activities.

9. CUSTOMER RELATIONSHIPS

- long-term partnerships,
- joint investment planning,
- participatory management model,
- technical and advisory support for members.

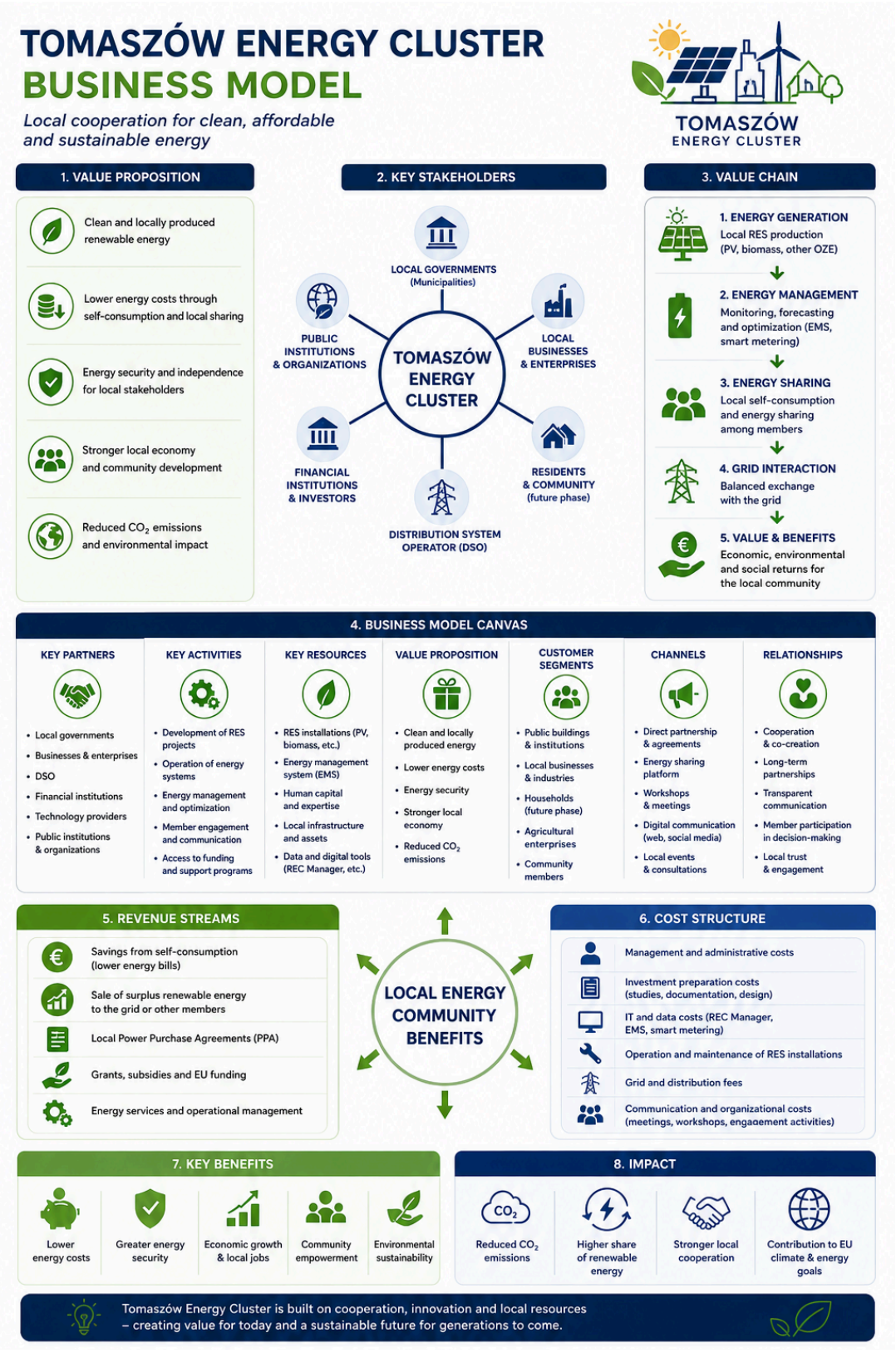

TOMASZÓW ENERGY CLUSTER
BUSINESS MODEL
Local cooperation for clean, affordable and sustainable energy
TOMASZÓW ENERGY CLUSTER
1. VALUE PROPOSITION
Clean and locally produced renewable energy
Lower energy costs through self-consumption and local sharing
Energy security and independence for local stakeholders
Stronger local economy and community development
Reduced CO_2 emissions and environmental impact
2. KEY STAKEHOLDERS
LOCAL GOVERNMENTS (Municipalities)
PUBLIC INSTITUTIONS & ORGANIZATIONS
LOCAL BUSINESSES & ENTERPRISES
TOMASZÓW ENERGY CLUSTER
FINANCIAL INSTITUTIONS & INVESTORS
RESIDENTS & COMMUNITY (future phase)
DISTRIBUTION SYSTEM OPERATOR (DSO)
3. VALUE CHAIN
1. ENERGY GENERATION
Local RES production (PV, biomass, other OZE)
2. ENERGY MANAGEMENT
Monitoring, forecasting and optimization (EMS, smart metering)
3. ENERGY SHARING
Local self-consumption and energy sharing among members
4. GRID INTERACTION
Balanced exchange with the grid
5. VALUE & BENEFITS
Economic, environmental and social returns for the local community
4. BUSINESS MODEL CANVAS
KEY PARTNERS
Local governments
Businesses & enterprises
DSO
Financial institutions
Technology providers
Public institutions & organizations
KEY ACTIVITIES
Development of RES projects
Operation of energy systems
Energy management and optimization
Member engagement and communication
Access to funding and support programs
KEY RESOURCES
RES installations (PV, biomass, etc.)
Energy management system (EMS)
Human capital and expertise
Local infrastructure and assets
Data and digital tools (REC Manager, etc.)
VALUE PROPOSITION
Clean and locally produced energy
Lower energy costs
Energy security
Stronger local economy
Reduced CO_2 emissions
CUSTOMER SEGMENTS
Public buildings & institutions
Local businesses & industries
Households (future phase)
Agricultural enterprises
Community members
CHANNELS
Direct partnership & agreements
Energy sharing platform
Workshops & meetings
Digital communication (web, social media)
Local events & consultations
RELATIONSHIPS
Cooperation & co-creation
Long-term partnerships
Transparent communication
Member participation in decision-making
Local trust & engagement
5. REVENUE STREAMS
Savings from self-consumption (lower energy bills)
Sale of surplus renewable energy to the grid or other members
Local Power Purchase Agreements (PPA)
Grants, subsidies and EU funding
Energy services and operational management
LOCAL ENERGY COMMUNITY BENEFITS
6. COST STRUCTURE
Management and administrative costs
Investment preparation costs (studies, documentation, design)
IT and data costs (REC Manager, EMS, smart metering)
Operation and maintenance of RES installations
Grid and distribution fees
Communication and organizational costs (meetings, workshops, engagement activities)
7. KEY BENEFITS
Lower energy costs
Greater energy security
Economic growth & local jobs
Community empowerment
Environmental sustainability
8. IMPACT
Reduced CO_2 emissions
Higher share of renewable energy
Stronger local cooperation
Contribution to EU climate & energy goals
Tomaszów Energy Cluster is built on cooperation, innovation and local resources – creating value for today and a sustainable future for generations to come.

Figure 2 Tomaszów Energy Cluster business model

The Tomaszowski Energy Cluster's business model is cooperative and hybrid, combining elements of the energy market, resource sharing, and local energy management. The cluster operates not as a traditional enterprise generating central profits, but as a platform for optimizing costs and value for its members. Ultimately, this model will evolve into a fully-fledged energy community (REC), in which high self-consumption, local energy balancing, and the integration of energy management systems will play a key role.

REC "RSE" BUSINESS MODEL

The business model of the Roztocze Energy Cooperative (RSE) is an extension and formalization of the Tomaszów Energy Cluster, moving from a collaborative model (cluster) to an operational energy community (REC) capable of managing billing and investments. The model is based on local energy balancing, maximizing self-consumption, and joint management of renewable energy infrastructure. The business model, similar to GENO Canvas, is presented below:

1. VALUE PROPOSITION

- Reducing energy costs for members through the use of local renewable energy sources,
- Increasing self-consumption and reducing energy purchases from the market,
- Improving the energy security of local government units and businesses,
- Stabilizing energy costs in the long term,
- Reducing CO_2 emissions and improving energy efficiency,
- Possibility of participating in joint investments (PV, energy storage).

2. CUSTOMER SEGMENTS

- local government units (municipalities),
- enterprises (SMEs, service and manufacturing companies),
- public entities (schools, institutions),
- ultimately: households and individual prosumers.

3. KEY ACTIVITIES

- energy generation from renewable energy sources (primarily PV),
- local energy balancing (production-consumption),
- energy flow management (EMS, smart metering – planned),
- infrastructure development (RES installations, energy storage),
- internal settlements between members,
- preparation of financial analyses and investment scenarios.

4. KEY RESOURCES

- renewable energy installations (existing and planned),
- energy infrastructure (DSO network),
- energy data (partially available – requires development),
- organizational structure of the cooperative,
- membership capital and access to public financing.

5. KEY PARTNERS

- Tomaszów Energy Cluster (strategic support),
- local government units (Narol, Bełżec, and others),
- enterprises (e.g., TermoSystemy Sp. z o.o.),
- distribution system operator (PGE),
- financing institutions (NFOŚiGW, EU programs),
- suppliers of IT technologies and systems.

6. REVENUE STREAMS

- internal energy settlements between REC members,
- sale of surplus energy to the grid,
- membership fees,
- subsidies and grants (e.g., FEnIKS, local government funds, NFOŚiGW),
- potentially: PPAs and energy management services.

7. COST STRUCTURE

- investments in renewable energy installations (PV, energy storage),
- costs of implementing metering and EMS systems,
- operating and management costs of the cooperative,
- network and distribution fees,
- costs of preparing analyses and design documentation.

8. CHANNELS

- physical flow of energy through the DSO network,
- billing and energy management systems,
- direct cooperation between members,
- information and consultation activities.

9. CUSTOMER RELATIONSHIPS

- partnership and co-ownership model (cooperative),
- joint investment decision-making,
- long-term cooperation and commitment of members,
- development of energy competencies and awareness.

The RSE business model is cooperative and focused on value for its members, not on maximizing central profits. A key element is local energy balancing and maximizing self-consumption, which translates directly into economic benefits for participants. This model is currently undergoing development and transition – from an analytical and organizational (pilot) approach to an operational and investment approach. In subsequent stages, its effectiveness will depend on the implementation of energy management systems, improved data quality, and the integration of energy storage facilities.


RSE
Roztoczańska Spółdzielnia Energetyczna
ROZTOCZE ENERGY COOPERATIVE "RSE"
Local energy. Shared benefits. Sustainable future.
1. VALUE PROPOSITION
Clean and locally produced renewable energy
Lower and more stable energy costs through self-consumption and local sharing
Energy security and independence for members
Stronger local economy and development of the region
Reduced CO_2 emissions and environmental impact
2. STAKEHOLDERS
LOCAL GOVERNMENTS (Municipalities)
PUBLIC INSTITUTIONS & ORGANIZATIONS
LOCAL BUSINESSES & ENTERPRISES
RSE Roztoczańska Spółdzielnia Energetyczna
FINANCIAL INSTITUTIONS & INVESTORS
RESIDENTS & COMMUNITY (future phase)
DISTRIBUTION SYSTEM OPERATOR (DSO)
3. VALUE CHAIN
1. ENERGY GENERATION
Local renewable sources (PV, biomass, other RES)
2. ENERGY MANAGEMENT
Monitoring, forecasting and optimization (EMS, smart metering)
3. ENERGY SHARING
Local self-consumption and sharing among members
4. GRID INTERACTION
Balanced exchange with the grid
5. VALUE & BENEFITS
Economic, environmental and social returns for the local community
4. BUSINESS MODEL CANVAS
KEY PARTNERS
Local governments
Businesses & enterprises
DSO
Financial institutions
Technology providers
Public institutions & organizations
KEY ACTIVITIES
Development of RES projects
Operation of energy systems
Energy management and optimization
Member engagement and communication
Access to funding and support programs
KEY RESOURCES
RES installations (PV, biomass, etc.)
Energy management system (EMS)
Human capital and expertise
Local infrastructure and assets
Data and digital tools (REC Manager, etc.)
VALUE PROPOSITION
Clean and locally produced renewable energy
Lower and more stable energy costs
Energy security and independence
Stronger local economy
Reduced CO_2 emissions
CUSTOMER SEGMENTS
Public buildings & institutions
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Investment preparation costs (studies, documentation, design)
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Lower energy costs
Greater energy security
Economic growth & local jobs
Community empowerment
Environmental sustainability
8. IMPACT
Reduced CO_2 emissions
Higher share of renewable energy
Stronger local cooperation
Contribution to EU climate & energy goals
RSE – Roztocze Energy Cooperative is building a resilient, inclusive and sustainable energy future based on cooperation, innovation and local resources.

Figure 3 Roztocze Energy Cooperative "RSE" business model

ENGAGEMENT AND COMMUNICATION

OVERVIEW OF THE OVERALL ENGAGEMENT STRATEGY (5W+1H METHODOLOGY)

The engagement strategy at the Roztocze Energy Cooperative (RSE) was designed in accordance with a participatory approach, assuming the active involvement of stakeholders in the co-design process of the REC model.

WHO (who we engage):

- local government units (municipalities, districts),
- local enterprises (SMEs),
- public entities (schools, institutions),
- local organizations and social institutions,
- technical experts and project partners,
- target: residents and households.

WHY (why we engage):

- increasing social acceptance of the REC,
- adapting the business model to the real needs of users,
- identifying barriers (technical, financial, organizational),
- building trust and shared responsibility,
- increasing the effectiveness of implementation and sustainability of the project.

WHAT (what is the subject of engagement):

- REC business model,
- organizational structure,
- investment directions (renewable energy sources, energy storage),
- energy needs of members,
- communication and development strategies. WHEN:
- in the preparation phase (analysis and planning),
- during the pilot phase (testing tools and models),
- in the implementation and development phase (ongoing engagement).

WHERE:

- local meetings (municipalities: Narol, Bełżec),
- design workshops,
- working meetings of partners,
- individual consultations.

HOW:

- workshops and coaching sessions,
- working and consultation meetings,
- data analyses and simulations (REC Manager),
- formal and direct communication,
- information materials and presentations.

