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D5.2. Support for the creation of Renewable Energy Communities in Rural Areas

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Author(s)	Organization
Jernej Zupančič, Jernej Jožič, Edin Lakić, Andrej F. Gubina	IRI UL
Rebeca Brocal	AVA ASAJA
Konstantin Stoyanov	TRU

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Executive Summary

This report presents the consolidated findings and practical guidance developed under Work Package 5 of the ECOLOOP project, focusing on economic and social support for farmers, foresters, and rural stakeholders engaging as prosumers of renewable energy. Its purpose is to provide a structured, accessible resource that integrates economic analysis, social readiness, policy guidance, and practical implementation strategies to support renewable energy uptake in rural areas.

A central focus of the report is the Energy Community Roadmap, which guides the establishment of sustainable rural renewable energy communities. Drawing on analyses of four ECOLOOP pilot countries: Spain, Slovenia, Estonia, and Bulgaria, the report highlights varying stages of development and regulatory frameworks, from Spain's advanced ecosystem of over 650 registered communities to emerging frameworks in Estonia and Bulgaria. Across all contexts, successful energy communities share common factors: strong local leadership, clear and realistic business models, effective communication and trust-building, supportive municipal engagement, access to financing, and diverse membership. Practical recommendations include thorough resource and regulatory assessments, selection of appropriate legal forms, structured governance, phased capacity building, and engagement with regional and EU-level support networks. Realistic timelines of 24 - 36 months from concept to operational status are emphasised to ensure sustainability. The report also includes an economic evaluation of renewable energy investments, assessing revenue under contracts for difference and power purchase agreements. Analyses demonstrate that both small-scale and larger RES installations can provide viable income streams for rural stakeholders, particularly when combined with collective community approaches that enable shared benefits and risk reduction.

Social engagement is highlighted as a critical dimension, with guidance on target groups, communication strategies, campaign design, and long-term governance frameworks. A cross-country readiness assessment provides insights into farmers' and foresters' capacity, motivations, and barriers for participation, supporting targeted interventions and informed decision-making.

Finally, the report consolidates formation guidelines for energy communities, covering legal structures, financial planning, technology options, risk management, and implementation steps. By integrating economic, social, and policy dimensions, this report offers a practical roadmap for rural stakeholders, including farmers, foresters, local authorities, and support organisations to navigate the transition to community-oriented renewable energy, fostering resilient, economically viable, and socially inclusive rural development.

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1. Introduction

1.1. Purpose of the document

The report covers several interconnected dimensions of rural renewable energy development, with a primary emphasis on the outcomes of *Task 5.3: Guidance on policy development to optimise the contribution of agroforestry to support sustainable rural development* and *Task 5.4: Support for the creation of renewable energy communities in rural areas*.

These tasks provide the backbone of the document by addressing both the enabling environment and the practical implementation of renewable energy initiatives. Task 5.3 contributes an in-depth understanding of the policy and regulatory frameworks shaping renewable energy deployment in agriculture and forestry across EU, national, and local levels. It identifies key barriers and opportunities and translates them into targeted policy recommendations and roadmap elements aimed at supporting decision-makers in fostering favourable conditions for rural energy transitions. Complementing this, Task 5.4 focuses on the operational dimension, delivering practical guidance, tools, and step-by-step approaches for the creation and management of renewable energy communities. It addresses critical aspects such as stakeholder mobilisation, governance structures, legal frameworks, financing approaches, and long-term community engagement, ensuring that rural actors are equipped to move from concept to implementation.

In addition, the report outlines energy community models and technological pathways, assesses the economic feasibility of selected renewable energy investments, examines social engagement strategies and readiness levels among rural actors, and provides practical guidelines for establishing and managing renewable energy communities. In doing so, it addresses both individual prosumer models (e.g. farm-based RES installations) and collective approaches through rural energy communities, linking financial, organisational, and policy aspects.

The findings and guidance presented in this report are closely aligned with and support the implementation of several ECOLOOP Use Cases (UCs) across pilot countries, ensuring coherence between analytical work and real-world application [1]. In Spain, UC ES.01 demonstrates the integration of Agri-PV, geothermal, and biogas systems within an energy community framework, directly reflecting the report's emphasis on technological pathways, integrated energy solutions, and community-based renewable energy models. In Bulgaria, UC BG.03 focuses on regulatory analysis, business model development, and stakeholder engagement to foster rural renewable energy uptake, closely corresponding to the report's contributions on policy frameworks, enabling conditions, and governance structures, particularly those developed under Tasks 5.3 and 5.4. Similarly, UC SI.06 in Slovenia addresses the redesign of subsidies and business models for biogas

and biomethane production, aligning with the report's economic and policy perspectives on improving financial viability and supporting scalable renewable energy solutions in agriculture.

Potential rural stakeholders can use this document as a practical reference to support decision-making and strategic planning. Farmers and foresters can assess their readiness and investment options; local authorities can better understand enabling conditions and governance models; rural advisors and support organisations can draw on engagement frameworks and best practices; and emerging energy communities can use the formation guidelines to structure their development process. By consolidating economic and social support elements into one accessible report, this document aims to facilitate informed, resilient, and community-oriented renewable energy uptake in rural areas.

1.2. Scope of the document

This document integrates selected results from Tasks 5.1 - 5.4, , with a primary focus on the outcomes of Tasks 5.3 and 5.4, which form the core of the report. The content is structured to provide practical guidance and implementation-oriented insights for rural stakeholders engaging in renewable energy initiatives, particularly through energy communities.

The chapters on the Energy Community Overview, rural energy communities, and the economic evaluation of RES investments build on the business model innovation work of Task 5.1, translating circular and sustainable bioeconomy concepts into concrete technological, organisational, and investment options applicable to farms and rural stakeholders.

In this report, Task 5.2 is primarily reflected through its social dimension, particularly in the chapters addressing engagement campaigns and the farmer and forester readiness assessment. These sections incorporate insights on social instruments, participation drivers, trust-building, and stakeholder motivation, highlighting the human and community factors that influence renewable energy uptake in rural areas rather than providing a comprehensive financial instrument review. In depth economic funding options were presented in previous deliverable *D5.1: Business models and financial and social instruments*, -together with business model design methodology.

The main contribution of this report lies in the integration of findings from Tasks 5.3 and 5.4. Policy-related insights and recommendations, together with the Energy Community Formation Guidelines, provide a structured framework for enabling renewable energy deployment in rural areas. These sections address regulatory conditions, governance models, stakeholder roles, and practical steps for establishing and operating renewable energy communities, supported by implementation-oriented tools and recommendations. Overall, the report consolidates the most relevant elements of the selected tasks into a coherent, practice-oriented resource. It is designed to support farmers, foresters, local authorities, and rural organisations in navigating the transition

towards renewable energy, with particular emphasis on community-based approaches and enabling policy and governance frameworks.

1.3. Structure of the document

The document is structured as described below:

- **Chapter 1. Introduction:** defines the purpose, scope, and overall structure of the document, outlining its objectives and explaining how the subsequent sections are organised.
- **Chapter 2. Energy Community Overview:** presents a comprehensive overview for energy communities, covering production- and service-oriented models, key technologies and activities, and the main challenges associated with their establishment.
- **Chapter 3. Rural Energy Communities:** examines the specific characteristics, barriers, opportunities, stakeholder roles, and systemic conditions shaping the development of energy communities in rural areas within the European context.
- **Chapter 4. Economic Evaluation of RES Investment:** analyses the economic viability of various renewable energy system configurations under different support schemes, presenting comparative investment results for household, stand-alone, and biomass-based installations.
- **Chapter 5. Social Aspects of Rural Energy Communities - Engagement Campaigns:** explores the importance of social engagement in rural energy communities, detailing target groups, campaign design elements, communication strategies, governance approaches, and conceptual frameworks for long-term participation.
- **Chapter 6. Farmer and Forester Readiness Assessment for Renewable Energy Adoption:** presents the methodology, results, and cross-country analysis of a readiness assessment evaluating farmers' and foresters' capacity, motivations, barriers, and potential roles in renewable energy adoption and energy communities.
- **Chapter 7. Energy Community Formation Guidelines:** provides practical guidance on establishing energy communities, including legal frameworks, formation steps, financial planning, technology options, risk management, support resources, and key recommendations.
- **Chapter 8. Conclusions:** contains the main conclusions of the deliverable and work performed.
- **Chapter 9 and 10. References and Acronyms**
- **Annexes:** ECOLOOP Survey, Survey statistics and Business model questionnaire

2. Energy community overview

The EU Clean Energy Package [2] introduces two legal definitions of energy communities: Citizen Energy Communities (CEC) under the Electricity Directive and Renewable Energy Communities (REC) under the Renewable Energy Directive. Both frameworks enable citizens, SMEs, and local authorities to collectively engage in energy activities based on democratic governance, specific ownership structures, and a primary focus on community benefits rather than profit maximisation. Energy communities are thus recognised as a distinct category of market actor promoting social innovation alongside economic activity.

According to REScoop.eu [3], Europe currently hosts around 2,250–2,500 energy cooperatives involving 1.5–2 million citizens, forming a growing grassroots movement around locally owned renewable energy projects. Approximately half of these initiatives are part of the REScoop.eu network [3].

Energy communities are most developed in countries with supportive regulatory frameworks, such as Denmark, Germany, the Netherlands, Belgium, and Spain. In Central and Eastern Europe, uptake remains lower due to financial and regulatory barriers, although progress is emerging in countries like Romania, Slovenia, and Croatia. The Energy Community Map maintained by REScoop.eu [3] tracks these initiatives across Europe.. It is visualized on the figure below:



Figure 2.1: Energy community map, taken from RESCOOP.EU

Earlier research by CE Delft [4] highlights the transformative potential of energy citizens: with enabling conditions in place, over 264 million Europeans could produce their own energy by 2050, generating 611 TWh by 2030 and 1,557 TWh by 2050, equivalent to 19% and 45% of EU electricity demand, respectively. Collective initiatives such as cooperatives could account for around 37% of this production, with the remainder coming from households, SMEs, and public entities.