DESCRIPTION OF ENGAGEMENT AND COMMUNICATION ACTIVITIES

1. KICK-OFF MEETING

- Type: Working meeting / Kick-off workshop
- Date: Initial pilot phase July 22, 2025
- Duration: approx. 3–4 hours
- Location: Bełżec
- Organizers: Project partners + cluster coordinator (TermoSystemy)
- Participants: Local government units, enterprises, experts
- Number of participants: 16

Table 2 Kick-off meeting agenda

Time	*Topic*	*Speaker*
10:50 - 11:00	Registration	
11:00 - 11:05	Welcome and introduction to the meeting	Kinga Szafran, Deputy Director, Department of Strategy and Development, Marshal's Office of the Lublin Voivodeship
11:05 - 11:15	Welcoming guests	Jacek Sikora, President of TermoSystemy Sp. z o.o., Coordinator of the Tomaszów Energy Cluster
11:15 - 11:45	Main assumptions of the project	Katarzyna Kiszczak, project coordinator, Department of Strategy and Development, Marshal's Office of the Lublin Voivodeship

11:45 - 12:45	Presentation of the cluster's development opportunities	Magdalena Rzemieniak, Expert of HERCULES Project
12:45 - 13:30	Discussion with the meeting participants	
13:30 - 14:00	Meeting summary	Magdalena Rzemieniak, Expert of HERCULES Project
14:00	Closing	

Objectives:

- present the project assumptions and the REC Manager tool,
- define the scope of cooperation,
- identify stakeholder expectations.

Involved organizations:

- Department of Strategy and Development, Marshal Office of the Lubelskie Voivodeship in Lublin
- Tomaszowski Energy Cluster
- TermoSystemy Sp. z o.o.
- Narol City and Commune
- Bełżec Commune
- Roman Catholic Parish of Our Lady Queen of Poland in Bełżec
- Energy Security Agency
- Grocery Store – Joanna Mańczak
- BOSCH Car Service – Jacek Zabandżała
- Arkadia Restaurant – Janusz Zieliński
- Lublin University of Technology

Key topics:

- REC model and its operation,
- energy needs of members,
- scope of data to be analysed.

Results:

- agreement on the scope of the pilot,
- identification of data gaps,
- initiation of the data collection process.



Figure 4 Kick-off meeting

2. COACHING SESSIONS AND EXPERT WORKSHOPS

Type: workshops/coaching sessions:

- Duration: cyclical (several meetings)
- Format: online + face-to-face meetings
- Participants: project partners, experts, REC members

Objectives:

- support in using the REC Manager tool,
- business model analysis,
- interpretation of simulation results.

Results:

- development of preliminary action scenarios,
- identification of investment needs,
- preparation of an implementation plan.

3. WORKING MEETINGS WITH LOCAL STAKEHOLDERS

- **Type**: Consultative/working meetings
- **Location**: Local Government Units (Narol, Bełżec)
- **Participants**: Municipality representatives, entrepreneurs, operators

Objectives:

- Clarifying energy needs,
- Discussing the collaboration model,
- Identifying implementation barriers.

Results:

- Better adaptation of the REC model,
- Identifying infrastructure constraints,
- Increasing partner engagement.

4. COMMUNICATION ACTIVITIES (LIMITED – CURRENT STATUS)

- formal communication between cluster members,
- lack of a broad information campaign for residents,
- lack of a unified communication package.

Recommended actions (next step):

- workshops for municipal councils,
- public consultations,
- information campaigns for residents,
- visual materials (infographics, presentations).

MATERIALS AND DOCUMENTATION OF OPERATIONS

It is recommended to attach to the report:

- photos from meetings and workshops,
- project presentations,

- information materials,
- working documents (e.g., analysis results, models),
- screenshots from the REC Manager tool.

EVALUATION OF ENGAGEMENT ACTIVITIES

The evaluation of activities was conducted qualitatively, due to the limited formalization of the evaluation process.

Methods used:

- observation of participation and activity,
- feedback during meetings,
- analysis of the level of partner engagement,
- identification of the number of participants.

Indicators (KPIs – approximate):

- number of meetings: several during the pilot phase,
- number of participants: 10–20 per meeting,
- level of engagement: high among institutional partners,
- level of resident engagement: low (no mass activities).

Conclusions:

- effective cooperation at the institutional level,
- limited social engagement (residents),
- need to expand communication activities,
- need to introduce more formal evaluation tools (surveys, KPIs, monitoring).

The engagement strategy in the RSE is based on strong collaboration between institutional and expert partners, which allowed for the successful implementation of the pilot phase. At the same time, a key challenge for the next stage is to extend activities to the social level, including the active involvement of residents and the implementation of more advanced communication and evaluation tools.

2.4. Pilot roadmap

PHASE 1: DATA & PREPARATION (0–6 months)

Objective: Build data foundation and system readiness

Key Actions:

- Data standardisation across members

- Central data collection system
- Initial simulations (REC Manager)

KPIs:

- ≥ 80% members with standardised datasets
- ≥ 70% energy points analysed
- ≥ 75% dataset completeness
- ≥ 3 simulation scenarios developed

Outcome:

- Baseline energy model established
- Data-driven decision framework

PHASE 2: OPTIMISATION (3–9 months)

Objective: Improve efficiency without major investments

Key Actions:

- Smart metering (15-min resolution)
- Demand-side optimisation (load shifting)
- Financial scenario analysis

KPIs:

- ≥ 60% assets with smart metering
- Peak demand reduction: 15–20%
- Data accuracy improvement: +30%
- ≥ 5 optimisation measures implemented

Outcome:

- Improved energy balance
- Reduced operational costs

PHASE 3: INVESTMENTS (6–18 months)

Objective: Increase RES share and self-consumption

Key Actions:

- Energy storage deployment
- PV expansion (phased approach)
- Investment planning & financing

KPIs:

- Self-consumption increase: +15–25%
- Installed RES capacity: +X MW
- 2–5 storage systems installed
- RES share increase: +20–30%

Outcome:

- Improved economic performance
- Higher system flexibility

PHASE 4: SCALING (12–24 months)

Objective: Expand REC and operational capacity

Key Actions:

- EMS (Energy Management System) implementation
- Member base expansion
- Local energy settlement model

KPIs:

- Member growth: +20–50%
- Self-consumption ≥ 60%
- ≥ 80% members using EMS
- ≥ 5 local energy agreements

Outcome:

- Fully operational REC model
- Scalable energy community

PHASE 5: STABILISATION & REPLICATION (24+ months)

Objective: Ensure long-term sustainability and replication

Key Actions:

- KPI monitoring & optimisation
- New energy services development
- Replication in other regions

KPIs:

- ROI: > 8–12%
- Energy cost reduction: 20–30%
- CO_2 reduction: ≥ 25%

- 1–3 new REC initiatives launched

Outcome:

- Stable and replicable REC model
- Long-term sustainability

OVERALL PILOT IMPACT (HIGHLIGHTS)

- Self-consumption increase: **up to +25%**
- Energy cost reduction: **20–30%**
- Peak demand reduction: **15–20%**
- CO_2 emissions reduction: **≥ 25%**
- ROI potential: **>10%**

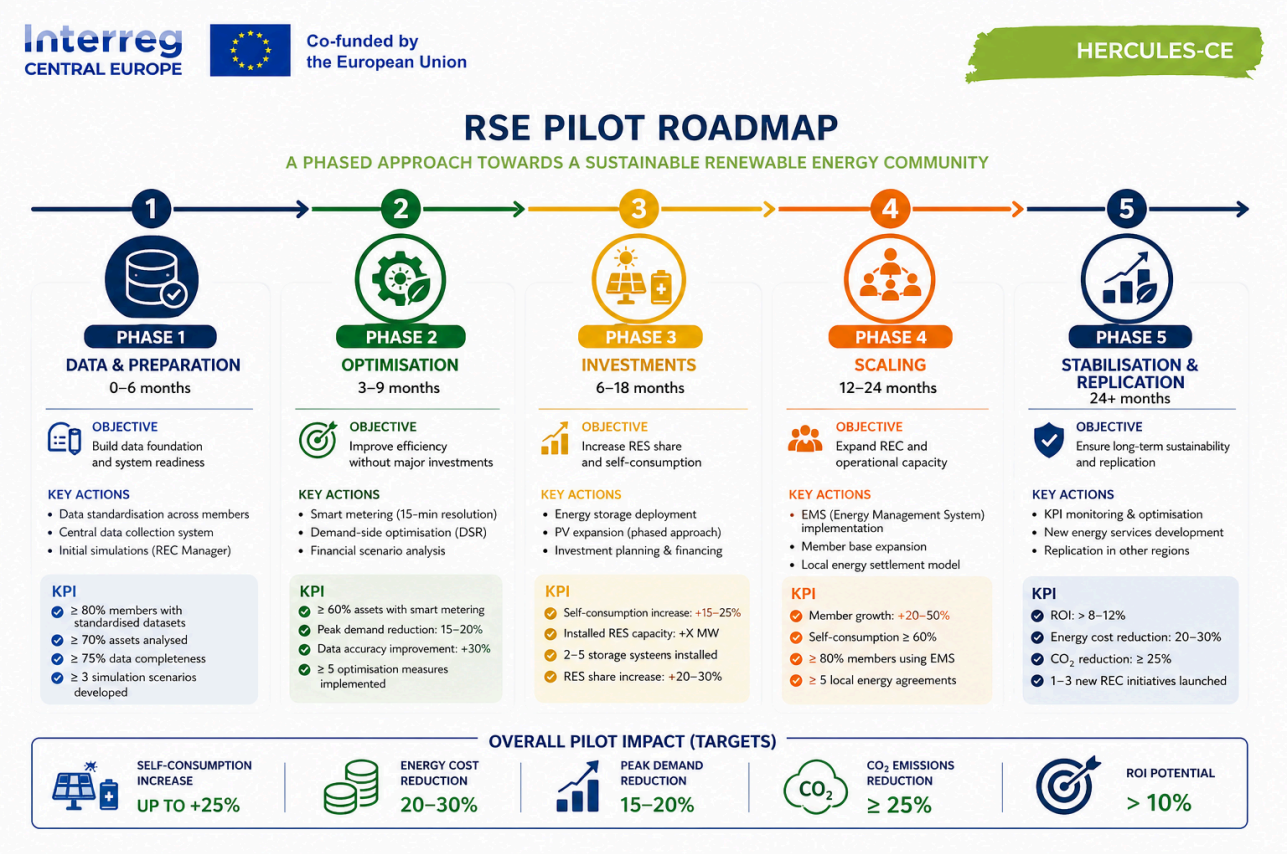


Figure 5 RSE pilot roadmap

3. PREPARATORY ACTIVITIES FOR THE REC

3.1. REC Manager Tool

The analysis for the Roztocze Energy Cooperative (RSE) was conducted using the REC Manager tool in a simplified model, due to limited availability of high-resolution data (lack of full 15-minute profiles). Despite these limitations, it was possible to develop preliminary energy indicators and identify key relationships and optimization potentials.

SCOPE OF ANALYSIS AND DATA AVAILABILITY

The analysis included:

- energy consumption data (partially aggregated annually),
- production data from renewable energy installations (primarily PV),
- estimated data for selected REC participants,
- scenario simulations (min/mid/max).

Limitations:

- lack of complete measurement data (15-minute data),
- incomplete financial data,
- lack of full integration of data systems between members.

KEY ENERGY INDICATORS (ANALYSIS RESULTS)

1. Energy consumed

- *Total consumption*: estimated based on data from local government units and enterprises (no full aggregate for the entire REC),
- *Average consumption per member*: varied (high for local government units and enterprises, low for small entities),
- *Annual profile*:

★ marked seasonality (higher consumption in winter),
★ lack of hourly data limits the analysis of the daily profile.

2. Energy withdrawn from grid

- significant share of energy drawn from the grid,
- dependence on the wholesale energy market,
- average per member: dependent on the level of own production,
- potential for reduction through increased self-consumption and storage.

3. Energy produced

- production based primarily on PV installations,
- characteristics:
  - high production in the summer months,
  - energy surplus during peak generation hours,
- lack of full utilization of local production.

4. Consumed energy

- Current level of self-consumption: moderate (system-limited),
- Limitations:
- lack of energy storage,
- lack of demand-side management (EMS),
- Growth potential: +15–25% (according to REC Manager simulations).

5. Shared energy

- currently low level of energy sharing,
- REC model in development phase – lack of a full billing system,
- growth potential with the implementation of local balancing mechanisms.

6. Co_2 emissions (scope 2)

- Emissions resulting primarily from energy drawn from the grid,
- Emission reduction proportional to:
  - Increased share of renewable energy,
  - Increased self-consumption,
- Potential reduction: ≥25% in the medium term.

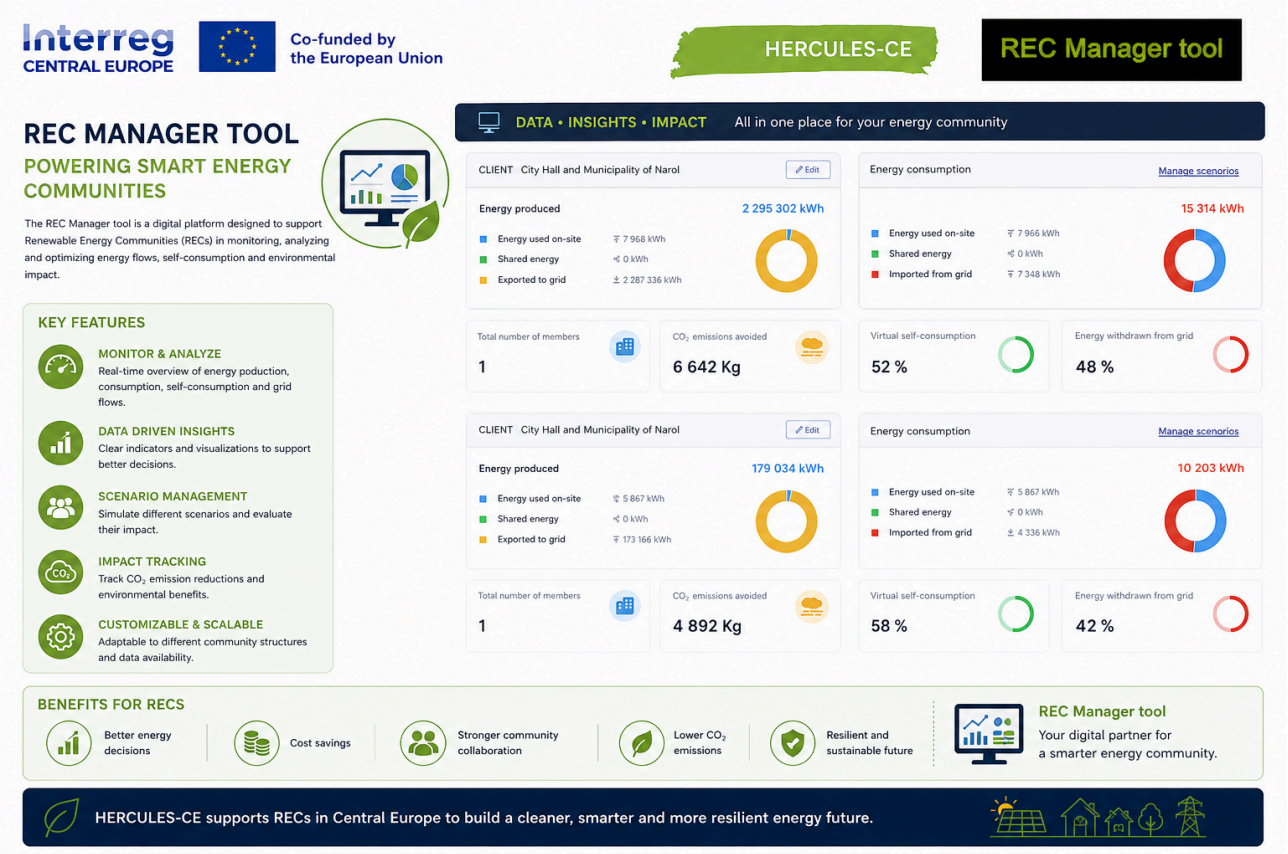


Figure 6 REC Manager Tool

ECONOMIC INDICATORS

The REC Manager analysis indicated:

- high sensitivity of energy costs to market prices,
- significant economic benefits resulting from:
  - increased self-consumption,
  - reduced energy purchases from the grid,
- potential ROI improvement from:
  - implementation of energy storage,
  - optimization of energy consumption,
- the need to phase investments to reduce financial risk.

KEY FINDINGS FROM THE ANALYSIS

1. **Greatest potential for efficiency improvement:**
   - increased self-consumption,

- implementation of energy storage,
- energy consumption optimization (DSR).

2. Main barriers:

- lack of high-resolution data,
- lack of system integration,
- network infrastructure limitations.

3. Importance of the REC Manager tool:

- enabled analysis despite data limitations,
- identified key development directions,
- provided a foundation for further, more advanced analyses**.**

Analysis conducted using the REC Manager tool confirmed that the RSE has significant potential for improvement in both energy and economic terms. Key development directions include increasing self-consumption, developing infrastructure (energy storage), and improving data quality. Implementing these actions will enable the transition from an analytical model to a fully operational and efficient energy community.

3.2. Risk Management Plan

Regulatory and legal risks

- Regulatory changes (RES, clusters, energy cooperatives) → Action: ongoing legislative monitoring, collaboration with a specialized law firm, updating the RSE statute and cluster agreement at least annually.
- Pilot model misaligned with the 70%/40% demand coverage requirements (cooperative) → Action: conservative RES capacity planning, investment phasing, "min/mid/max capacity" scenarios + ongoing adjustments based on actual consumption profiles.
- Relationship with DSOs (connection conditions, nodal settlements) → Action: early DSO involvement in the project, grid working teams, agreed-upon procedures for meter data exchange.

Technical and network risks

- Limited connection capacity and local grid congestion
- → Action:
  - Analysis of the capacity of the mains/15 kV lines at the planning stage,
  - Prioritizing RES locations where the grid is strongest,

- Considering energy storage and power control (DSR/peak shaving).

- Insufficient quality of measurement data for balance optimization
- → Action: Introduce a minimum measurement standard:
  - Remotely read meters,
  - Interval (e.g., 15 min),
  - Central data collection system for the cluster/cooperative.
- Risk of non-operation or delays of RES investments (procedures, contractors)
- → Action: Plan B regarding the project portfolio – excess candidate RES locations, schedule with a time margin, pre-qualification of contractors.

Financial and investment risks

- Underestimation of investments in renewable energy and storage
- → Action:
  - Scenario-based financial analyses (pessimistic, realistic, optimistic),
  - Budget reserve (e.g., 10–15%),
  - Diversification of financing sources (grants, preferential loans, local government funds, member funds).
- Volatility of energy prices on the wholesale market
- → Action:
  - Comparing the effects of the pilot project to several reference price scenarios,
  - Utilizing long-term contracts within the community (relatively constant internal price),
  - Gradual increase in the share of own energy and limiting market exposure.
- Risk of insolvency of some members (companies, local governments)
- → Action: Membership rules with safeguards (e.g., shareholding, investment contribution, internal debt limits), procedures for member exit from the cooperative/cluster.

Organizational and social risks

- Lack of understanding of the difference between a cluster and a cooperative among decision-makers and residents
- → Action: Simple communication package:
  - cluster vs. cooperative: who, where, why, Information workshops for municipal councils, businesses, and residents.

- Divergent member expectations regarding benefit sharing

- → Action:
  - Transparent settlement model (e.g., energy discount rules, surplus distribution),
  - "pre-entry" benefit simulations for each member type,
  - Clear financial regulations for the cooperative and a "code of cooperation" within the cluster.

• Limited human resources for project management (coordinator, RSE board, local government units)

• → Action:
  - Establishing a joint TKE+RSE project office,
  - Outsourcing some tasks (analytics, legal services, IT) to specialized entities,
  - Standardization of processes (contract templates, procedures for joining new members).

Data and IT risks

- Lack of a coherent IT system for energy management (EMS / VPP)
- → Action: In a pilot project, implement a simple, scalable system for:
  - collecting data from meters,
  - visualizing production and consumption,
  - reporting to members and institutions.
- Data security risks (metering and billing data)
- → Action: Selecting solutions compliant with GDPR and CSIRT recommendations, access control, and operation logging.

Details regarding the plan are included in Section of the report titled "Risk Management Plan".

3.3. Preparatory engagement activities

Preparatory engagement activities – RSE (ROZTOCZE ENERGY COOPERATIVE)

Preparatory activities for stakeholder engagement for RSE were carried out as part of the HERCULES-CE project workshops and included two key elements: stakeholder mapping (Berlin) and the development of an engagement strategy (Labin). Both stages laid the foundation for further pilot and implementation activities.

1. STAKEHOLDER MAPPING (BERLIN WORKSHOP)

Objective:

Identification of key stakeholders, defining their roles, level of influence, and level of interest in the REC project.

Scope of work:

• Identifying stakeholder groups related to the REC,

• Assigning them to categories (high/low influence vs. high/low interest),

• Determining potential roles in the project (leaders, users, regulators, partners),

• Preliminary analysis of relationships and interdependencies between stakeholders.

Identified groups:

• Local government units (key decision-makers),

• Local enterprises (key users and investors),

• Public entities (energy consumers),

• Distribution system operator (high influence, technical regulator),

• Financing institutions and regulators,

• Residents (target REC participants – currently low level of involvement).

Key findings:

• Highest influence and involvement: Local government units and enterprises,

• High influence, lower involvement: Distribution system operator,

• Low influence, potentially high future importance: Residents,

• Need to differentiate communication strategies depending on the group.

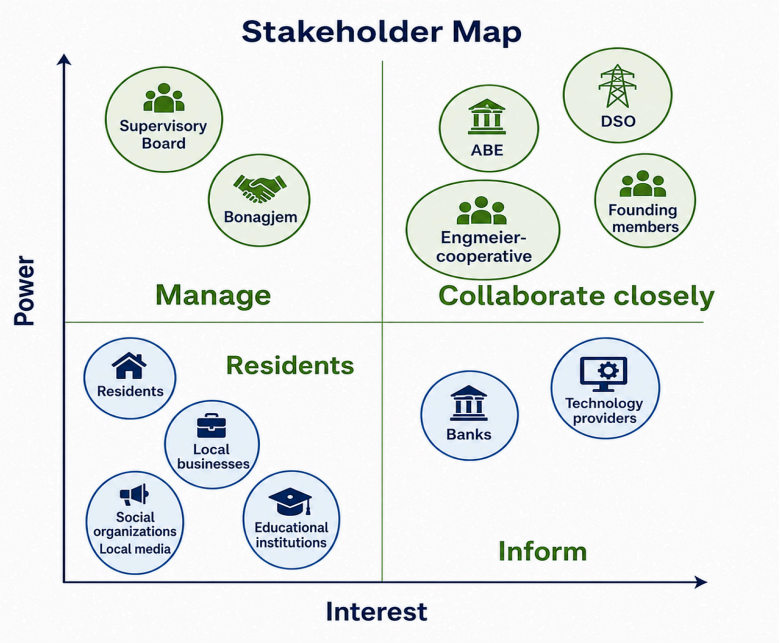


Figure 7 Stakeholder map

ENGAGEMENT STRATEGY (LABIN WORKSHOP)

Objective:

- Develop a coherent stakeholder engagement plan based on the 5W+1H methodology.

Scope of work:

- • defining engagement objectives,
- • selecting communication tools and forms,
- • tailoring methods to specific stakeholder groups,
- • planning a timeline of activities.

Main elements of the strategy:

WHO (who we engage):

- Local government units, businesses, public institutions,
- experts and project partners,
- ultimately residents and households.

WHY (why):

- increasing social acceptance,
- improving the fit of the REC model to user needs,

- identifying barriers and risks,
- building long-term commitment.

HOW (how):

- workshops and working meetings,
- coaching sessions,
- individual consultations,
- information activities (in subsequent stages).

UPDATES AND CHANGES AFTER THE WORKSHOP

During the pilot project, several significant modifications were made to the initial assumptions:

1. Strengthening the institutional approach:

- greater emphasis on collaboration with local government units and businesses,
- focusing on key stakeholders with the greatest influence.

2. Limited community engagement (at this stage):

- activities with residents were postponed until a later stage,
- this was due to:
- the lack of a ready-made operational model,
- the need to organize data and the REC structure.

3. Adapting the strategy to data limitations:

- greater emphasis on analytical and expert activities,
- use of the REC Manager tool to support the decision-making process.

Preparatory activities in the area of stakeholder engagement for the REC allowed for:

- identification of key actors and their roles in the project,
- development of a coherent engagement strategy,
- adaptation of the approach to actual local and organizational conditions.

A key conclusion is the need to gradually expand engagement, from the institutional model (current stage) to the social model (subsequent phases of REC development).

4. METHODOLOGY

The pilot action follows the methodology below:

a) A transborder coaching session will be organised involving PP2, PP3, PP4, PP5, PP7, and PP8, to assess three Renewable Energy Communities (RECs) – one each from Poland, Hungary, and Germany – and to determine how to enhance their sustainability and energy performance, complemented by a risk management plan aligned with the defined objectives.

b) In the pilot action reports, PP02 and PP08 will assess the energy performance and the business models of the RECs, while

c) PP07 will assess the change of business plan for REC linked to heating districts and moving from bioenergy to heat pump.

d) Involved partners will convene to jointly discuss the outcomes of the testing activities.

e) The findings will then be presented to each REC, followed by the development of tailored implementation plans.

f) These proposed implementation plans for the two RECs will be jointly validated by the partners and accompanied by a lessons learnt document.

The pilot methodology was developed based on the HERCULES-CE project WP2 assumptions and the guidelines included in Report Template D.2.1.1. A step-by-step approach was adopted, combining quantitative data analysis with qualitative assessment and participatory elements. The process included six key stages, described below.

4.1. Coaching sessions with project partners

The first step consisted of cross-border coaching sessions involving the project partners:

Session I. *Transborder Coaching Activity:* "Introduction to the tool and discussion of the functionalities and configuration of the models," 20 November 2025.

Session II. *Transborder Coaching Activity:* "Business models and cases from successful RECs in Burgenland and Austria," 7 November 2025.

Session III. *Transborder Coaching Activity:* "Business models and cases from successful RECs in Burgenland and Austria," 18 November 2025.

Session IV. *Transborder Coaching Activity:* "REC-Manager x OPTIVICE.energy," 11 December 2025.

Session V. *Transborder Coaching Activity:* "LOOKING FOR ENERGY – The pathway to Verona's first community-driven Renewable Energy Community," 15 January 2026.

Session VI. *Transborder Coaching Activity:* "Assessment of business models and energy performance of RECs," 27 January 2026.

Session VII. *Transborder Coaching Activity:* "Business Models and Energy Efficiency Solutions for District Heating and Renewable Integration," 26 February 2026.

Session goals**:**

- Agreeing on a common methodological approach,
- Defining the scope of data required for analysis,
- Determining how to use the REC Manager tool,
- Identifying business model and energy efficiency assessment indicators.

During meetings:

- The structure of the pilot report was clarified,
- The classification of barriers (regulatory, financial, technical, social) was discussed,
- The method for presenting the results in the form of an implementation plan was established.

The sessions were of a workshop nature and enabled the exchange of experiences between project partners, which increased the coherence of the analytical approach.

4.2. Collecting operational and financial data

The second stage in LV was the preparation and distribution of a data sheet necessary to be entered into the digital tool.

The sheet included, among others:

- technical data (installed renewable energy capacity, energy consumption profile),
- financial data (operating and investment costs, revenues),
- organizational data (membership structure, management model),
- strategic data (development goals, planned investments).

The sheet was forwarded to the cluster coordinator for further distribution to members of the Tomaszowski Energy Cluster and the Roztocze Energy Cooperative (REC "RSE").

Limitations:

- lack of complete financial data,
- lack of detailed consumption profiles (15-minute intervals),
- data partially outdated or in different formats,
- uneven level of information detail. The identified data gaps became a key element of further needs analysis.

4.3. Entering data into the rec manager tool

The collected information was entered into the REC Manager tool (Hercules digital tool) for:

- assessment of the business model,
- preliminary analysis of the energy balance,
- generation of comparative reports,
- data visualization.

The tool assessed three entities participating in the REC structure:

- TermoSystemy Sp. z o.o. Energy Company
- Narol City and Municipality Office
- Bełżec Municipality Office

While working with the tool, it was assessed:

- data integration functionality,
- report clarity,
- project progress tracking,
- real-time visualization usability.

At the same time, the need was indicated:

- Improved processing speed for larger data sets,

- Better metadata standardization,
- Improved data export for offline analysis.

4.4. Simulation of simple models

Due to the lack of detailed operational data (in particular, the lack of custom profiles), simulations were performed based on the reference models available in REC Manager.

Built-in profiles used:

- Small Shop REC Energy (6/7 days),
- Italian Family for HD.