Most energy cooperatives in Europe remain relatively small, typically focusing on local renewable projects such as solar PV. However, notable exceptions demonstrate the scalability of this model. For example, Ecopower in Belgium and Som Energia in Spain each involve around 67,000 - 68,000 members, while larger retail-oriented initiatives such as Cooperative Energy in the United Kingdom and Green Planet Energy in Germany serve extensive customer bases [5].

Experience shows that cooperatives grow significantly once operational projects are in place and members benefit directly, for example through lower energy costs or increased autonomy. REScoop.eu plays a key role in supporting over 2,500 energy communities and two million members by fostering collaboration, policy advocacy, and knowledge sharing across Europe [5].

2.1. Energy production and Energy services communities

In the following tables Table 2.1 and Table 2.2, most notable community projects on renewable generation and energy services are presented.

Table 2.1: Overview of Energy production ECs

Technology	Example / Location	Key Features
Solar PV	Klimaatscholen 2050 (Belgium)	Community-financed rooftop PV in schools; reduces costs; citizen ownership
	Som Energia: Generation kWh (Spain)	Collective self-consumption; zero-interest member loans; subsidy-free PV
	Energy4All / Schools' Energy Coop (UK)	PV on public buildings; citizen investment + education; stable returns

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	Energent – Gent Zonnestad (Belgium)	Group purchasing, advisory services; supports households and SMEs
	Enercoop & ZEZ (France, Croatia)	Citizen-owned PV; integration with supply and digital trading
Wind	Krammer Wind Park (Netherlands)	102 MW large-scale cooperative wind; full citizen ownership regained
	Viure del Aire del Cel (Spain)	First community wind turbine; fully citizen-financed
	Middelgrunden & Hvidovre (Denmark)	Offshore and nearshore wind; strong public participation; large-scale
	Ecopower/ Allons en Vent (Belgium)	Large cooperative ownership; local engagement and education
Hydro	Isle of Eigg (Scotland)	Community microgrid (hydro, wind, solar); ~90% renewable; energy autonomy
	Whalley Hydro (England)	Small-scale hydro; strong environmental compliance
	Rumbling Bridge Hydro (Scotland)	500 kW cooperative hydro; stable local income
Biomass & Geothermal	Ecopower (Belgium)	Biomass pellets production; integrated energy services; circular model
	Bürgerenergie West (Germany)	Biomass district heating; manure-based; community-financed
	Thermo Bello (Netherlands)	Geothermal district heating; supplies homes and businesses; community-led

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Table 2.2: Energy service providing ECs

Service Type	Example / Location	Key Features
Electricity Supply	Coopérnico (Portugal)	Citizen-financed renewable supply; ~800 clients; PV-based generation
	Ènostra (Italy) / Goiener (Spain)	Cooperative retail supply; 4,000–13,000 customers; local renewable sourcing
	Ecopower, Enercoop, Som Energia, Greenpeace Energy, EWS	Large-scale cooperative suppliers; tens of thousands to >200,000 clients
	Bürgerwerke (Germany)	Aggregates citizen-generated electricity; local self-supply model
	Cociter (Belgium)	Federation of cooperatives; supplies ~15,000 households
Social Inclusion	Repowering London (UK)	Solar on social housing; job training; “energy champions” programmes
	Enercoop / Energie Solidaire (France)	Micro-donations via bills; supports energy poverty initiatives
	Ecopower (Belgium)	Renewable electricity access for vulnerable households at cost price
Storage Services	Energent – Buurzame Stroom (Belgium)	Collective PV (~750 kWp); district storage; shared energy system model

	EWS (Germany)	Grants for household battery systems; supports decentralised storage
E-mobility Services	The Mobility Factory (EU-wide)	Shared EV platform owned by cooperatives; cross-border collaboration
	Partago (Belgium)	50 EVs; 500 members; cooperative car-sharing
	Som Mobilitat (Spain), Coöperatieauto (NL), others	Expanding cooperative EV-sharing networks
	CoopStroom (Belgium)	Hybrid model: municipal + community EV use; efficient asset sharing

2.2. Challenges in establishing EnCs

Many communities continue to face significant barriers that limit their ability to participate fully in the energy transition. These obstacles can be grouped into four main categories:

1. **Complex or disproportionate administrative procedures** - As energy communities are a relatively new concept, Member States are still developing regulatory and administrative frameworks. In some cases, existing procedures or market imbalances create inequities and hinder the level playing field for these communities.
2. **Limited readiness of infrastructure and actors** - Many system actors, including utilities and municipalities, are still adapting to evolving energy market rules. Energy communities often have to compensate for this lack of maturity, creating operational and coordination challenges.
3. **Insufficient transparency and information** - Energy is complex, and many consumers are unaware of the opportunities energy communities offer. This knowledge gap is often worsened by misinformation.

4. **Restricted access to financing** - Traditional financing solutions frequently fail to accommodate the value-driven, citizen-centered investment models of energy communities, leaving projects with limited equity or portfolios struggling to secure funding.

To overcome these challenges, targeted solutions aligned with the requirements of the Clean Energy Package, which mandates Member States to establish enabling frameworks for Renewable Energy Communities, can be grouped as 4 measures:

- **Simplified administrative procedures** - National energy regulators should recognise the diverse actors forming energy communities and facilitate access through streamlined procedures or one-stop-shops. Municipal and regional authorities are best placed to provide this support due to their proximity to citizens and ability to engage in dialogue.
- **Capacity building and technical support for municipalities** - Municipalities play a crucial role in supporting energy communities, but complexity around public procurement and limited understanding of new market actors can hinder engagement. Training, clear governance models, and stable regulatory frameworks—including municipal tendering rules favoring community initiatives—can enable municipalities to better support local energy projects.
- **Tailored financing tools** - Member States should develop financing mechanisms that reward citizen ownership and participation, such as grant-to-loan funds (e.g., Scotland's CARES fund), to make community-driven projects financially viable.
- **Support for socially oriented energy communities** - Many energy communities pursue broader societal goals, such as promoting local energy transitions, improving energy efficiency, addressing energy poverty, and providing system flexibility. These activities often require substantial investment, and additional support schemes should be provided to facilitate community action on these social objectives.

3. Rural Energy Communities

This section synthesises the core features, constraints and enabling conditions that shape the emergence and consolidation of Rural Energy Communities (RECs) in European contexts. Drawing on the literature, the following subsections frame Rural Energy Communities not merely as decentralised renewable projects, but as integrated socio-technical systems embedded in rural development trajectories.

This analytical framing is complemented by the empirical context provided by the ECOLOOP project, which develops and demonstrates integrated renewable energy and circular economy solutions in rural areas across Europe. While the project is not explicitly centred on Renewable Energy Communities as a governance model, its pilot sites (Table 3.1) offer relevant real-world configurations in which many of the socio-technical dimensions identified in the literature can be observed.

Table 3.1: Synthetic overview of the four ECOLOOP pilot sites and their analytical relevance for the discussion of Rural Energy Communities.

Pilot	System type	Core focus	Main actors	Relevance to RECs
Spain	Agro-energy system	Agri-PV, biogas, geothermal	SMEs, farmers' association	Multi-actor rural energy system with potential for collective models
Estonia	Bioindustrial forestry system	Biomass, biomaterials	Industry, landowners, research	Provides resource base and value chains relevant for RECs
Slovenia	Industrial energy system	Biomass CHP, flexibility	Industry, energy operators	Illustrates infrastructure and system integration challenges
Bulgaria	Corporate circular system	Biogas, Agri-PV, circular economy	Large company, farmers	Demonstrates integrated local systems with stakeholder involvement

As such, ECOLOOP pilot sites provide valuable insights into the enabling conditions, structural constraints and actor constellations that may support or hinder the emergence of community-based energy models in rural contexts.

3.1. Specific characteristics of Rural Energy Communities

Rural Energy Communities (RECs) are typically defined by strong territorial embeddedness, collective ownership and democratic governance rooted in local control and benefit generation [7][8][10][11][22][30]. They function as voluntary legal entities with open participation and a primary focus on delivering environmental, social and local economic value rather than maximising profit [10][13][22][30]. Governance is commonly based on one-member-one-vote principles, which supports inclusive participation, transparency and trust, particularly in rural settings where proximity between actors plays a key role [8][24][29]. These initiatives are largely place-based and often involve a substantial share of local residents, especially in smaller municipalities [27][18][29]. Organisational forms such as cooperatives, associations and municipally supported schemes are prevalent, as they allow communities to pool limited resources and sustain long-term engagement [6][12][27]. In Spain, collective self-consumption - especially rooftop PV on public buildings shared through allocation coefficients- has become the main operational model, even when projects do not formally meet the legal definition of an energy community [22][25].

Rural renewable energy communities emerge within specific socioeconomic and institutional contexts, typically characterised by low population density, limited technical capacity and constrained access to finance [7][9][12][15]. They are often located in municipalities with fewer than 5,000 inhabitants and rely on collective self-consumption schemes, cooperative grids or community-owned infrastructure [12][18]. In many cases, progress depends heavily on local leadership, particularly where participation is voluntary and members face time and expertise constraints [9]. Development is also shaped by regulatory complexity and limited awareness of these models, including within public administrations [9][12]. While EU legislation does not explicitly distinguish RECs, they fall under the broader categories of Renewable Energy Communities and Citizen Energy Communities, both of which emphasise voluntary participation, local control and community-oriented objectives [13][11][19]. In practice, rural initiatives often evolve as hybrid models that combine renewable generation with participatory governance [19][29]. These contextual conditions are partially reflected in the ECOLOOP pilot sites, which are located in rural or peri-rural areas and involve agricultural, forestry and industrial actors operating under constraints related to resource management, coordination and technical capacity. Evidence from Spain highlights the strong rural dimension of Renewable Energy Communities initiatives: 69.3% are located in rural municipalities, and 64% of Citizen Energy Communities operate in such areas despite their relatively small population share [18][29].