The simulations allowed:

- estimate the potential level of self-consumption,
- analyse the impact of renewable energy capacity on the local energy balance,
- assess the model's sensitivity to changes in energy consumption.

The inability to run advanced models was due to:

- insufficient quality of input data,
- lack of detailed financial and operational parameters.

However, the use of simplified models made it possible to obtain approximate results and identify key factors influencing the profitability of the community.

4.5. Analysis of gaps and needs

Based on the simulation results and data evaluation, a gap analysis was carried out, including:

1. Data gaps:
    - lack of current cost data,
    - lack of detailed operational KPIs,
    - lack of full document and version history,
    - lack of environmental indicators.
2. Technical gaps:

- lack of a central data collection system,
- lack of a uniform measurement standard,
- lack of an EMS system.

3. Organizational gaps:
   - lack of a formal project office,
   - lack of data ownership assignment,
   - insufficient documentation standardization.
4. Communication gaps:
   - lack of simplified information materials,
   - lack of a broad campaign aimed at residents.

Gap analysis allowed us to translate diagnostic conclusions into specific implementation actions.

4.6. Development of an action plan and a risk management plan

The final stage was the development:

- Implementation Plan,
- Risk Management Plan.

The action plan was divided into:

- short-term activities (1–6 months),
- medium-term (6–12 months),
- long-term (12–24 months).

The risk management plan included five categories:

- regulatory risks,
- technical and network risks,
- financial risks,
- organizational risks,
- data and IT risks.

For each risk specified:

- possible consequences,
- level of impact,
- preventive measures,
- monitoring mechanisms.



Figure 8 Development of an Action Plan and a Risk Management Plan

METHODOLOGY SUMMARY

The methodology used combined:

- quantitative analysis (data from REC Manager),
- qualitative analysis (organizational and financial assessment),
- participatory approach (coaching sessions),
- scenario analysis,
- risk analysis.

Despite the data limitations, the adopted methodology made it possible:

- conducting a thorough diagnosis of the current state,
- identifying key barriers to development,
- developing a realistic implementation plan,
- creating a foundation for further scaling the REC model in the region.

5. INTRODUCTION OF THE REC

5.1. Basic information

REC is developed based on cooperation between:

- Tomaszowski Energy Cluster
- Roztocze Energy Cooperative (REC "RSE")

This model combines the formula of an energy cluster (a platform for strategic and investment cooperation) with the form of an energy cooperative (an operational and settlement structure enabling local energy balancing).

ENTITIES COVERED BY THE PILOT ANALYSIS

As part of the pilot, three key entities were assessed:

- TermoSystemy Sp. z o.o. – an energy company acting as a technical and operational entity,
- Narol City and Municipality Office – a local government unit,
- Bełżec Municipality Office – a local government unit.

These entities constitute the institutional core of the community and are responsible for generating both demand (energy consumption in public buildings) and potential supply of energy from renewable energy installations.

REC STRATEGIC GOALS

The community development strategy is based on five main goals:

1. **Reducing energy costs** – reducing local government and business energy purchase costs by increasing the share of local energy and stabilizing prices within internal settlements.

2. **Increasing local self-consumption** – maximizing the use of energy generated locally by community members instead of selling surpluses to the grid at market prices.
3. **Improving energy security** – reducing the sensitivity of local government and businesses to energy price fluctuations and the wholesale market.
4. **Reducing CO_2 emissions** – increasing the share of renewable energy in the local energy mix and reducing the carbon footprint of public entities.
5. **Increasing local government independence from the wholesale market** – developing a local balancing model and gradually reducing exposure to external energy prices.

MEMBERSHIP STRUCTURE

The current and potential membership structure of the REC is as follows:

- Local government units – approx. 30%
- Enterprises – approx. 40%
- Public entities (e.g., schools, organizational units) – approx. 20%
- Potentially, households – approx. 10%

This structure indicates a dominant role for the public sector and businesses in the initial phase of development, with the possibility of extending it to residents in subsequent stages.

5.2. Technical profile

TECHNOLOGIES

Current and planned infrastructure includes:

- Photovoltaic (PV) installations – operational and planned for expansion,
- Lack of energy storage (recommended as an element increasing self-consumption),
- Lack of full smart metering infrastructure.

Technical development is at a transitional stage – there is production potential, but there are no tools to optimize balancing.

BUSINESS MODEL

REC will operate in the model:

- connected to the Distribution System Operator (DSO) grid,
- with planned local balancing,
- with the possibility of selling surplus energy to the grid.

This model means that the community is not an island system, but operates within the national electricity grid, which allows for flexible management of surpluses, but at the same time exposes it to connection constraints.

KEY TECHNICAL CHALLENGES

1. Lack of detailed energy consumption profiles (15-minute),
2. Lack of an integrated Energy Management System (EMS),
3. Local grid connection limitations,
4. Lack of a uniform standard for collecting measurement data.

These challenges limit the ability to optimize system performance and utilize the full potential of digital tools.

5.3. Financial performance

CURRENT FINANCIAL SITUATION

During the pilot phase, significant gaps in financial data were identified:

- lack of complete cost data (operational and investment),
- lack of up-to-date financial KPIs,
- incomplete and partially inconsistent data in the system.

This means that the current profitability assessment is preliminary and requires further data supplementation.

SOURCES OF REVENUE

Potential and existing revenue sources include:

- energy sales to the grid,
- internal settlements within the community,
- membership fees,

- potential grants and support programs (e.g., European Funds for Infrastructure, Climate, Environment, local government funds, National Fund for Environmental Protection and Water Management),
- members' own funds. The financial model is based on the assumption of increasing the share of own energy in the balance and diversifying investment financing.

FINANCIAL AND SYSTEMIC BARRIERS

- data heterogeneity,
- lack of full system integration,
- inability to export full data sets for offline analysis,
- lack of standardized financial reporting.

These barriers make it difficult to clearly assess economic efficiency and plan for the long term.

5.4. Engagement methodology

ACTIVITIES TO DATE

The current engagement model is based mainly on:

- formal communication between members,
- institutional meetings,
- exchange of documents and information within organizational structures.

However, there was no broad information campaign aimed at residents, nor was a coherent communication package developed to explain the differences between the cluster and the energy cooperative.

IDENTIFIED NEEDS

In order to increase social acceptance and participation it is recommended:

- organizing information workshops for municipal councils,
- open consultations with residents,
- preparing simplified visual materials,

- developing a unified communication package ("cluster vs. cooperative – who, where, why").

Expanding the participatory model will be crucial for scaling the community and including households in subsequent stages of development.

The analysed REC is at the development stage – it has a solid institutional foundation and technical potential, but it requires:

- supplementing operational and financial data,
- implementing measurement infrastructure and an EMS system,
- clarifying the financial model,
- strengthening public communication.

A structure based on cooperation between local government units and enterprises provides a stable foundation for further development and scaling of the energy community model in the region.

STAKEHOLDER MAP AND PROCEDURE OPTIONS

The development of REC, based on cooperation with the Tomaszowski Energy Cluster, requires a differentiated approach to individual stakeholder groups. Below is a stakeholder map with recommended action strategies based on their level of involvement, influence, and investment readiness.

Stakeholder map (functional division)

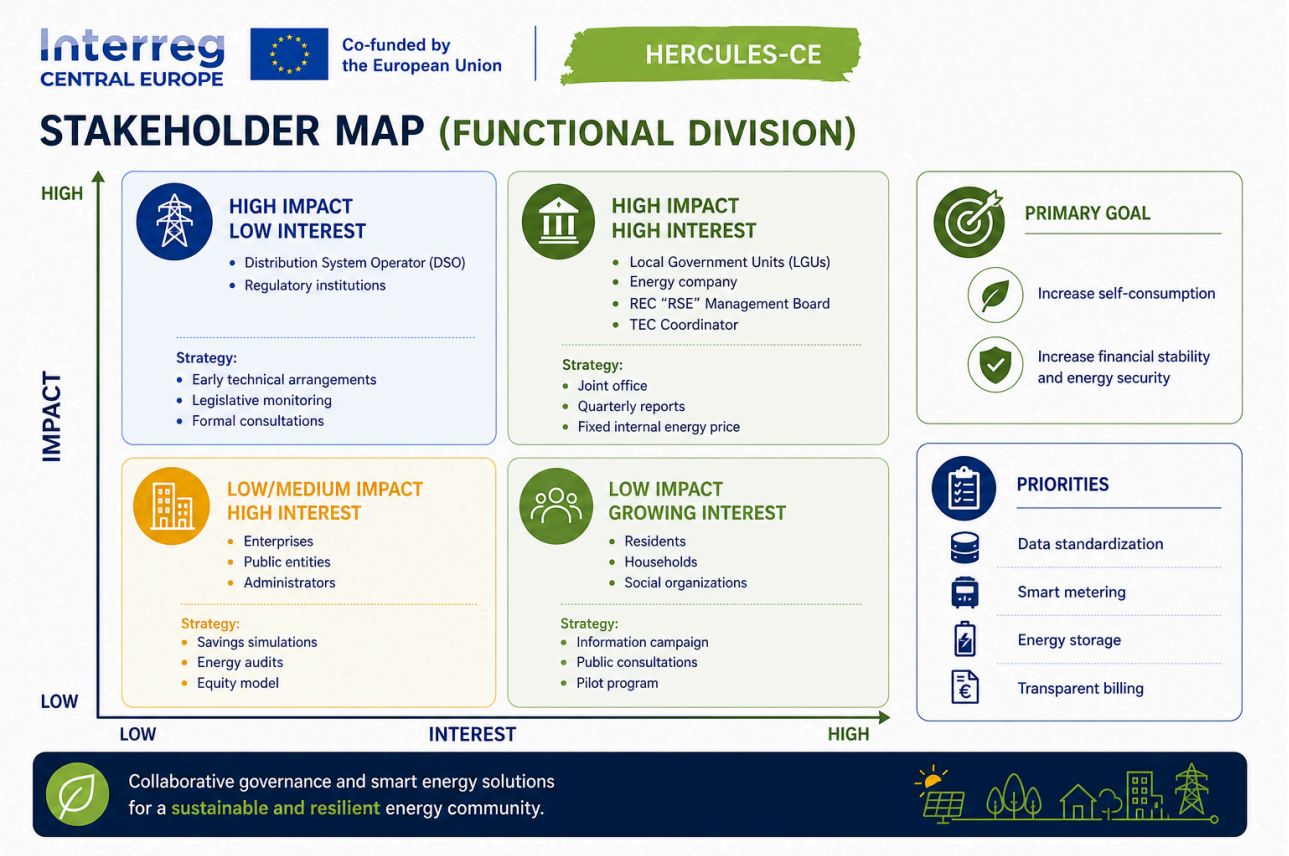


Figure 9 Stakeholder Map (functional division)

STRATEGIC STAKEHOLDERS (HIGH INFLUENCE / HIGH IMPORTANCE)

- Local Government Units (e.g., Narol City and Commune Office, Bełżec Commune Office)
- Energy Company – TermoSystemy Sp. z o.o.
- REC "RSE" Management Board
- TEC Coordinator

Role: decision-making, investment, organizational

Impact: very high

Responsibility: strategic direction, investments, contracts

Recommended actions:

Strategic management:

- Establishment of the REC "RSE" office

- Quarterly reviews of energy and financial results
- Agreeing on a unified investment strategy

Stabilization of the financial model:

- Establishing benefit-sharing principles
- Internal energy price model
- Investment reserve (10–15%)

Risk management:

- Legislative monitoring
- Analysis of pricing scenarios (min/mid/max)
- Early consultations with DSOs

OPERATIONAL STAKEHOLDERS (MEDIUM IMPACT / HIGH IMPORTANCE)

- Local government units, schools, health centres, etc.
- Local businesses
- Building administrators

Role: Energy consumption generators, potential investors

Impact: medium

Responsibility: Data provision, participation in balancing

Recommended actions:

Strategic management:

Data standardization:

- Implementation of a uniform reporting sheet
- Mandatory 15-minute data (ultimately)

Economic motivation:

- Savings simulations for each entity
- Individual balancing analyses
- Entry options (equity/investment/passive)

Consumption optimization:

- Energy audits

- Load scheduling
- Analysis of energy storage capabilities

SOCIAL STAKEHOLDERS (LOW–MEDIUM IMPORTANCE AT THE START / GROWING IMPORTANCE OVER TIME)

- Residents
- Households
- Social Organizations

Role: Future Members, Social Acceptance

Impact: Growing

Responsibility: Participation, Local Support

Recommended Activities:

STAGE 1 – Information

- Campaign "What Does REC Offer to Residents?"
- Simple infographics: Production – Consumption – Savings
- Open Consultations

STAGE 2 – Social Pilot

- Program for the First 20–30 Households
- Preferential Tariff Model

STAGE 3 – Scaling

- Participatory Model
- Support for Households at Risk of Energy Poverty



Figure 10 Social stakeholders

EXTERNAL STAKEHOLDERS (REGULATORY AND INFRASTRUCTURAL)

- Distribution System Operator (DSO)
- Financing Institutions
- Control and Regulatory Institutions

Role: Connection Conditions, Financing, Legal Compliance

Impact: high

Responsibility: System Decisions

Distribution System Operator (DSO)

Actions**:**

- Early Technical Arrangements
- GPZ Capacity Analysis
- Phased Investment Plan

- Consideration of Energy Storage as a Grid Relief Tool

Financing Institutions

Actions with Available Grants:

- Completed Project Documentation
- ROI Scenario with and without Grants

Actions Without Support:

- Hybrid Model (LGU Contribution + Preferential Loan)
- Investor Membership

Table 3 Stakeholders matrix – risk - action

Stakeholder	Major Risk	Remedial Action
Local Government Units	Budget constraints / lack of acceptance	Phased model, ESCO, workshops for councillors
Enterprises	Lack of investment readiness	Low entry threshold, ROI simulations
Residents	Low awareness and trust	Educational campaign, consultations
Distribution System Operator	Connection constraints	Power phasing, energy storage
Financing institutions	Lack of subsidies	Hybrid model, financing diversification

COMMUNICATION STRATEGY: WHO – HOW – WHEN - TOOL



Figure 11 Communication strategy: WHO - HOW - WHEN - TOOL

SCENARIOS OF PROCEEDINGS IN CONFLICT SITUATIONS

CONFLICT BETWEEN LOCAL AUTHORITIES AND ENTERPRISES (DIVISION OF BENEFITS)

Solution:

- Transparent settlement algorithm
- Individual simulations
- "Fixed internal price" vs. "Profit share" variant

LOW SOCIAL ACCEPTANCE

Solution:

- Pre-investment information campaign

- Demonstration PV installations
- Publicly published quarterly report

CONNECTION RESTRICTIONS

Solution:

- Power staging
- Energy storage
- Peak response management (DSR)

RECOMMENDED MODEL FOR REC

The most optimal option for the current structure:

PHASE 1 – CORE STABILIZATION

Local government units + energy company as the foundation.

PHASE 2 – BUSINESS EXPANSION

Inclusion of energy-intensive businesses.

PHASE 3 – SOCIAL INTEGRATION

Gradual opening to residents.

6. ASSESSMENT OF THE REC

6.1. Business model assessment

The assessment of the business model was carried out based on the data entered into the REC Manager tool (HERCULES digital tool) and on simulations performed using a simplified model, due to the lack of complete operational data required to apply advanced models (absence of 15-minute consumption profiles and incomplete cost data).

The analysis covered the entities participating in the pilot within the framework of the following structure:

- Tomaszowski Energy Cluster
- Roztocze Energy Cooperative (REC „RSE")

COST STRUCTURE

At this stage, the business model includes the following cost categories:

Investment costs (CAPEX):

- PV installations (existing and planned),
- potential energy storage systems (recommended),
- metering systems and IT infrastructure (smart metering, EMS),
- project development and grid connection costs.

Operating costs (OPEX):

- maintenance of installations,
- administrative operation of the cooperative,
- distribution fees,
- energy balancing costs.

Due to the incompleteness of financial data, the full cost analysis is indicative and requires completion at the implementation stage.

REVENUE STRUCTURE

REC's revenue model is based on:

- internal energy settlements between members,
- sale of surplus energy to the grid,
- membership fees,
- potential public support (European Funds for Infrastructure, Climate, Environment, National Fund for Environmental Protection and Water Management, local government funds),
- possible preferential instruments (loans, grants).

A key element in increasing profitability is maximizing self-consumption, because energy consumed locally generates higher economic value than energy sold to the grid.

KEY FINDINGS FROM THE SIMULATION

POTENTIAL TO IMPROVE ROI WITH INCREASED SELF-CONSUMPTION

Simulations using the simplified model indicate that:

- increasing self-consumption by approximately 15–20% can significantly shorten the investment payback period,
- the use of energy storage systems or load shifting improves the local energy balance,
- optimizing energy consumption hours by local government units (LGUs) and enterprises enhances financial efficiency.

Conclusion: The business model should focus not only on increasing RES capacity, but primarily on optimizing energy consumption within the community.

SENSITIVITY OF THE MODEL TO ENERGY PRICES

The model shows high sensitivity to:

- the level of wholesale energy prices,
- the level of distribution tariffs,
- regulatory changes concerning the settlement mechanisms of energy cooperatives.

Under high energy price conditions:

- ROI shortens,
- the profitability of local production increases.

In the event of falling energy prices:

- the model requires greater operational efficiency,
- reducing fixed costs becomes critical.

Conclusion: It is recommended to apply scenario analysis (pessimistic / realistic / optimistic) in investment planning.

NEED TO STAGE INVESTMENT

Simulations indicate that:

- one-time deployment of full RES capacity increases financial risk,

- the lack of metering data makes precise scaling of installations difficult,
- grid connection constraints may force capacity reductions.

Recommended approach:

Stage 1 – Core stabilization

- implementation of smart metering,
- analysis of actual consumption profiles,
- optimization of existing installations.

Stage 2 – Expansion of RES capacity

- increasing PV capacity in line with real demand,
- possible deployment of energy storage systems.

Stage 3 – Model scaling

- inclusion of new members,
- expansion of local balancing mechanisms.

Conclusion: A phased approach reduces financial risk, improves investment precision, and increases social acceptance.

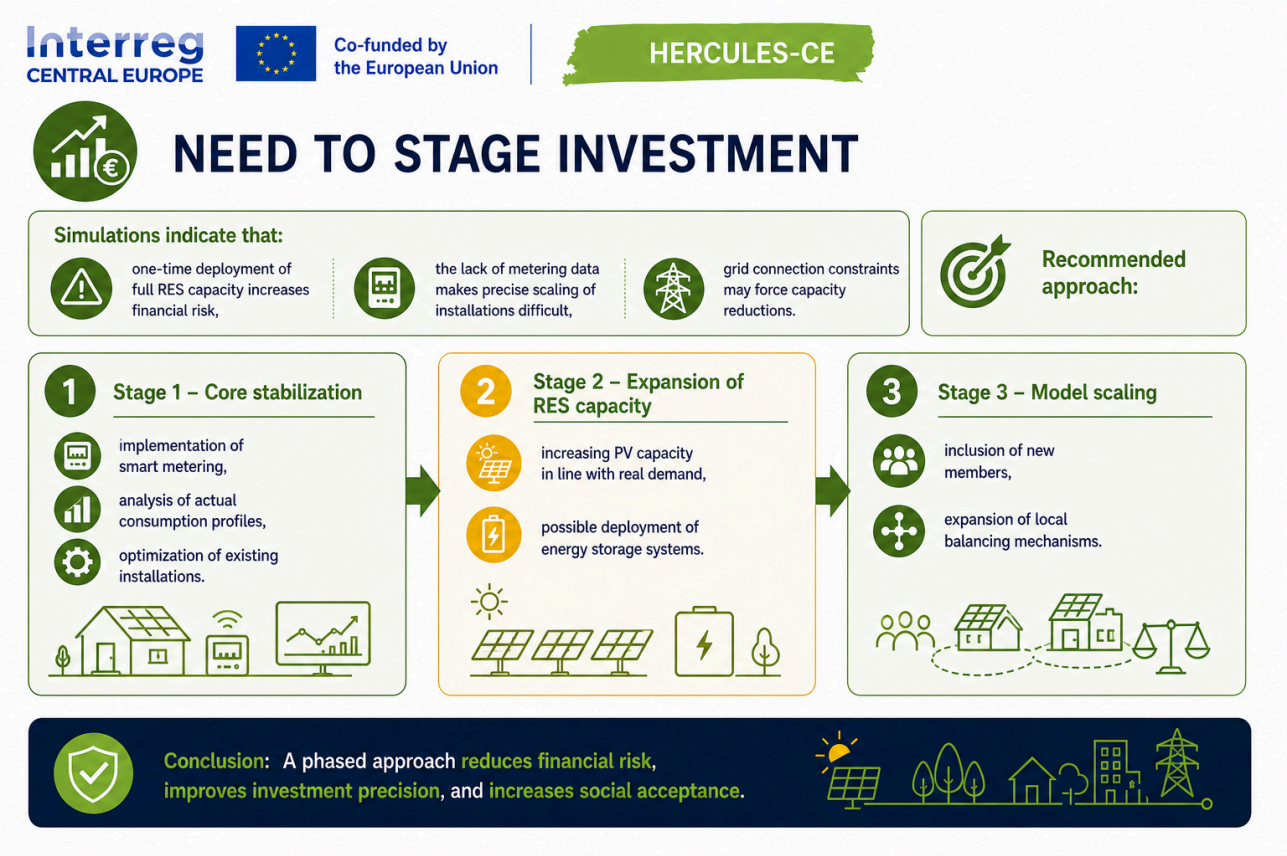


Figure 12 Need to stage investment

STRENGTHS OF THE MODEL

- Strong institutional core (LGUs + energy company),
- Stable energy consumption profile in the public sector,
- Potential for the development of local RES generation,
- Possibility of integration with the digital tool (REC Manager).

WEAKNESSES OF THE MODEL

- Lack of complete operational and financial data,
- Absence of energy storage infrastructure,
- Grid constraints,
- Lack of a unified EMS system.

RECOMMENDATIONS FOR THE BUSINESS MODEL

1. Implementation of a smart metering system.
2. Preparation of a detailed financial model with scenario analysis.
3. Introduction of an internal energy price stabilization mechanism.
4. Gradual expansion of RES capacity aligned with actual demand.
5. Diversification of financing sources (grants + own contribution + preferential instruments).

The REC business model has the potential for stable development; however, its profitability largely depends on:

- the level of self-consumption,
- the structure of operational costs,
- energy price volatility,
- the quality of operational data.

For the years 2026–2027, the priority should be transitioning from a simulation-based model to a model grounded in real metering data, enabling full financial analysis and the safe and predictable scaling of the energy community.

6.2 Energy performance assessment

LACK OF COMPLETE MEASUREMENT DATA – IMPLICATIONS FOR THE ENERGY AND FINANCIAL MODEL

One of the key limitations of the pilot was the lack of complete, high-resolution metering data (15-minute energy consumption profiles). The data currently available is aggregated (monthly or annual), which:

- limits the ability to precisely balance energy in real time,
- makes it difficult to analyse peak demand (peak load),
- prevents accurate modelling of energy flows within the community,
- reduces the precision of financial forecasts (ROI, cash flow),
- restricts the implementation of advanced models in the REC Manager.

The absence of detailed data directly increases investment uncertainty — particularly regarding the sizing of PV installations and energy storage systems. As a result, investment decisions must be based on simplified models and scenario-based approaches.

CONCLUSIONS FROM THE SIMULATION (SIMPLE MODEL)

Despite data limitations, the simulations carried out made it possible to identify key directions for system optimization.

INCREASE IN SELF-CONSUMPTION POSSIBLE THROUGH ENERGY STORAGE

The simulations indicate that the current model (without storage) generates energy surpluses during periods of high PV production, which are fed into the grid at prices less favourable than the value of energy consumed locally.

The deployment of energy storage systems enables:

- shifting energy use from peak production hours to afternoon and evening hours,
- increasing the level of self-consumption by an estimated 15–25%,
- reducing dependence on wholesale market energy prices,
- stabilizing energy costs for local government units (LGUs) and enterprises.

Economic effect:

- increased value of energy utilized locally,
- shorter investment payback period (ROI),
- improved stability of the financial model under volatile energy price conditions.

System effect:

- reduced burden on the distribution grid,
- lower risk of local grid congestion.

LOAD OPTIMIZATION REDUCES PEAK DEMAND

The analysis shows that even without investing in energy storage, partial efficiency gains are possible through energy consumption profile management (load management).

Actions include:

- scheduling the operation of energy-intensive equipment,
- shifting energy use to periods of high PV generation,
- implementing automated control systems (DSR – Demand Side Response),
- optimizing the operation of pumps, heating, and cooling systems.

Technical effects:

- reduction of peak demand by 10–20%,
- lower load on grid infrastructure,
- reduction of capacity-related charges.

Financial effects:

- lower distribution costs,
- reduced risk of exceeding contracted capacity,
- improved efficiency of RES investments.

Conclusion: Load optimization should be the first stage before expanding generation capacity.

EMISSION REDUCTION PROPORTIONAL TO THE INCREASE IN RES SHARE

Increasing the share of renewable energy in the community's energy balance directly translates into CO_2 emission reductions.

The mechanism is straightforward:

- each unit of energy generated locally from PV replaces energy from the national energy mix,
- the higher the level of self-consumption, the greater the actual emission reduction.

Simulations indicate that:

- a 20% increase in the RES share in the energy balance may result in a proportional reduction in CO_2 emissions,
- the use of energy storage systems enhances climate effectiveness by reducing the need to draw electricity from the grid during peak hours.

Environmental effects:

- reduction of the carbon footprint of local government units (LGUs),
- improvement of ESG indicators,
- strengthened position when applying for EU funding.

Strategic effects:

- support for the achievement of EU climate objectives,
- increased regional resilience in the energy transition,
- building the region's image as a leader in energy transition.

Although the lack of complete metering data limits modelling precision, even simplified simulations clearly indicate that:

1. The greatest efficiency improvement potential lies in increasing self-consumption.
2. Energy storage and demand management are more impactful than simply expanding PV capacity.
3. Financial and environmental effects are strongly interconnected.

A key step for 2026–2027 should be the implementation of a smart metering system (15-minute intervals) and a centralized EMS, enabling the transition from an estimation-based model to one grounded in real operational data.

6.3 Needs assessment (based on the HERCULES-CE Strategy)

REGULATORY AND LEGAL RISKS

- **Changes in regulations** (RES, clusters, energy cooperatives)

  → *Mitigation:* continuous legislative monitoring, cooperation with a specialized law firm, and updating the REC "RSE" statute and cluster agreement at least once a year.

- **Misalignment of the pilot model with the 70% / 40% demand coverage requirements (cooperative model)**

  → *Mitigation:* conservative RES capacity planning, phased investments, "min / mid / max capacity" scenarios, and ongoing adjustments based on real consumption profiles.

- **Relations with the DSO** (connection conditions, node-based settlements)

  → *Mitigation:* early involvement of the DSO in the project, working groups on grid matters, and agreed procedures for metering data exchange.

TECHNICAL AND GRID RISKS

- **Limited connection capacity and local grid congestion**

  → *Mitigation*:

  - analysis of primary substation (GPZ) / 15 kV line capacity at the planning stage,
  - prioritizing RES locations where the grid is strongest,
  - consideration of energy storage and power control solutions (DSR / peak reduction).

- **Insufficient quality of metering data for energy balance optimization**

  → *Mitigation*: introduction of a minimum metering standard:

  - remote-read meters,
  - 15-minute interval data,
  - centralized data collection system for the cluster/cooperative.

- **Risk of delays or underperformance in RES investments** (procedures, contractors)

  → *Mitigation*: portfolio-based backup plan – surplus candidate RES locations, time buffers in the schedule, prequalification of contractors.

FINANCIAL AND INVESTMENT RISKS

- **Underestimation of RES and storage investment costs**

  → *Mitigation:*

  - scenario-based financial analyses (pessimistic, realistic, optimistic),
  - budget contingency reserve (e.g., 10–15%),
  - diversification of financing sources (grants, preferential loans, LGU funds, member contributions).

- **Wholesale energy price volatility**

  → *Mitigation:*

  - benchmarking pilot results against multiple reference price scenario,
  - use of long-term internal agreements within the community (relatively stable internal price),
  - gradual increase of own energy share and reduced exposure to the market.

- **Risk of insolvency of certain members (companies, LGUs)**

  → *Mitigation*: membership rules with safeguards (e.g., equity contribution, investment share, internal debt limits), defined exit procedures from the cooperative/cluster.

ORGANIZATIONAL AND SOCIAL RISKS

- **Lack of understanding of the difference between a cluster and a cooperative among decision-makers and residents**

  → *Mitigation*: simple communication package:

  - cluster vs cooperative,
  - information workshops for municipal councils, entrepreneurs, and residents.