From a structural perspective, rural RECs benefit from access to land and existing agricultural infrastructure, which enables a wider technological range than is typically feasible in urban areas

[14][16][23]. This includes ground-mounted photovoltaics, agrivoltaics, wind, biomass, biogas and hydropower systems [16][23][227][29]. Although rural areas account for 44% of EU territory but only 19% of its population, and often face higher poverty risks, they also hold significant untapped renewable potential [16][15][23]. This positions RECs as important instruments for decentralised energy generation and local value retention. In some regions, particularly Alpine and Nordic contexts, long-standing cooperative models already manage both generation and distribution infrastructure [27]. Depending on regulatory and infrastructural conditions, RECs may operate through grid-connected or decentralised systems, integrating storage, electric mobility and demand flexibility [12][24][29]. The technological diversity described in the literature is also evident in the ECOLOOP pilots, which combine distributed renewable energy sources such as biogas production from agricultural residues, biomass-based energy systems and Agri-PV applications within integrated rural settings.

The development of RECs generally follows a staged process: defining a shared vision, assessing technical and financial feasibility, implementing and connecting projects to the grid, and ensuring long-term operation and management [8]. Financing typically combines community contributions, public funding, debt, equity and, increasingly, crowdfunding, often with municipalities playing a facilitating role [22][24]. Revenues are frequently reinvested into local priorities, including energy efficiency, social inclusion and broader community development [14][28][29]. In contrast, the ECOLOOP pilot cases are primarily driven by SMEs, industrial operators or large organisations, with project-based implementation logics that differ from the community-led development pathways described in the literature.

Moreover, rural energy communities often extend beyond electricity generation to include building renovation, thermal energy, shared mobility and other local services, reflecting their role as broader community development mechanisms [22][29]. Overall, they contribute to economic diversification, employment, energy security and territorial resilience, functioning as integrated systems that link energy production, governance and local development within the rural transition [15][23][29][24].

From this perspective, the ECOLOOP pilots can be understood as illustrating key functional components of such systems, particularly in relation to technological integration and circular resource use, while only partially reflecting the governance and ownership features typically associated with RECs.

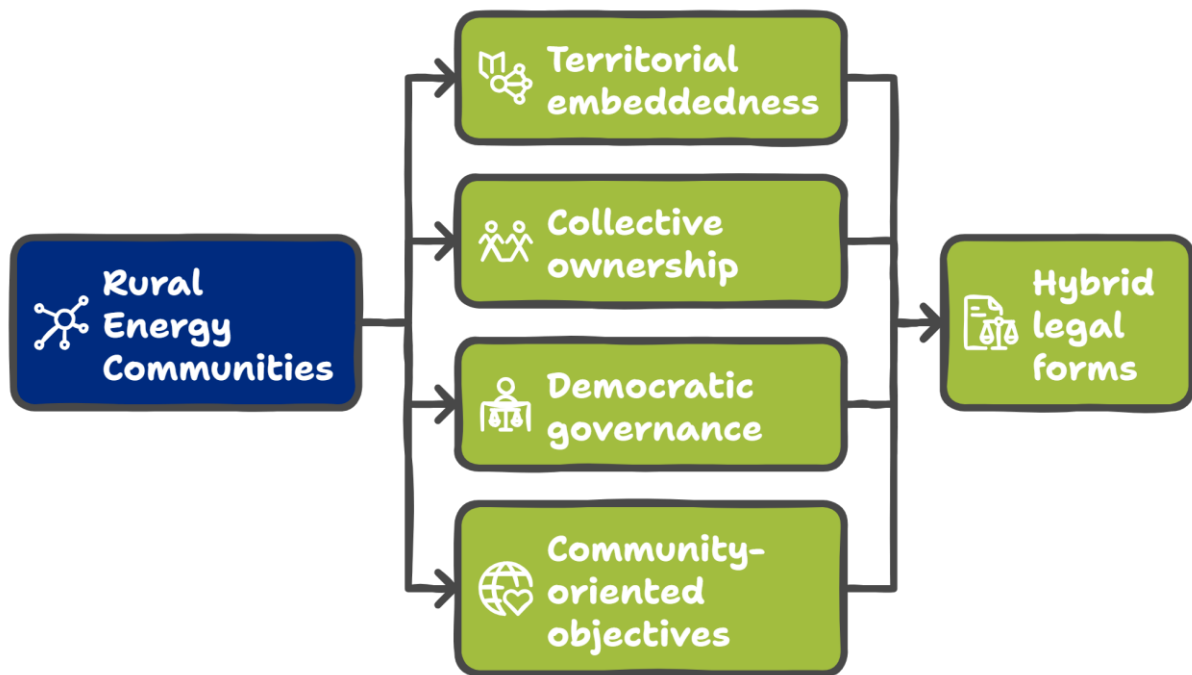


Figure 3.1: Conceptual dimensions of Rural Energy Communities

3.2. Barriers to the development of Rural EnCs

Barriers to Rural Energy Communities (see Figure 3.2) are not only theoretical but are consistently observed across real-world rural energy systems, including those developed under innovation projects such as ECOLOOP. The literature consistently identifies regulatory uncertainty as a core structural constraint on Rural Energy Communities (EnCs), particularly where incomplete or inconsistent transposition of EU directives (RED II, IEMD and RED III) creates legal ambiguity and delays enabling frameworks, in some cases leaving energy communities without formal definition [7][13][23]. Administrative complexity, ranging from registration and licensing to planning permissions, grid connection agreements and slow permitting, extends project timelines and raises transaction costs, sometimes delaying implementation by up to two years [7][13][22][29]. Legal definitions can also be problematic: overly narrow ones may exclude valid initiatives, while overly broad frameworks risk enabling “false energy communities” dominated by corporate actors [12][29]. Additional uncertainty arises from national divergences in standards, unclear taxation rules and cumulative administrative costs [13][16]. In several cases, limited legislative progress despite announced reforms further reinforces institutional instability [18]. These regulatory and administrative barriers are reflected in the ECOLOOP context, where pilot activities, such as the development of Agri-PV systems combined with biogas production (Spain, Bulgaria) or biomass-based energy systems integrated in industrial environments (Slovenia), must navigate permitting

procedures, grid access conditions and evolving regulatory requirements across different national frameworks.

Financial constraints are closely intertwined with regulatory barriers. Rural EnCs often operate at scales that are unattractive to commercial banks, leading to reliance on grants, member contributions and public support, with a significant share of communities depending on such funding [7][16][18]. Access to finance, especially in early project stages, is widely identified as a critical bottleneck [16]. Economic viability is further affected by low disposable incomes, high upfront costs, limited competitiveness with retail suppliers and declining wholesale electricity prices [12][29]. In some Member States, unclear fiscal treatment, lack of dedicated support schemes or requirements to sell electricity through incumbent utilities constrain independent operation [13][24]. Financial guarantees in liberalised markets may also exceed acceptable risk levels for lenders [24]. In rural contexts, agricultural volatility and rising input costs further limit investment capacity [16], while in parts of Southeastern Europe, centralised energy systems and low electricity prices weaken incentives for community-led models [28]. Similar financial dynamics can be observed in the ECOLOOP pilots, where capital-intensive infrastructures, such as biogas plants processing agricultural waste (Spain, Bulgaria) or biomass-based CHP systems (Slovenia), are primarily supported through project funding, industrial investment or institutional actors, rather than community-based financing mechanisms.

Technical and infrastructural limitations remain significant, particularly in rural areas with constrained grid capacity, limited smart meter deployment and restricted access to available grid nodes [13][29]. Collective self-consumption schemes face additional procedural and technical barriers linked to regulatory compliance and activation timelines [22]. Technology-specific challenges further shape feasibility: hydropower involves long development cycles, wind projects may face local opposition, bioenergy depends on stable supply chains, and poorly located installations risk environmental and social trade-offs [14][23]. At the same time, accelerated permitting requirements under RED III place additional pressure on under-resourced rural administrations, where limited technical capacity and coordination gaps hinder implementation [23]. These infrastructural and technical constraints are also evident in the ECOLOOP pilots, which involve the integration of multiple distributed energy sources: such as Agri-PV, geothermal systems and biogas (Spain), or biomass-based value chains and biorefineries (Estonia), requiring coordination with grid operators, system optimisation and, in some cases, adaptation of existing infrastructure.

Social, organisational and governance challenges are equally prominent. Limited transparency, weak stakeholder engagement and unclear governance structures can undermine trust and long-term viability [8][19]. Many initiatives rely on voluntary participation, which can lead to resource constraints, leadership fatigue and difficulties aligning ambitions with regulatory and technical realities [9][29]. Low awareness, limited energy literacy and confusion around legal models reduce citizen engagement [11][12][28]. In some regions, mistrust towards institutions and energy

companies, combined with historical and political factors, further discourages collective action [7][28]. Demographic decline, ageing populations and energy poverty in rural areas also reduce participation capacity, while issues of inclusiveness, such as unequal benefit distribution or underrepresentation of certain groups remain persistent challenges [28][29]. In contrast, the ECOLOOP pilots are largely driven by companies, research organisations and sectoral actors (e.g. agro-industrial, forestry or energy operators), which reduces reliance on voluntary citizen participation but highlights a structural gap between community-led governance models described in the literature and more institutionally driven implementation approaches.