- **Diverging expectations regarding benefit distribution**

  → *Mitigation:*

  - transparent settlement model (e.g., energy discount rules, surplus distribution),
  - pre-entry benefit simulations for each type of member,
  - clear financial regulations for the cooperative and a "code of cooperation" within the cluster.

- **Limited human resources for project management (coordinator, REC "RSE" board, LGUs)**

  → *Mitigation:*

  - establishment of a joint TEC+ REC "RSE" project office,
  - outsourcing selected tasks (analytics, legal services, IT) to specialized entities,
  - process standardization (contract templates, procedures for onboarding new members).

IT AND DATA-RELATED RISKS

- **Lack of a coherent IT system for energy management (EMS / VPP)**

  → *Mitigation*: in the pilot phase, implement a simple, scalable system for:

  - collecting meter data,
  - visualizing production and consumption,
  - reporting to members and institutions.

- **Data security risks (metering and settlement data)**

  → *Mitigation:* selection of solutions compliant with GDPR and CSIRT recommendations, access control mechanisms, and operation logging.

7. IMPLEMENTATION PLAN

7.1. Measures to Strengthen the Business Model and Sustainability

REGULATORY AND LEGAL CHALLENGES

Step 1:

- Continuous monitoring of amendments to the RES Act and regulations concerning energy cooperatives,
- Annual update of the REC "RSE" statute and cluster agreement,
- Consultations with a law firm specializing in energy law,
- Analysis of the impact of distribution tariff changes on the REC financial model.

Estimated effect:

Increased legal certainty for REC operation and development, reduced regulatory risk, and greater stability of the operational model.

Estimated timeframe:

Medium term (6–18 months, ongoing activity).

FINANCIAL BARRIERS

Step 2:

- Development of scenario analysis (min/mid/max),
- Preparation of documentation for support programs (European Funds for Infrastructure, Climate, Environment, National Fund for Environmental Protection and Water Management),
- Establishment of an internal investment fund for REC members,
- Introduction of a budget contingency reserve (10–15%) for new investments.

Estimated effect:

Improved access to capital, enhanced ROI, reduced investment risk, and greater resilience to energy price fluctuations.

Estimated timeframe:

Short term (3–6 months)

TECHNICAL AND ORGANIZATIONAL CHALLENGES

Step 3:

- Implementation of smart metering (15-minute interval),
- Launch of a centralized data collection system (EMS),
- Training of a local REC manager in energy management and data analysis,
- Standardization of data templates and reporting procedures.

Estimated effect:

Better control over the energy system, reduced operational errors, improved energy balancing, and higher member satisfaction.

Estimated timeframe:

Medium term (6–12 months)

GRID AND INFRASTRUCTURAL CONSTRAINTS

Step 4:

- Early cooperation with the Distribution System Operator (DSO),
- Analysis of primary substation (GPZ) and medium-voltage line capacity,
- Phased expansion of PV installations,
- Assessment and deployment of energy storage systems as a stabilizing element.

Estimated effect:

Improved energy balance, reduced risk of grid congestion, and the ability to scale the REC in the future.

Estimated timeframe:

Long term (12–24 months)

AWARENESS AND STAKEHOLDER ENGAGEMENT

Step 5:

- Launch of an information campaign for members and residents,
- Organization of workshops for municipal councils and entrepreneurs,
- Preparation of simplified visual materials (infographics, dashboard),
- Introduction of quarterly energy and financial performance reports.

Estimated effect:

Stronger community engagement, greater acceptance of investments, higher member retention, and increased operational transparency.

Estimated timeframe:

Short term (1–3 months for initiation; ongoing activities thereafter)

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ACTION PLAN – OVERCOMING KEY CHALLENGES

1 REGULATORY AND LEGAL CHALLENGES

STEP 1:

- Continuous monitoring of amendments to the RES Act and regulations concerning energy cooperatives,
- Annual update of the REC "RSE" statute and cluster agreement,
- Consultations with a law firm specializing in energy law,
- Analysis of the impact of distribution tariff changes on the REC financial model.

ESTIMATED EFFECT:
Increased legal certainty for REC operation and development, reduced regulatory risk, and greater stability of the operational model.

ESTIMATED TIMEFRAME:
Medium term (6–18 months, ongoing activity).

2 FINANCIAL BARRIERS

STEP 2:

- Development of scenario analysis (min/mid/max),
- Preparation of documentation for support programs (European Funds for Infrastructure, Climate, Environment, National Fund for Environmental Protection and Water Management),
- Establishment of an internal investment fund for REC members,
- Introduction of a budget contingency reserve (10–15%) for new investments.

ESTIMATED EFFECT:
Improved access to capital, enhanced ROI, reduced investment risk, and greater resilience to energy price fluctuations.

ESTIMATED TIMEFRAME:
Short term (3–6 months)

3 TECHNICAL AND ORGANIZATIONAL CHALLENGES

STEP 3:

- Implementation of smart metering (15-minute interval),
- Launch of a centralized data collection system (EMS),
- Training of a local REC manager in energy management and data analysis,
- Standardization of data templates and reporting procedures.

ESTIMATED EFFECT:
Better control over the energy system, reduced operational errors, improved energy balancing, and higher member satisfaction.

ESTIMATED TIMEFRAME:
Medium term (6–12 months)

4 GRID AND INFRASTRUCTURAL CONSTRAINTS

STEP 4:

- Early cooperation with the Distribution System Operator (DSO),
- Analysis of primary substation (GPZ) and medium-voltage line capacity,
- Phased expansion of PV installations,
- Assessment and deployment of energy storage systems as a stabilizing element.

ESTIMATED EFFECT:
Improved energy balance, reduced risk of grid congestion, and the ability to scale the REC in the future.

ESTIMATED TIMEFRAME:
Long term (12–24 months)

5 AWARENESS AND STAKEHOLDER ENGAGEMENT

STEP 5:

- Launch of an information campaign for members and residents,
- Organization of workshops for municipal councils and entrepreneurs,
- Preparation of simplified visual materials (infographics, dashboard),
- Introduction of quarterly energy and financial performance reports.

ESTIMATED EFFECT:
Stronger community engagement, greater acceptance of investments, higher member retention, and increased operational transparency.

ESTIMATED TIMEFRAME:
Short term (1–3 months for initiation; ongoing activities thereafter)

A structured approach – legal, financial, technical, infrastructural, and social – ensures a sustainable and resilient energy community.



Figure 13 Action Plan - overcoming key challenges

7.2. Measures to Improve Energy Performance

STEP 1: PHASED EXPANSION OF PHOTOVOLTAIC (PV) INSTALLATIONS

Scope:

- Adjustment of PV capacity to actual energy consumption,
- Prioritization of buildings owned by local government units (LGUs) and enterprises with stable consumption profiles,
- Integration of new capacity with the EMS system.

Estimated effect:

- Increased share of RES in the energy balance,
- Reduced electricity purchases from the wholesale market,
- CO_2 emission reduction.

Estimated timeframe:

Medium term (6–12 months)

KPI - **STEP 1**:

- Share of RES in the energy balance (%)
- Annual PV energy production (MWh)
- Reduction of electricity purchases from the grid (%)
- CO_2 emission reduction (t/year)
- Investment payback period (ROI, years)

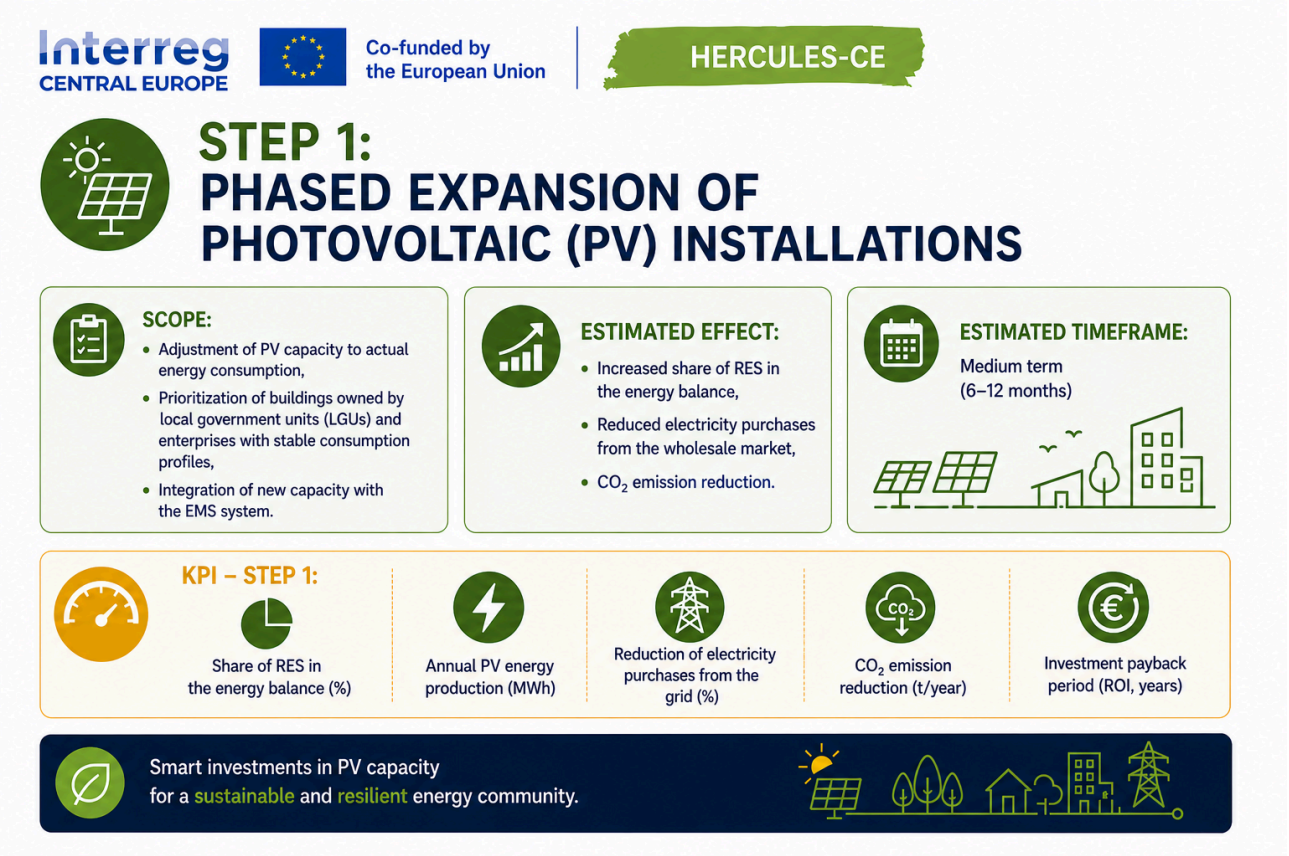


Figure 14 Step 1: Phased expansion of PV installations

STEP 2: ENERGY CONSUMPTION OPTIMIZATION (LOAD SHIFTING / DSR)

Scope:

- Analysis of 15-minute interval data,
- Shifting operation of equipment to PV production hours,
- Automated load control.

Estimated effect:

- 15–20% reduction in peak demand,
- Lower distribution costs,
- Improved local energy balancing.

Estimated timeframe:

Short term (3–6 months)

KPI - STEP 2:

- Peak load reduction (%)
- Distribution cost savings (PLN/year)
- Increase in self-consumption (%)
- Number of implemented DSR mechanisms
- Reduction in contracted capacity exceedances (number/year)

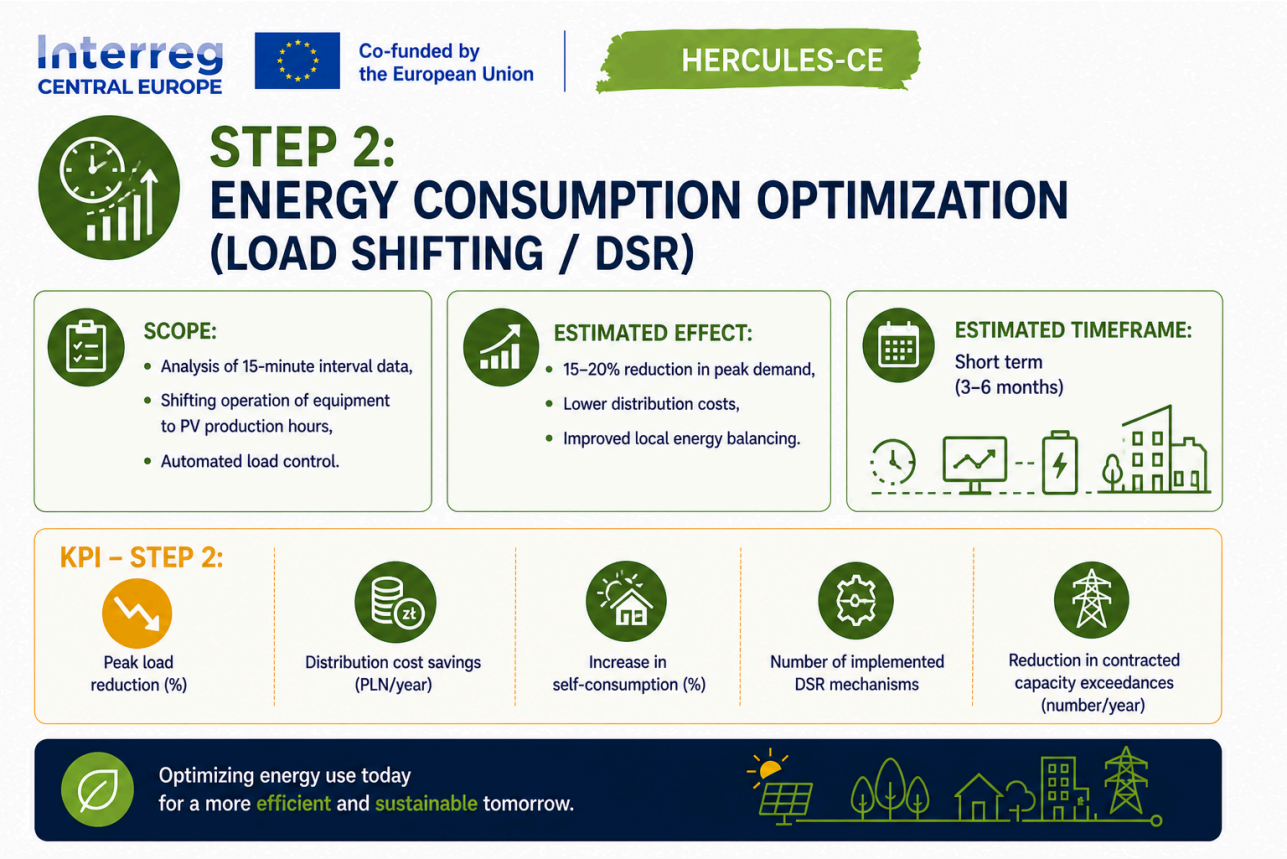


Figure 15 Step 2: Energy consumption optimization

STEP 3: THERMAL RETROFITTING OF LGU BUILDINGS

Scope:

- Energy audit,

- Modernization of building envelope and heating systems,
- Integration with the RES development plan.