At a broader ecosystem level, fragmentation represents an additional barrier. The absence of centralised registries, diversity of legal forms and uneven regulatory development limit transparency and hinder scaling, with many communities remaining small and at early stages [18]. European-level initiatives such as REScoop.eu and the Energy Community Platform aim to address these gaps through advocacy, training and knowledge-sharing, although the proliferation of dispersed resources can itself create complexity for users [20][21]. Complementary instruments like the European Energy Communities Facility attempt to bridge pre-investment gaps by providing targeted financial and technical support [17]. Overall, the interaction of regulatory, financial, technical and social barriers highlights the multidimensional and mutually reinforcing nature of constraints affecting Rural EnCs across governance levels and territorial contexts [4][5][25]. From this perspective, the ECOLOOP pilot cases illustrate how these barriers persist even in well-resourced innovation settings, where technological integration—across agriculture, forestry and energy systems—advances more rapidly than the development of enabling governance and regulatory frameworks for community-based models.

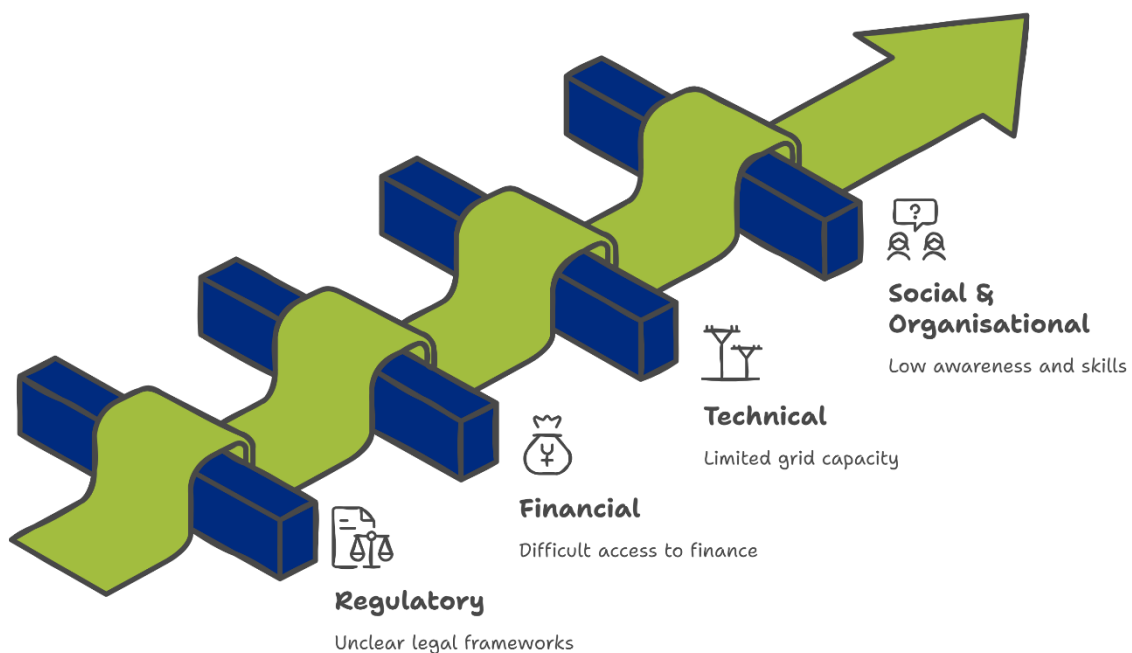


Figure 3.2: Main barriers to the development of Rural Energy Communities in rural contexts.

3.3. Opportunities and added value of Energy Communities in rural areas

While barriers remain substantial, Rural Energy Communities are associated with a wide range of interrelated benefits across economic, social and technical dimensions, which are synthesised in Figure 3.3.

Rural Energy Communities (RECs) generate significant economic value in rural areas through local value retention, income diversification and strengthened municipal revenues [7][10][11][23][27]. By enabling local generation and self-consumption, they reduce electricity costs, mitigate price volatility and lower production expenses for households, farms and small businesses, freeing resources for reinvestment in modernisation and electrification [11][16][24]. Revenues from surplus energy and community benefit schemes are often reinvested in local development, public services and social initiatives, reinforcing circular economic dynamics within the territory [10][23][27]. Evidence of a territorial multiplier effect—EUR 2.57 per euro invested over 20 years—highlights the durability of these impacts [27]. Renewable deployment can also strengthen municipal fiscal capacity and support dual land use, combining energy production with ongoing agricultural activity [16][23]. Similar value-retention dynamics can be observed in the Spanish ECOLOOP pilot (Horta Sud), where the integration of Agri-PV, biogas and geothermal systems is designed to supply energy to local users while valorising agricultural residues, thereby linking energy production with local economic activity.

RECs further create productive opportunities by leveraging rural resource endowment [14][16][29]. Access to land, rooftops and biomass enables diversified energy portfolios, including photovoltaics, wind, biogas and biomass systems [14][16]. Agrivoltaics can enhance land-use efficiency, provide crop protection and improve system performance, while biomass and biogas solutions embed circular economy practices by converting agricultural residues into energy and integrating heat into local networks [14][16]. These dynamics contribute to price stability and reduced exposure to external markets, positioning rural areas as key actors in climate mitigation and ecological transition [29]. This resource-based diversification is strongly reflected across ECOLOOP pilots: in Spain and Bulgaria through Agri-PV and biogas integration linked to agricultural production, in Slovenia through biomass-based CHP systems using wood residues, and in Estonia through the valorisation of forestry biomass for high-value biomaterials within a bioeconomy framework.

From a social and territorial perspective, RECs strengthen community empowerment, participatory governance and collective responsibility through shared ownership models [8][12][24]. They foster trust between citizens and institutions, enhance energy literacy and support civic engagement [8][28]. In Spain, a significant share of communities address social

challenges, including energy poverty, gender and vulnerable groups, demonstrating strong socio-economic embeddedness [18]. RECs are increasingly recognised as tools to tackle energy poverty by combining self-consumption with efficiency measures, reducing reliance on public support [22]. Broader impacts include support for ageing populations, social inclusion and community revitalisation [22][29], while growing territorial diffusion and supportive regulatory frameworks indicate increasing institutional integration [18]. While these social dynamics are less explicit in the ECOLOOP pilots, the Bulgarian case (Albena) illustrates how integrated local systems can connect agriculture, energy production and service provision within a single territorial ecosystem, involving multiple stakeholder groups such as farmers, energy operators and local businesses.

Technically and organisationally, RECs operate as local innovation and governance platforms [7][9][13]. Collaboration with municipalities and specialised actors facilitates access to expertise, financing and regulatory pathways, allowing communities to function as testing grounds for decentralised energy solutions [7][29]. Technical assistance has been shown to strengthen governance structures and organisational capacity over time [9]. Collective self-consumption models provide viable business cases even in the absence of strong national support, improving prosumer conditions and contributing to more efficient grid use, particularly when combined with storage and smart systems [13]. However, challenges such as local congestion and price volatility highlight the need for flexibility and storage integration [13]. In this sense, the ECOLOOP pilots act as innovation environments where different technological configurations: hybrid renewable systems, bioenergy conversion processes or flexibility services, are tested under real conditions, although primarily driven by project consortia rather than community-led governance structures.

Finally, RECs enhance energy security, autonomy and systemic resilience [10][11][29]. By reducing dependence on fossil fuels and external energy sources, and by distributing risks across communities, they broaden access to the benefits of the energy transition [29]. The recent energy crisis has further highlighted their potential as accessible and scalable models for collective action [28]. Through their integration with local economic and land-use systems, RECs reinforce territorial value chains and position rural areas as active contributors to the renewable energy transition [19][23]. Across the ECOLOOP pilots, similar resilience-oriented logics can be identified, particularly in relation to local energy production, resource circularity and reduced external dependency, even if these are implemented through organisational or industrial actors rather than formal community structures.

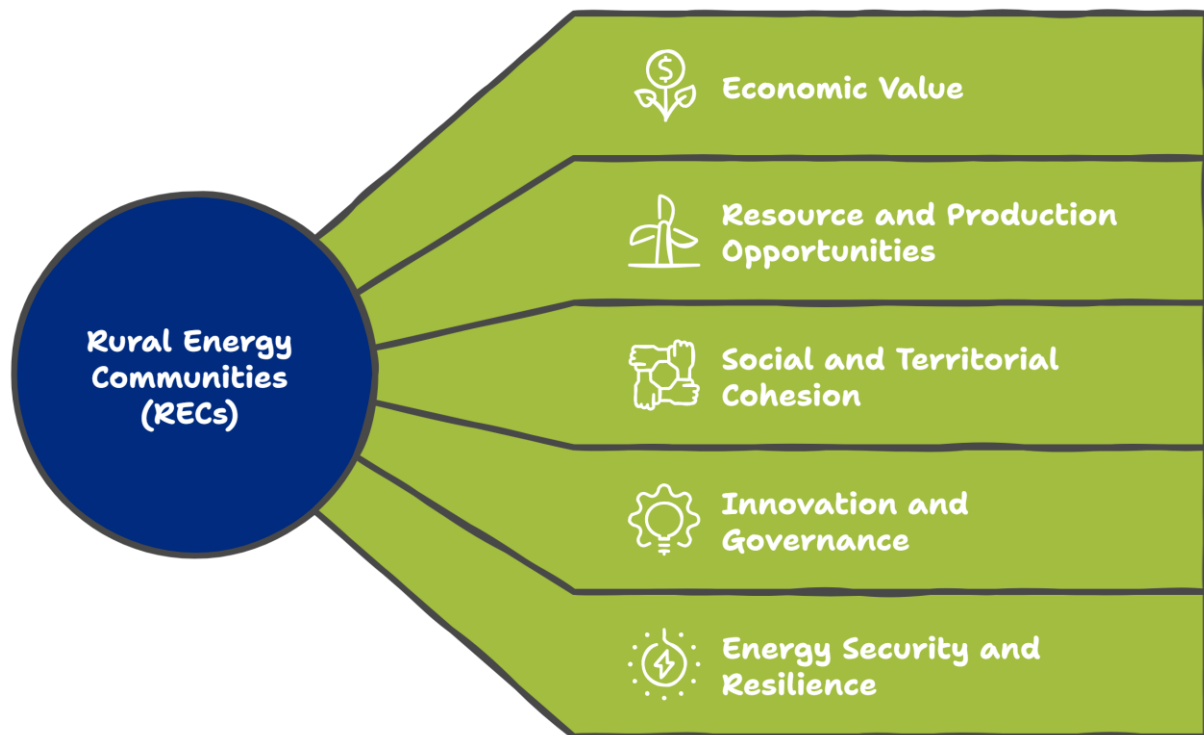


Figure 3.3: Main benefits of Rural Energy Communities in rural areas.

3.4. Role of farmers, foresters and rural SMEs

Farmers, foresters and rural SMEs occupy a central role in Rural Energy Communities (Rural EnCs), given their control over land, buildings, biomass resources and productive infrastructure, as well as their strong embeddedness in local socio-economic systems [6][10][11][14][16][19]. Farmers and landowners can host renewable installations, such as wind, photovoltaics (including agrivoltaics), biogas and, in some cases, small hydropower or contribute by leasing land, supplying feedstock or investing as members [14][16][23][29]. Agricultural land and rooftops provide key deployment sites, while anaerobic digestion links farming activities with energy and fertiliser production, integrating agricultural and energy systems [14][28]. Through self-production, farmers can reduce operating costs (e.g. irrigation, storage, processing), while surplus energy can be commercialised within community schemes or local networks [16][23]. Electrification also enables productive uses such as renewable-powered irrigation or processing, strengthening the link between energy access and rural value chains [24]. These roles are directly illustrated in the ECOLOOP pilots: in the Spanish case, farmers contribute agricultural residues and participate through sectoral organisations, supporting biogas production and agrivoltaic integration; in Bulgaria, agricultural producers are linked to the biogas system both as feedstock suppliers and beneficiaries of organic fertilisers and energy use in greenhouses.

Beyond physical assets, farmers contribute organisational capacity, long-term territorial presence and experience with cooperative models. Agricultural cooperatives, in particular, act as natural

aggregators, pooling resources for renewable projects while supporting circular economy objectives [7]. Their involvement can also improve access to funding instruments such as the European Agricultural Fund for Rural Development, the European Agricultural Guarantee Fund and the European Regional Development Fund [16]. At governance level, they participate as members, suppliers and promoters, reinforcing stakeholder engagement and territorial cohesion [10]. Foresters play a similar role by providing biomass resources and infrastructure, which are often critical for project viability in rural areas [11][19][29]. A comparable resource-provider role is observed in the Estonian pilot, where forest owners and land managers supply biomass from short-rotation plantations, forming the basis for downstream bio-based value chains and carbon-related business models.

Rural SMEs also participate as members under European and national frameworks, contributing as investors, consumers, technical partners or service providers across activities such as self-consumption, storage, mobility and building renovation [10][12][18][22][29]. They frequently collaborate with municipalities and citizens, embedding technical expertise and supporting local supply chains and employment [12][14][19]. In many cases, SMEs represent a significant share of participation alongside citizens and municipalities [18]. Their involvement provides access to competitively priced renewable energy and, in some cases, substantial cost reductions, strengthening business viability and regional competitiveness [23][29]. SMEs and local economic actors may also establish energy companies, provide capital or develop integrated production and supply models, sometimes supported by cooperative banks and regional financial institutions [24]. This function is particularly visible in the Slovenian pilot, where industrial actors operate biomass-based energy systems and provide energy services within a local industrial ecosystem, and in the Spanish pilot, where specialised SMEs are responsible for the design, installation and operation of Agri-PV and biogas infrastructures.

Reinvestment of community revenues can further stimulate local economic activity, including the creation of new cooperatives and service providers linked to the energy sector [28]. However, participation is not uniform: in some regions, agricultural cooperatives remain less engaged due to conservative structures or past negative experiences, highlighting the importance of socio-institutional context [28]. Overall, the involvement of farmers, foresters and rural SMEs anchors Rural EnCs in existing territorial systems, facilitates resource mobilisation and implementation, and supports income diversification and local ownership within the rural energy transition [11][16][23]. Across the ECOLOOP pilots, these actors are central to system functioning, although their role is often framed within project-based or industrial structures rather than fully community-owned configurations, highlighting both their enabling potential and the institutional gap with typical REC models.

3.5. Key dimensions for the development of Rural Energy Communities

To synthesise the analytical framework presented in this section, Figure 3.4 summarises the five key dimensions that underpin the development of Rural Energy Communities: governance, financial architecture, technical feasibility, organisational capacity and socio-environmental integration. These dimensions are interdependent and jointly shape the viability, scalability and territorial embeddedness of RECs across diverse rural contexts.



Figure 3.4: Key dimensions shaping Rural Energy Communities

The literature consistently frames governance as a foundational dimension for Rural Energy Communities (RECs), emphasising democratic control, transparency and clearly defined roles as safeguards for community autonomy [7][11][30]. Effective governance combines inclusive participation, equitable benefit-sharing and conflict-resolution mechanisms, supported by trust-building through accountability and open communication, particularly critical in rural contexts [8][28]. These principles are typically embedded in formal legal entities such as cooperatives, associations or mixed public-private structures aligned with European directives and national frameworks [18][22][27]. Legal clarity and integration into policy frameworks directly influence the ability of RECs to develop and scale, with Member State differences creating uneven

conditions across Europe [13][29]. Municipalities play a key role as facilitators and partners: providing assets, supporting permitting and sometimes participating financially while structured participatory processes underpin legitimacy and continuity [18][22][30][31]. In contrast, governance structures in the ECOLOOP pilots are predominantly driven by project consortia, industrial actors or institutional partnerships, rather than by citizen-led entities, highlighting a structural divergence from the democratic governance models described in the literature.

Financial architecture constitutes a second core pillar, requiring diversified funding models and lifecycle-oriented strategies [12][16][18]. RECs typically combine member contributions, public funding, loans and third-party financing, enabling gradual expansion and risk-sharing [12][16][18]. Early-stage feasibility assessment, robust business models and careful financial planning are critical for bankability, alongside diversified revenue streams such as energy savings, surplus sales or leasing arrangements [7][16][27][28]. Economic viability depends on structured funding, phased implementation and monitoring systems capable of managing long-term assets and revenues [14][30]. Access to flexible financing, simplified procedures and dedicated support schemes further enhances participation, particularly where low-risk and cooperative-based models align with citizen preferences [28][29]. The ECOLOOP pilots reflect alternative financial configurations, largely based on public funding, industrial investment and project-based financing, rather than community capital mobilisation, illustrating different pathways to deploying similar technological systems.

Technical and infrastructural conditions are closely linked to regulatory and organisational factors. Technology choices depend on resource availability, system design, grid access and local capacities [14][16][24][27]. RECs may integrate multiple technologies: solar, wind, biomass or hydro alongside storage and hybrid systems [16][27]. Technical assistance, covering design, compliance, financing and capacity-building, is essential and must be adapted to local contexts [9]. Grid integration, permitting processes and adequate network infrastructure remain decisive, particularly where municipal capacity requires strengthening through technical expertise and digital tools [14][23]. This dimension is strongly represented across the ECOLOOP pilots, which explicitly focus on the integration of multiple distributed renewable energy sources: Agri-PV, biogas, biomass and geothermal systems, within site-specific configurations adapted to local resource conditions.

Organisational capacity and staged development further shape REC trajectories. Projects typically evolve through phases: from initial mobilisation and resource assessment to formalisation, implementation and long-term management. Each requires specific technical, financial and social inputs [10][22]. Strong core groups, access to skills and resources, effective partnerships and supportive policy environments are critical throughout [10][31]. Intermediary organisations and advisory structures facilitate knowledge transfer, build credibility and strengthen local capacity, while education and training reinforce cooperative values and social cohesion [9][18][28][31]. In the ECOLOOP context, organisational capacity is primarily embedded in structured consortia

combining research organisations, SMEs and sectoral actors, which contrasts with the grassroots mobilisation processes typically observed in RECs while still fulfilling similar coordination and implementation functions.

More broadly, REC development is inherently multidimensional, integrating energy, economic, social and environmental objectives [11]. Energy activities intersect with cost reduction, revenue generation, carbon mitigation, land-use optimisation and community wellbeing [11][23][24][31]. Land-use planning must balance renewable deployment with environmental protection, prioritising suitable areas and integrating restoration measures [23]. Fair benefit distribution, productive energy uses and alignment with broader policy goals enhance legitimacy and resilience [24][29]. Cultural and gender dimensions are increasingly recognised as integral to inclusive governance and long-term viability [18][24]. Rather than converging towards a single model, RECs evolve through context-specific adaptations shaped by territorial and institutional conditions [19][27]. The ECOLOOP pilots exemplify this multidimensionality, combining energy production with agricultural, forestry and industrial value chains, as well as circular resource use, although the social and governance dimensions are less developed compared to the comprehensive models described in the literature.