Estimated effect:

- 20–25% reduction in heating energy consumption,
- Lower operating costs for LGUs,
- Long-term improvement in energy efficiency.

Estimated timeframe:

Long term (12–24 months)

KPI – STEP 3:

- Reduction in thermal energy consumption (%)
- Annual cost savings (PLN)
- CO_2 emission reduction (t/year)
- Improvement of building EP indicator (kWh/m^2/year)
- Investment payback period (years)

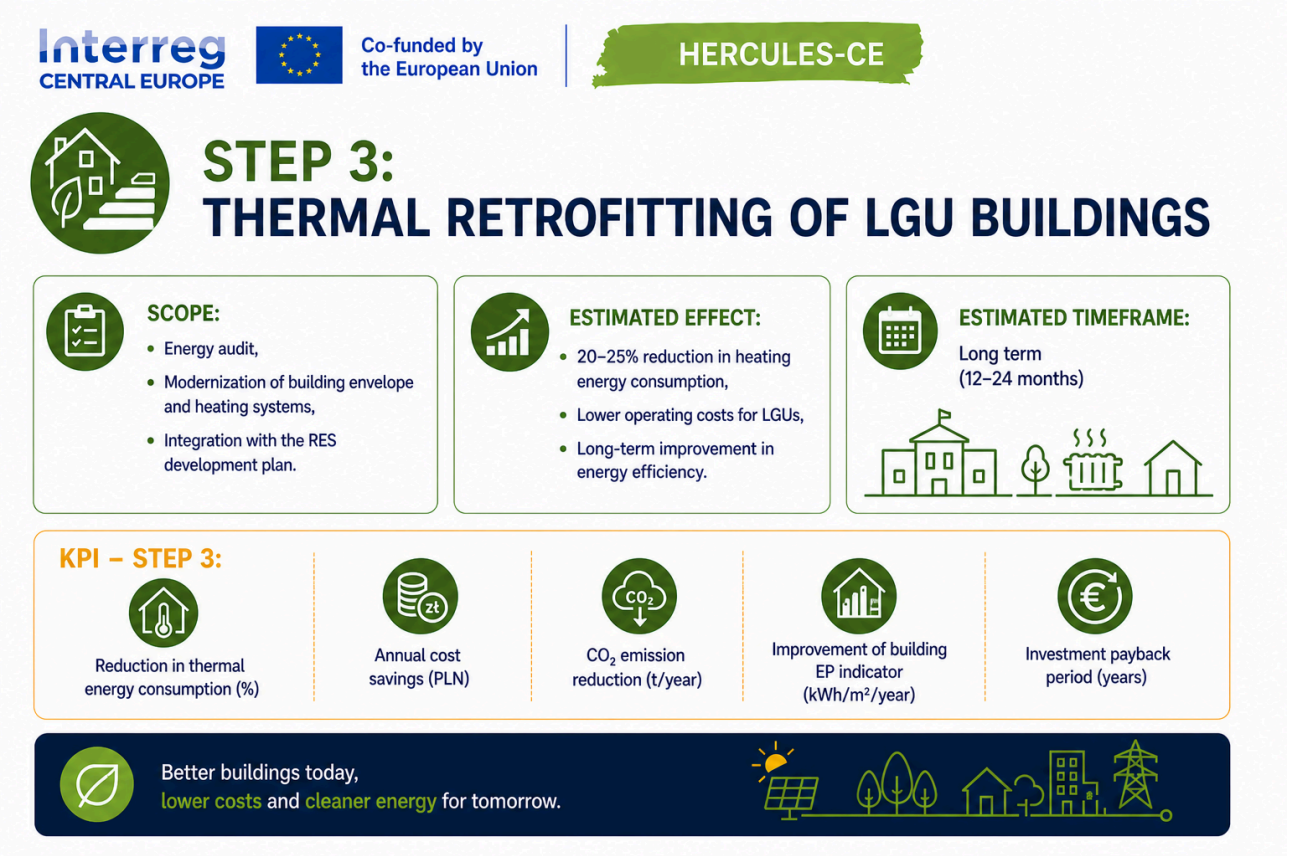


Figure 16 Step 3: Thermal retrofitting of LGU buildings

STEP 4: INSTALLATION OF ENERGY STORAGE SYSTEMS (BESS)

Scope:

- Analysis of required storage capacity,
- Integration with the EMS system,
- Optimization of charging and discharging based on production and consumption profiles.

Estimated effect:

- 15–25% increase in self-consumption,
- Reduced energy export to the grid,
- System stabilization and peak load reduction.

Estimated timeframe:

Medium–long term (9–12 months)

KPI – STEP 4:

- Increase in self-consumption (%)
- Storage capacity (kWh)
- Number of storage cycles (cycles/year)
- Reduction in energy export to the grid (%)
- Shortening of overall system ROI (years)
- Peak load reduction (%)

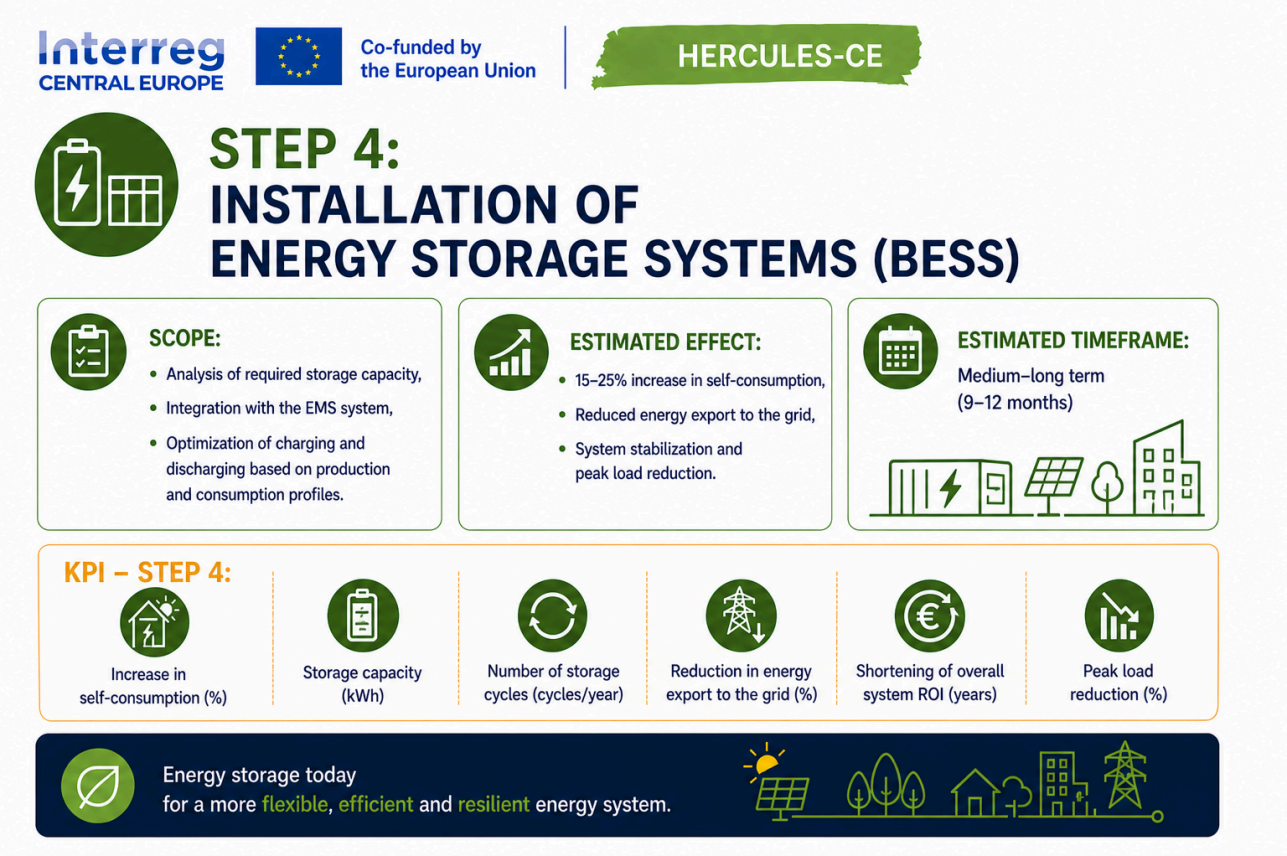


Figure 17 Step 4: Installation of energy storage systems (BESS)

SUMMARY OF MEASURABLE EFFECTS (2–3 YEAR HORIZON)

Potential cumulative effects of implementing the measures:

- Increase in self-consumption: +20–30%
- Peak demand reduction: 15–20%
- Increase in RES share: up to 80–85% of the energy balance
- CO_2 emission reduction: proportional to RES share (several hundred tons/year)
- Shortened ROI: by 1–3 years compared to the non-optimized scenario.

8. RISK MANAGEMENT PLAN

In this section, the focus is placed on technical and organizational-behavioural measures that can directly contribute to:

- increasing the energy efficiency of REC members,
- raising the level of self-consumption of locally generated energy,
- increasing the share of renewable energy in the community's energy balance,
- reducing dependence on electricity drawn from the grid.

The proposed measures are based on the results of simulations performed using the simplified REC Manager model. Although the lack of complete metering data limits modelling precision, the tool clearly indicates key directions for improving the energy balance.

STEP 1: PHASED EXPANSION OF PHOTOVOLTAIC (PV) INSTALLATIONS

Description of the measure:

Expansion of PV capacity on buildings owned by local government units (LGUs) and selected REC members, while aligning installed capacity with actual energy demand. Development should be linked to an analysis of consumption profiles and a local balancing plan.

Estimated effect:

- Increase in the share of renewable energy in the community's balance (e.g., from approx. 60% to 80–85% of energy covered locally),
- Reduction in electricity purchases from the wholesale market,
- CO_2 emission reduction proportional to the increase in RES share.

According to REC Manager simulations, increasing PV capacity while better aligning it with consumption profiles can improve the community's energy balance by several to several dozen percent, depending on the level of self-consumption.

Estimated timeframe for achieving effects:

Medium term (6–12 months from the start of the investment).

STEP 2: OPTIMIZATION OF ENERGY CONSUMPTION THROUGH AUTOMATION AND LOAD MANAGEMENT (LOAD SHIFTING)

Description of the measure:

Implementation of Demand Side Response (DSR) mechanisms, including:

- analysis of 15-minute interval consumption data (after smart metering deployment),
- shifting operation of energy-intensive equipment to periods of highest PV production,
- automated control of systems (pumps, ventilation, cooling, EV charging).

Estimated effect:

- Reduction of peak demand by approx. 15–20%,
- Lower capacity-related charges,
- Better utilization of locally generated energy,
- Reduced dependence on grid electricity during high-price periods.

Simulations indicate that load optimization can improve balancing efficiency even without additional investment in new RES capacity.

Estimated timeframe for achieving effects:

Short term (3–6 months after implementation of metering systems and management procedures).

STEP 3: BUILDING RETROFITTING AND IMPROVEMENT OF ENERGY EFFICIENCY

Description of the measure:

Implementation of modernization measures in buildings owned by LGUs and subordinate entities, including:

- energy audits,
- insulation of external building envelopes,
- window and door replacement,
- modernization of heating and ventilation systems.

These measures are long-term and structural in nature, leading to a permanent reduction in energy demand.

Estimated effect:

- Reduction in heating energy consumption by up to 20–25%,
- Lower operating costs for LGUs,
- Improved efficiency in the use of locally generated energy,
- Long-term CO_2 emission reduction.

Over the long term, improved building efficiency enhances the financial stability of the REC and strengthens its ESG indicators.

Estimated timeframe for achieving effects:

Long term (12–24 months, depending on investment scope).

SUMMARY

Technical measures (PV expansion, energy storage, smart metering) and behavioural measures (energy consumption management) are complementary.

Key conclusions from the simulations:

- Expanding RES capacity alone does not guarantee maximum efficiency — increasing self-consumption is crucial.
- Load management can deliver fast results with relatively low investment costs.
- Long-term energy efficiency requires building modernization and structural reduction of energy demand.

Integrated implementation of the above measures will enable gradual growth of the RES share, improvement of the energy balance, and stabilization of the REC financial model within a 2–3-year horizon.

9. CONCLUSIONS

9.1. Results of the Pilot Action

The pilot activities carried out under WP2 enabled the testing of the energy community operational model under real-life conditions, using the REC Manager tool. The pilot included an analysis of the business model, an assessment of the potential for improving energy efficiency, identification of regulatory and technical barriers, and the development of an implementation plan.

MAIN FINDINGS

1. **Potential to increase self-consumption**

   Simulations demonstrated that increasing self-consumption (e.g., through energy storage systems and load optimization) can significantly improve the REC's energy balance and shorten the investment payback period.

2. **Importance of metering data**

   The lack of detailed data at 15-minute intervals limited the ability to use advanced models in REC Manager. Implementing smart metering is essential for further optimization.

3. **Model sensitivity to energy prices**

   The business model shows high sensitivity to wholesale energy price volatility. Scenario analysis (min/mid/max) was identified as an essential element of further planning.

4. **Need for phased investment**

   Implementing the full investment scope in a single phase would increase financial and technical risk. A phased model was therefore recommended.

5. **Importance of professionalized management**

   The need to establish a TEC + REC "RSE" office was identified to coordinate technical, financial and communication activities.

ASSESSMENT OF IMPLEMENTATION

Most of the planned activities were completed in analytical and planning terms. However, in several areas adjustments were necessary due to:

- lack of complete operational data,
- budget constraints,
- varying levels of stakeholder engagement,
- technical limitations of the distribution grid.

STEP 1: IMPLEMENTATION OF A SMART METERING SYSTEM (15-MINUTE INTERVAL MEASUREMENT)

The process of data standardization was initiated and the technical specification of the system was prepared.

- **Result:**

  An implementation plan was developed, technical requirements were identified, and the scope of integration with REC Manager was defined.

- **Barriers/modifications**:

  Lack of full financing for the investment; implementation postponed to the next execution phase.

STEP 2: SCENARIO ANALYSIS OF THE FINANCIAL MODEL (MIN/MID/MAX)

A simplified analysis was carried out using the basic REC Manager model.