Taken together, these interrelated dimensions—governance, financial design, technical feasibility, organisational capacity and socio-environmental integration—determine the long-term viability and legitimacy of Rural Energy Communities across diverse rural contexts [7][9][12][14][23][27][31]. From an analytical perspective, the ECOLOOP pilots can be interpreted as partial realisations of these dimensions, with strong emphasis on technical integration and resource efficiency, but more limited alignment with participatory governance and community ownership structures.

3.6. Rural Energy Communities in the European project landscape

Rural Energy Communities (RECs) are embedded within an evolving European policy, funding and project ecosystem that positions them as key instruments for decentralised decarbonisation, rural development and energy sovereignty [7][12][16][29]. Their legal basis stems from the Clean Energy for All Europeans Package, particularly RED II (revised as RED III) and the Internal Electricity Market Directive, which require Member States to establish enabling frameworks and streamline permitting [12][23][29]. Implementation takes place through national transposition and is supported by a wide range of EU financial instruments—including EAFRD, ERDF, the Just Transition Fund, Horizon programmes and the Recovery and Resilience Facility—aligning RECs with broader climate and agricultural policy objectives [12][16][23][29]. However, access to funding is typically

mediated at national and regional levels, and deployment remains strongly influenced by local socio-economic and institutional conditions, favouring place-based approaches over standardised models [12][26]. The ECOLOOP project is situated within this broader European innovation landscape, particularly under Horizon Europe, contributing to the demonstration of integrated renewable energy systems in rural areas, albeit without an explicit focus on community-led governance structures.

Within this framework, dedicated support structures have emerged. The Rural Energy Community Advisory Hub (RECAH) provided guidance on legal, financial and organisational aspects, as well as tailored technical assistance to rural communities across Member States, contributing practice-based insights to the European debate [9][13][16]. It operated alongside initiatives such as the Energy Communities Repository and intersected with research projects including COMETS, NEWCOMERS, SocialRES and COME RES, which explore governance, participation and innovation in community energy [11]. Broader EU-funded projects under Horizon and LIFE programmes have addressed technical, financial and social dimensions, reinforcing the role of these initiatives as experimental and learning platforms [26]. At the same time, academic literature remains more focused on models and barriers than on long-term outcomes, further highlighting the importance of project-based learning [19]. Compared to these initiatives, which often prioritise governance innovation and citizen participation, ECOLOOP places stronger emphasis on technological integration, circular resource use and sector coupling (agriculture, forestry and energy), thereby complementing existing research by addressing the techno-economic foundations that may enable future REC development.

Empirical evidence reflects both the scale and uneven distribution of energy communities in Europe. Estimates suggest thousands of initiatives and widespread citizen participation, with growing contributions to installed renewable capacity and significant investment volumes [27][29]. However, geographical disparities are marked: countries such as Germany, the Netherlands and Denmark lead, while others show limited development [27][29]. Following directive transposition, new communities have expanded rapidly in countries like Spain and Italy, alongside longstanding cooperative traditions in certain regions [27]. Diverse organisational and technological models—from cooperatives to bioenergy villages—demonstrate the adaptability and replication potential of RECs under shared EU policy frameworks [16][24]. In Spain, multiple initiatives illustrate alignment between EU funding, national regulation and local experimentation, supported by increasing numbers of community energy projects [22][29]. Within this heterogeneous landscape, the Spanish ECOLOOP pilot aligns with regions experiencing recent growth in decentralised renewable initiatives, while the Estonian, Slovenian and Bulgarian pilots reflect contexts where resource availability, industrial structures or centralised systems shape alternative pathways to rural energy system development.

Despite this expansion, structural challenges persist. Rural RECs remain at early stages in advanced system functions, indicating the need for continued support beyond deployment, particularly in

governance and capacity building [7]. Uneven national implementation of EU directives has also led to distortions, including the emergence of “false communities”, underlining the importance of robust legal frameworks [29]. Sectoral organisations and federations, together with research institutions, play a key role in representation, replication and knowledge development [27]. At the same time, initiatives addressing energy poverty highlight the social dimension of RECs, linking renewable energy deployment with redistribution mechanisms [26][29]. Overall, while the European ecosystem provides a comprehensive regulatory, financial and knowledge base, outcomes remain uneven and strongly dependent on national and local conditions. From this perspective, ECOLOOP contributes to the European ecosystem by addressing implementation-level challenges—such as system integration, resource efficiency and cross-sectoral coordination—while also illustrating the gap between technologically advanced rural energy systems and fully developed community-based governance models.

3.7. Systemic challenges beyond enabling frameworks for Rural Energy Communities.

While the literature provides detailed insights into governance, financing, enabling frameworks and resource mobilisation [7][9][12][13][14][16][18][22][29], less attention is given to systemic challenges that extend beyond project-level conditions. In particular, issues of scale and structural integration remain underexplored. RECs are typically framed as place-based and proximity-driven [7][8][27][29], yet the implications of scaling, through membership growth, inter-municipal aggregation or market integration are rarely analysed. This raises tensions between democratic governance principles and organisational expansion, particularly regarding decision-making efficiency, professionalisation and capital requirements [8][29]. Similarly, replicability remains uncertain, as models rooted in strong cooperative traditions may not transfer easily to contexts with weaker institutional capacity [27][29]. Evidence from the ECOLOOP pilots illustrates a related but distinct challenge: while large-scale, multi-actor energy systems, such as the hybrid Agri-PV and biogas configuration in Spain or the industrial biomass systems in Slovenia, demonstrate technical scalability, they do not inherently resolve questions of governance scaling or community participation, highlighting a gap between system expansion and collective ownership models.

The interaction between RECs and existing energy market structures also remains insufficiently examined. While barriers such as grid access and regulatory complexity are well documented [7][13][22][23][29], the broader political economy of liberalised markets receives less attention. The ability of RECs to participate in flexibility markets, influence pricing or access fair grid conditions is shaped by frameworks designed for large-scale actors [13][24][29]. As a result, communities are often positioned as complementary actors rather than as agents capable of reshaping market structures [11][29]. This structural asymmetry is evident in pilots such as

Slovenia, where advanced CHP systems are explicitly designed to provide ancillary services to the grid, or Bulgaria, where integrated energy systems operate within existing market logics. These cases demonstrate that technical capability to engage with markets does not automatically translate into community-level agency within those markets.

Financial sustainability beyond initial funding phases represents another key gap. Although diversified financing models are widely described [12][16][18][24], less focus is placed on long-term resilience under changing policy and market conditions. Rural contexts, often characterised by lower income levels and limited investment capacity, may be particularly vulnerable to subsidy withdrawal or price volatility [15][16][29]. The long-term risk profile of small-scale, localised systems remains insufficiently addressed. In contrast, ECOLOOP pilots are largely driven by industrial actors, research institutions or vertically integrated companies, as observed in Bulgaria and Estonia. While this structure enhances financial robustness and investment capacity, it also underscores the structural difficulty for citizen-led or community-based models to mobilise comparable capital under current market conditions.

Social dimensions are frequently acknowledged, including inclusion, gender and energy poverty [18][22][29], yet a more explicit justice-oriented perspective is often lacking. Issues such as unequal access, intra-community disparities and participation fatigue receive limited systematic analysis. While cooperative governance is assumed to ensure fairness [8][29], empirical evidence on internal dynamics and conflicts remains scarce [9][29]. The ECOLOOP pilots further illustrate that, in the absence of explicit participatory structures, social benefits, such as local employment, resource efficiency or environmental improvements, may still be generated, but without necessarily addressing distributional justice or inclusive decision-making processes.

Digitalisation represents an emerging but underdeveloped dimension. Although technologies such as smart metering and flexibility systems are recognised as enablers [13][24], their implications for data governance, benefit allocation and digital dependency are rarely examined. Uneven access to digital infrastructure and skills may introduce new forms of exclusion within otherwise inclusive models. This dimension becomes particularly relevant in pilots such as Bulgaria and Slovenia, where advanced monitoring systems, SCADA platforms and optimisation tools are central to system operation, raising questions about data ownership, control and accessibility that remain largely absent from REC-focused literature.

Finally, longitudinal perspectives are limited. The literature focuses primarily on early-stage development and enabling conditions [9][10][22][29], with less attention to long-term organisational evolution, asset management and institutional adaptation [14][27]. Questions related to leadership continuity, professionalisation and the transition towards hybrid models remain insufficiently explored, constraining understanding of long-term stability. The ECOLOOP framework, with its emphasis on technological demonstration and short- to medium-term

validation, reflects this broader gap, as long-term governance evolution, community integration and institutional durability remain outside the primary scope of most pilot implementations.

Taken together, these challenges—scale, market integration, financial resilience, justice, digital governance and institutional evolution—highlight that enabling frameworks, while necessary [12][23], are not sufficient to ensure the durable integration of RECs. Addressing them requires moving beyond project-level approaches towards a deeper analysis of structural, market and socio-technical dynamics shaping rural energy transitions. In this context, projects such as ECOLOOP provide valuable insights into the technical and economic feasibility of integrated rural energy systems, but also indirectly expose the limitations of current approaches in bridging the gap between technological innovation and community-based energy governance (see Figure 3.5).

Challenge	REC Literature	ECOLOOP Pilots
 Scale	Limited analysis	Technically scalable systems
 Market Integration	Weak agency	Active participation
 Financial Resilience	Uncertain long-term sustainability	Strong investment capacity
 Justice	Assumed but not demonstrated	Limited participatory structures
 Digitalisation	Underexplored governance	Advanced monitoring and optimisation
 Institutional Evolution	Lack of long-term perspective	Focused on short-medium term

Figure 3.5: Comparison between structural challenges of Rural Energy Communities and empirical evidence from ECOLOOP pilot sites

4. Economic evaluation of RES investment

In this chapter, we will introduce the economic aspects of RES investments on 3 scales: a household rooftop 10 kWpPV installation, 100kWp standalone PV installation and 1 MW biomass generation unit. Although different scales are connected to different investors' aims, all were evaluated against the electricity market conditions and upcoming support schemes for energy sales. We investigated net-metering scheme for households configurations and Contracts for Difference (CfD) and Power Purchase Agreement (PPA) as an exit mechanism for net-metering schemes. Larger units, solar and biomass production were analysed from aspects of CfD and PPA only.

4.1. Supporting schemes

CfDs are already well-established financial instruments with diverse applications across various sectors. In recent years, they have gained significant popularity in the RES sector as a mechanism to stabilise revenues and mitigate risks for investors. CfDs are based on the difference between a fixed strike price and a reference price. The strike price is typically determined through tendering procedures by the bidders, while the reference price is pre-set for specific time periods (hours, days, weeks, months). The core of the mechanism involves an annual net payment exchanged between two parties. The process works as follows: if the strike price exceeds the reference price, producers receive payments. Conversely, if the reference price exceeds the strike price, producers must make payments to the counterparty, typically a government or corresponding national entity [30]

PPAs are designed to facilitate the sale or purchase of electricity outside the wholesale electricity market. These contracts are entered into by two or more entities, outlining terms such as duration, quantity, pricing methods, and invoicing procedures [31].

Due to the wide range of PPA structures, implementing and executing the mechanism can be complex. For this study, a simplified scenario with two entities is considered. The electricity producer owns the biomass power plant, while the consumer is an energy-intensive company that operates continuously. This implies that all electricity produced by the producer is fully consumed by the company, which also fully bears the reconciliation costs.

Recent research has increasingly examined long-term contracting mechanisms to support renewable energy deployment, with particular focus on CfDs and. A key strand of the literature explores hybrid contracting models designed to reduce revenue volatility while maintaining

efficient market signals. In literature, [33] critically analyse conventional CfD schemes, highlighting how linking support payments directly to physical output may distort dispatch incentives and investor behaviour. They propose a financial CfD design that decouples support from actual generation, thereby reducing market distortions. However, their contribution remains largely conceptual and lacks techno-economic validation under real operating conditions.

In contrast, [34] investigate empirical hedging strategies for PPAs using short- and medium-term electricity futures. Through stochastic modelling, they assess hedge effectiveness under price and volume risks. While this work provides valuable insights into market-based risk management, it does not address the interaction between PPAs and public support instruments such as CfDs.

Similarly, [35] develops a portfolio optimisation framework to evaluate revenue stability in mixed CfD–merchant exposure structures for wind and solar assets. Although this advances understanding of hybrid revenue models, the analysis is limited to non-dispatchable technologies and does not consider the simultaneous coexistence of different contracting mechanisms.

Taken together, these studies represent the current state of the art in risk mitigation and investment support for variable renewable energy sources. Nevertheless, important gaps remain. The literature pays limited attention to firm, dispatchable renewables such as bioenergy; it lacks integrated modelling of CfD and PPA coexistence; and it offers insufficient techno-economic analysis grounded in real project data.

This calculation partially addresses these shortcomings by conducting a techno-economic assessment of a biomass power plant operating under separate and combined CfD and PPA arrangements. Using national-level data from Slovenia, we examine how each mechanism influences investment attractiveness, revenue stability, and system efficiency, particularly under conditions of surplus generation and negative electricity prices. By doing so, we bridge a methodological and empirical gap while contributing to the development of diversified and resilient contracting strategies applicable to dispatchable renewable technologies.

More broadly, the calculations aim to inform both policy design and project development by providing evidence-based insights into the structure and viability of hybrid support mechanisms, and by demonstrating the potential role of decentralised bioenergy systems in achieving the EU's green transition objectives.

At the EU level, a wide range of support instruments has been introduced to accelerate renewable energy deployment [36]. Most recently, the electricity market design reform adopted in May 2024 through Regulation (EU) 2024/1747 [37] reinforced the role of long-term contracting mechanisms. In particular, Contracts for Difference (CfDs) and Power Purchase Agreements (PPAs) are recognised as key tools to stimulate investment in renewable energy technologies, including bioenergy and biomass-based power generation.

4.2. RES investment types

In this subchapter we describe the background for each of the investment types and the motivation behind it. The analysed investment cases are closely aligned with the implementation pathways explored in the ECOLOOP pilot activities across Spain, Bulgaria, Slovenia, and Estonia. In particular, medium-scale installations, such as the 100 kWp standalone PV system reflect realistic entry points for community-based investments, where RECs can jointly develop and operate shared assets. The comparison between CfD and PPAs provides relevant insights for support scheme design and optimisation, directly supporting pilot activities such as the Slovenian use case on redesigning subsidies and business models.

Furthermore, the inclusion of a 1 MW biomass generation unit reflects the potential for dispatchable renewable energy solutions in rural areas, which are particularly relevant for agricultural and forestry contexts present across all pilot countries. While Slovenia and Estonia show stronger alignment with biomass-based systems, Bulgaria and Spain focus on potential for biogas applications. The economic evaluation methodology applied in this chapter can therefore be adapted across pilots to assess the feasibility of locally available feedstocks and technologies.

Overall, the economic analysis supports the translation of ECOLOOP concepts into investment options, providing practical insights for both individual farmers and emerging energy communities, while informing policy and business model development across different national contexts. The economic analyses, presented in this chapter are not intended as pilot-specific calculations, but rather as a strategic and transferable framework for evaluating renewable energy investments across different rural contexts. The focus is on demonstrating the benefits of various RES technologies and developing a robust, replicable methodology for assessing the economic performance of REC investments. At this stage of the project, detailed, location-specific economic modelling was not yet required, as the corresponding social engagement and implementation activities had not reached the phase where such analyses would be directly applied.

Instead, this approach ensures that a consistent and adaptable analytical foundation is established in advance. Within the ongoing KER 6 activities, this methodology will be further refined and tailored to specific pilot contexts, incorporating country-specific boundary conditions, regulatory environments, and technical configurations.

This will enable the development of targeted guidelines and decision-support tools for rural stakeholders, supporting informed investment decisions and facilitating the practical deployment of renewable energy solutions in line with local conditions. Importantly, the economic evaluation presented in this report represents only one dimension of this support framework. It is complemented by social engagement guidelines, which address stakeholder motivation, participation, and trust-building, as well as by policy analysis, recommendations, and identified regulatory requirements. Together, these elements provide a comprehensive and integrated approach, ensuring that renewable energy initiatives are not only financially viable, but also socially accepted and supported by an enabling policy environment.

4.2.1. Household PV installation

The first case considers a prosumer, where the power profile is based on the yearly load profile of an average Slovenian household [38]. The profile of a rooftop PV system with a capacity of 10 kWp was added to assess self-consumption and market interactions. The annual PV production data were obtained from [38] and scaled accordingly. The total annual electricity consumption of the prosumer is 6,76 MWh, while the PV system produces 12,15 MWh annually, as shown in Figure 4.1. During periods of high production, the excess electricity is sold at market prices, while during times of higher consumption than generation, the prosumer purchases electricity from the grid at a retail price of 0.2025 EUR/kWh [39]. Prosumers participating in the analysed schemes are not eligible for additional support mechanisms such as net metering or net billing.

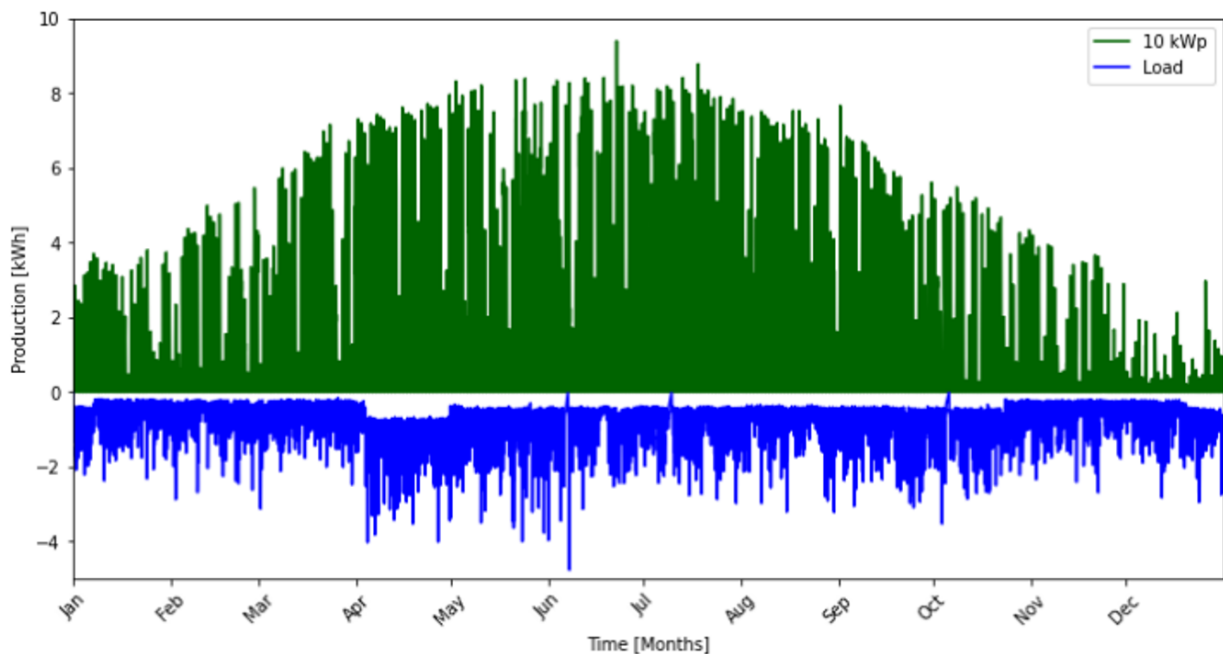


Figure 4.1: Household Consumption and PV generation profiles

Household decided for PV installation in order to reduce its energy consumption costs, and gaining revenues from energy sales. They can sell surplus to the energy market, where their energy is purchased at a market price level, they can additionally enter CfD scheme or decide for PPA with another energy consumer.