- **Result:**

  The impact of energy prices and the level of self-consumption on ROI and overall model stability was determined.

- **Barriers/modifications:**

  The lack of detailed cost data limited the precision of the analysis; it was recommended that the model be updated after the implementation of smart metering.

STEP 3: PHASED PV EXPANSION AND ANALYSIS OF ENERGY STORAGE

Simulations were conducted to assess the impact of increasing PV capacity and deploying energy storage systems.

- **Result:**

The potential to increase the RES share and improve the energy balance was confirmed.

- **Barriers/modifications:**

Grid connection constraints and regulatory uncertainty require a phased investment approach.

STEP 4: INFORMATION CAMPAIGN AND STAKEHOLDER WORKSHOPS KICK-OF MEETING

Working and consultation meetings were held with local government units and REC "RSE" partners. A kick-off event was also held. (D.2.4.2) - Thursday, July 22, 2025, Meeting place: Karpiówka Inn in Bełżec Zamojska 5, 22-670 Bełżec.

- **Result:**

Increased awareness of the economic and environmental benefits of the REC model.

- **Barriers/modifications:**

No broad campaign targeting residents has yet been conducted; communication activities require expansion.

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WP2 PILOT ACTIVITIES – KEY RESULTS



The pilot activities carried out under WP2 enabled the testing of the energy community operational model under real-life conditions, using the REC Manager tool.

The pilot included an analysis of the business model, an assessment of the potential for improving energy efficiency, identification of regulatory and technical barriers, and the development of an implementation plan.



MAIN FINDINGS

1



Potential to increase self-consumption

Simulations demonstrated that increasing self-consumption (e.g., through energy storage systems and load optimization) can significantly improve the REC's energy balance and shorten the investment payback period.

2



Importance of metering data

The lack of detailed data at 15-minute intervals limited the ability to use advanced models in REC Manager. Implementing smart metering is essential for further optimization.

3



Model sensitivity to energy prices

The business model shows high sensitivity to wholesale energy price volatility. Scenario analysis (min/mid/max) was identified as an essential element of further planning.

4



Need for phased investment

Implementing the full investment scope in a single phase would increase financial and technical risk. A phased model was therefore recommended.

5



Importance of professionalized management

The need to establish a TEC + REC "RSE" office was identified to coordinate technical, financial and communication activities.

ASSESSMENT OF IMPLEMENTATION

Most of the planned activities were completed in analytical and planning terms. However, in several areas adjustments were necessary due to:

- lack of complete operational data,
- budget constraints,
- varying levels of stakeholder engagement,
- technical limitations of the distribution grid.

STEP 1



IMPLEMENTATION OF A SMART METERING SYSTEM (15-MINUTE INTERVAL MEASUREMENT)

The process of data standardization was initiated and the technical specification of the system was prepared.

Result:
An implementation plan was developed, technical requirements were identified, and the scope of integration with REC Manager was defined.

Barriers/modifications:
Lack of full financing for the investment; implementation postponed to the next execution phase.

STEP 2



SCENARIO ANALYSIS OF THE FINANCIAL MODEL (MIN/MID/MAX)

A simplified analysis was carried out using the basic REC Manager model.

Result:
The impact of energy prices and the level of self-consumption on ROI and overall model stability was determined.

Barriers/modifications:
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STEP 3



PHASED PV EXPANSION AND ANALYSIS OF ENERGY STORAGE

Simulations were conducted to assess the impact of increasing PV capacity and deploying energy storage systems.

Result:
The potential to increase the RES share and improve the energy balance was confirmed.

Barriers/modifications:
Grid connection constraints and regulatory uncertainty require a phased investment approach.

STEP 4



INFORMATION CAMPAIGN AND STAKEHOLDER WORKSHOPS KICK-OFF MEETING

Working and consultation meetings were held with local government units and REC "RSE" partners. A kick-off event was also held. (D.2.4.2) - Thursday, July 22, 2025 Meeting place: Karpiówka Inn in Bełżec Zamojska 5, 22-670 Bełżec.

Result:
Increased awareness of the economic and environmental benefits of the REC model.

Barriers/modifications:
No broad campaign targeting residents has yet been conducted; communication activities require expansion.

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Figure 18 WP2 pilot activities - key results

ACTIVITIES NOT FULLY IMPLEMENTED

Some measures (e.g., full deployment of smart metering and installation of energy storage systems) have not yet been fully implemented, mainly due to:

- budget constraints,
- the need to secure external financing,
- the necessity to refine technical data,
- awaiting regulatory stabilization regarding the functioning of energy cooperatives.

However, these actions have been incorporated into the implementation plan for 2026–2028.

FINAL CONCLUSIONS

The pilot fulfilled its diagnostic and planning function and enabled:

- identification of key development barriers,
- assessment of the potential to improve the energy balance,
- preliminary validation of the business model,
- development of a realistic pathway for further REC development.

Although not all measures were implemented operationally, the pilot established a solid foundation for transitioning from the analytical phase to the investment phase, based on data-driven decision-making and gradual scaling of the energy community.

9.2. RECOMMENDATIONS TO IMPROVE REC ENERGY PERFORMANCE AND SUSTAINABILITY

Based on the results of the pilot and the experience gained from implementing activities within the energy community developed by TEC and REC „RSE", the following recommendations were formulated to further improve energy efficiency, enhance economic viability, and ensure the long-term sustainability of the REC model. The recommendations address technical, organizational, financial, and regulatory aspects.

TECHNICAL RECOMMENDATIONS

IMPLEMENTATION OF SMART METERING AND EMS (SHORT-TERM PRIORITY)

Rationale:
The lack of 15-minute interval metering data limits the ability to precisely balance energy and apply advanced models in the REC Manager tool.

Recommendation:

- installation of remote-read meters for all key REC members,
- implementation of a centralized Energy Management System (EMS),
- automated data reporting and KPI monitoring.

Expected effect:

- improved energy balancing,
- increased self-consumption,
- more accurate financial and investment models.

Required support:

- financial (grants, preferential loans),
- technical (IT system integration).

INCREASING SELF-CONSUMPTION THROUGH ENERGY STORAGE (MEDIUM-TERM PRIORITY)

Recommendation:

- cost-effectiveness analysis of Battery Energy Storage Systems (BESS),
- phased deployment at the largest energy consumers,
- integration with demand management mechanisms (DSR).

Expected effect:

- 15–25% increase in self-consumption,
- shortened investment payback period,
- improved system stability.

Required support:

- financing programs for storage investments,
- stable regulations regarding settlement of stored energy.

ENERGY CONSUMPTION OPTIMIZATION (SHORT-TERM PRIORITY)

Recommendation:

- implementation of load shifting in LGUs and enterprises,
- scheduling of energy-intensive equipment operation,
- peak demand analysis.

Expected effect:

- 15–20% reduction in peak demand,
- lower distribution costs,
- improved efficiency in the use of locally generated energy.

FINANCIAL RECOMMENDATIONS

DEVELOPMENT OF A LONG-TERM FINANCIAL MODEL

Recommendation:

- scenario analysis (min/mid/max),
- 10–15-year cash-flow model,
- sensitivity analysis to energy price volatility.

Effect:

- reduced investment risk,
- increased transparency for LGUs and partners.

DIVERSIFICATION OF FINANCING SOURCES

Recommendation:

- applying for EU and national funds (e.g., European Funds for Infrastructure, Climate, Environment, National Fund for Environmental Protection and Water Management),

- establishment of an internal investment fund for REC members,
- hybrid financing model (grant + own contribution + loan).

Effect:

- improved access to capital,
- enhanced financial stability.

ORGANIZATIONAL RECOMMENDATIONS

ESTABLISHMENT OF A PROJECT OFFICE (SHORT-TERM PRIORITY)

Recommendation:

- appointment of a technical and financial coordinator,
- standardization of documentation and reporting,
- quarterly KPI monitoring.

Effect:

- professionalization of management,
- improved decision-making processes.

STRENGTHENING COMMUNICATION AND SOCIAL PARTICIPATION

Recommendation:

- information campaign for residents,
- workshops for municipal councils and entrepreneurs,
- publication of energy and financial performance results.

Effect:

- greater social acceptance,
- increased number of REC members.

REGULATORY RECOMMENDATIONS

CONTINUOUS LEGISLATIVE MONITORING

Recommendation:

- monitoring amendments to RES regulations,
- updating statutory documents,
- legal consultations in the case of significant regulatory changes.

Effect:

- reduced legal risk,
- ensured operational stability.

Required systemic support:

- simplification of grid connection procedures,
- stable and predictable settlement rules for energy cooperatives.

PRIORITIES FOR THE NEXT 1–12 MONTHS

1. Implementation of smart metering and data standardization.
2. Optimization of energy consumption (DSR).
3. Development of a detailed financial model.
4. Establishment of the project office.

MEDIUM- AND LONG-TERM ACTIONS (12–36 MONTHS)

1. Installation of energy storage systems.
2. Phased expansion of PV capacity.
3. Thermal retrofitting of LGU buildings.
4. Scaling the model to other municipalities.

CONDITIONS FOR IMPLEMENTATION AND REPLICATION IN OTHER COMMUNITIES

For the model to be replicated in other communities, the following conditions are necessary:

- access to investment financing,
- provision of regulatory support,
- implementation of digital energy management tools,
- development of competencies among local energy managers,
- standardization of data collection from the outset of the project.

SUMMARY

The greatest potential for improving the efficiency and long-term sustainability of the REC lies in:

- increasing self-consumption,
- improving data quality and digitalization,
- professionalizing management,
- establishing a stable financial model based on scenario analysis.

Integrated implementation of the recommended measures will enable a sustained increase in the share of renewable energy, improvement of the energy balance, and long-term economic and organizational stability of the energy community.

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RECOMMENDATIONS

TECHNICAL RECOMMENDATIONS

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Recommendation:
- scenario analysis (min/mid/max),
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- increased transparency for LGUs and partners.

5. DIVERSIFICATION OF FINANCING SOURCES

Recommendation:
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- establishment of an internal investment fund for REC members,
- hybrid financing model (grant + own contribution + loan).

Effect:
- improved access to capital,
- enhanced financial stability.

ORGANIZATIONAL RECOMMENDATIONS

6. ESTABLISHMENT OF A PROJECT OFFICE (SHORT-TERM PRIORITY)

Recommendation:
- appointment of a technical and financial coordinator,
- standardization of documentation and reporting,
- quarterly KPI monitoring.

Effect:
- professionalization of management,
- improved decision-making processes.

7. STRENGTHENING COMMUNICATION AND SOCIAL PARTICIPATION

Recommendation:
- information campaign for residents,
- workshops for municipal councils and entrepreneurs,
- publication of energy and financial performance results.

Effect:
- greater social acceptance,
- increased number of REC members.

REGULATORY RECOMMENDATIONS

8. CONTINUOUS LEGISLATIVE MONITORING

Recommendation:
- monitoring amendments to RES regulations,
- updating statutory documents,
- legal consultations in the case of significant regulatory changes.

Effect:
- reduced legal risk,
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Smart technologies, sound finances and strong cooperation build resilient and sustainable energy communities.

Figure 19 Recommendations

9.3. REFLECTION ON PARTICIPATORY APPROACH

The participatory approach constituted an important element of the pilot implementation, although its scope varied depending on the stakeholder group. The energy community developed within TEC and REC "RSE" is based on cooperation between LGUs, enterprises, and public entities, which naturally required dialogue and consultation at the planning and business model analysis stages.

TOOLS AND FORMS OF PARTICIPATION APPLIED

During the pilot, the following tools and activities were used:

WORKING MEETINGS AND WORKSHOPS

- workshops involving representatives of LGUs and the energy company,
- consultations on the financial model and RES development options,
- discussion of simulation results from the REC Manager tool.

INDIVIDUAL CONSULTATIONS

- meetings with representatives of local government units,
- technical consultations regarding energy consumption profiles,
- agreement on the scope of data entered into the digital tool.

JOINT DEVELOPMENT OF THE IMPLEMENTATION PLAN

- co-creation of the action timetable,
- identification of technical and regulatory barriers,
- scenario analysis (min/mid/max) conducted jointly with partners.

ASSESSMENT OF THE EFFECTIVENESS OF PARTICIPATORY ACTIVITIES

The participatory approach proved particularly effective among key stakeholders (LGUs, the energy company, and the REC "RSE" management board). It enabled:

- increased understanding of REC operating mechanisms,
- joint identification of investment priorities,
- trust-building among partners,

- acceptance of a phased development model.

At the same time, broader social participation (residents, households) was limited and remained at an initial stage. No wide-scale information campaign or formal public consultations were conducted during the pilot phase.

IMPACT OF STAKEHOLDERS ON PLANNING AND IMPLEMENTATION

Local stakeholders — particularly LGUs and enterprises — influenced:

- the selection of development scenarios,
- investment priorities,
- the scope of financial analysis,
- the identification of technical and organizational barriers.

They also co-decided on:

- the sequence of implementation steps (e.g., smart metering before PV expansion),
- the need for phased investment,
- the selection of optimization measures (load shifting).

It can therefore be concluded that, for key REC members, participation was substantive rather than merely consultative.

GOOD PRACTICES IDENTIFIED

The pilot highlighted the following good practices:

- transparent presentation of financial simulation results,
- joint scenario analysis (min/mid/max),
- openness to modifying the plan based on partner feedback,
- inclusion of organizational and communication aspects in the implementation plan,
- regular information exchange between cluster and cooperative members.

It was also good practice to avoid unilaterally imposing technical solutions – decisions were preceded by analysis and discussion.

LIMITATIONS AND CHALLENGES

Despite positive experiences, several limitations were identified:

- lack of broad engagement of residents,
- limited number of open meetings,
- varying levels of technical knowledge among participants,
- absence of a dedicated communication team.

These challenges indicate the need to expand participatory activities in subsequent stages of REC development, particularly if households are to be included.

CONCLUSIONS AND FUTURE RECOMMENDATIONS

In the next stages of development, it is recommended to:

1. Organize open public consultations prior to major investments.
2. Prepare simplified informational materials (infographics, online dashboards).
3. Appoint a person responsible for community communication within the project office.
4. Involve residents in a pilot participation program (e.g., the first 10–20 households).

SUMMARY

The participatory approach applied in the pilot was effective with regard to key institutional partners and allowed stakeholders to have a real influence on the planning process. At the same time, it should be expanded to a broader segment of the local community to ensure long-term acceptance and sustainability of the REC model.

In subsequent stages, the development of the energy community should rely on a more systematic and multi-level participatory model, combining strategic consultations with the active involvement of residents in the energy transition process.