4.2.2. Stand-alone PV installation

In contrast to a household (prosumer) model, where electricity is partially consumed on-site - a large production unit owner operates exclusively as a power generator, without engaging in self-consumption. All electricity generated by the installation is exported directly to the grid and sold

on the electricity markets, typically under merchant conditions or through long-term contractual arrangements. This configuration reflects a purely market-oriented investment strategy, where revenues depend entirely on wholesale prices and applicable support mechanisms.

Such a scenario can represent a variety of photovoltaic (PV) applications, including ground-mounted systems, agrivoltaic installations combining energy and agricultural production, as well as larger commercial or industrial rooftop systems. Unlike smaller distributed prosumer setups, these installations are designed primarily to optimise generation output and revenue streams rather than offset on-site demand.

Applying the same scaling methodology used in the household case, a PV system with an installed capacity of 100 kWp is estimated to produce approximately 121.50 MWh of electricity per year under the given irradiation and performance assumptions. This annual output forms the basis for evaluating market revenues, financial performance, and potential contractual arrangements.

4.2.3. Biomass powered electricity generation

In order to conduct a representative economic analysis of a biomass power plant situated in Slovenia, the total annual Slovenian yearly biomass power plant generation, on an hourly basis, was obtained from [40] and the installed capacity from [41]. These national-level datasets were used in place of pilot site data due to the unavailability of high-resolution operational data at the initial stages of the project. The use of aggregated, country-level data provides a consistent and complete basis for scalable analysis. For this purpose, the data was normalised to reflect the energy production of a biomass plant with a nominal capacity of 1 MW operating under average national conditions. The resulting generation profile is shown in Figure 4.2. It is worth noting the drop in production during the last quarter of the year. This behaviour realistically reflects the operation of the plant, as such a decline could represent scheduled maintenance activities.

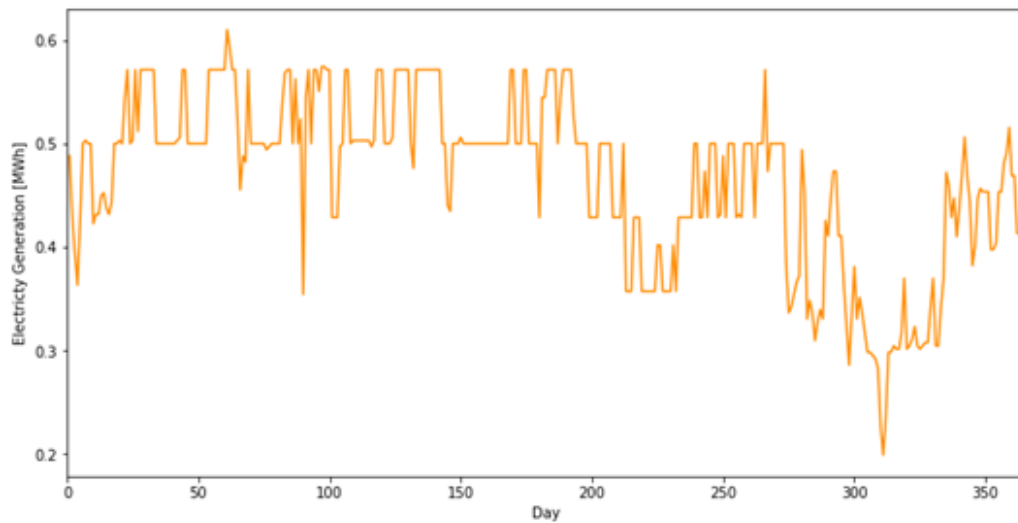


Figure 4.2: 1MW Biomass plant yearly production profile

The economic analysis, including data processing, normalization, and scaling, was performed using Python, leveraging its capabilities for handling time-series data and computational modelling—generation/service revenues/benefits.

4.3. Results

The economic evaluation of the production profiles used 3 distinctive price signals, that were basis for evaluation of produced energy: Day-ahead electricity prices, price setpoints for CfD scheme and PPA agreed purchase rates. On the figure below we present the dynamics of the Day-ahead market prices to which the energy producers is exposed.

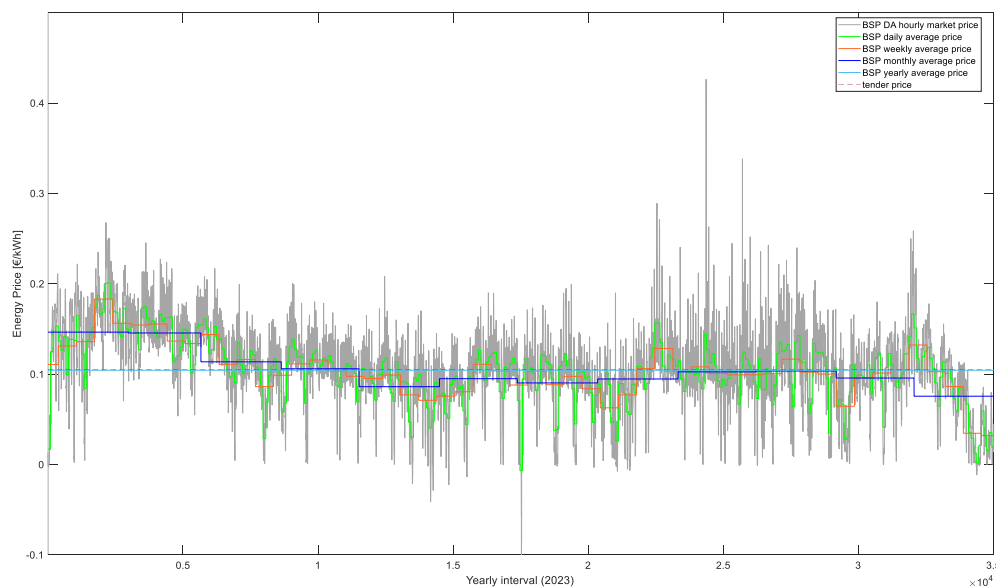


Figure 4.3: Yearly profile of hourly Day-ahead market prices

CfD as a support mechanism helps to protect producer and government bodies, purchasing the energy, from price fluctuations. Strike prices were determined based on the average Day-Ahead Market (DAM) price in Slovenia for 2023 [42], set at 105 EUR/MWh. The analysis explores three strike price scenarios: 85 EUR, 105 EUR, and 120 EUR/MWh. Reference prices cover various intervals, including average hourly, daily, weekly, monthly, and yearly periods, and are also based on the Day ahead (DA) energy market. The CfDs can include band gaps, designed to introduce flexibility by disregarding minor discrepancies between the strike and reference prices. This approach minimises the number of insignificant payments, which have negligible effects on annual net payments.

Due to the wide range of PPA structures, implementing and executing the mechanism can be complex. For this study, a simplified scenario with two entities is considered. The electricity producer owns the biomass power plant, while the consumer is an energy-intensive company that operates continuously. This implies that all electricity produced by the producer is fully consumed by the company, which also fully bears the reconciliation costs.

Given the low liquidity of Slovenian power futures, the prices were sourced from the Hungarian derivative exchange HUDEX [43], considered the most suitable approximation as Quarter Futures for 2024 Q2, Q3, Q4, and 2025 Q1. These prices were then adjusted by factors of 2 %, 7 %, and 12 % to ensure profitability for both stakeholders, the producer and the consumer. A price spread of 10 % was applied to enable a sensitivity analysis. Also in this case, the contract duration was set to 15 years, with economic analyses conducted on an annual basis.

4.3.1. Household PV installation

As stated previously, the household owner has a yearly consumption of 6,76 MWh yearly. In case of single tariff energy purchase from the grid (202,5 €/MWh), his yearly energy bill amounts to 1365,60 €. After the 10 kWp PV installation, his PV generates 12,15 MWh yearly, partially covering his demand in some time intervals, while surplus is being sold to the electricity market. Table below contains key economic information:

Table 4.1: Yearly legacy mechanism results from households

Household demand	
Yearly energy demand	6,76 MWh
Yearly energy cost	1.365,60 €
After PV installation	
Yearly production	12,15 MWh
Net-metering scheme	1.087,92 €

D5.2. Support for the creation of Renewable Energy Communities in Rural Areas

Net - Billing scheme	25,43 €
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In Table 4.1 above, the calculated annual electricity costs for the consumer are presented. The first figure shows the total annual cost of electricity if the consumer purchases electricity from the grid at the household tariff and does not generate renewable energy sources (RES) themselves - i.e., does not own a RES installation.

The second and third rows present the calculations for a prosumer included in a net-metering scheme, where electricity is accounted for according to the system currently in force in Slovenia, and for a prosumer included in a potential net-billing scheme, where the prosumer purchases electricity from the grid at the household tariff and sells it at the market price.

A consumer with a solar power plant participating in net-metering successfully covers all electricity consumption costs and generates a surplus credit of 1,088 € for the next billing period. In the net-billing scheme, the consumer also fully covers total energy consumption costs and, in addition, gains a credit of 25 € for the following year.

Table 4.2: prosumers revenues in CfD schemes with various strike and reference prices

Annual electricity purchase cost [€]	722.2				
Annual sales revenue [€]	699.7				
Additional remuneration from CfD scheme					
Target price [€/MWh]	Reference price				
	Hourly [EUR]	Daily [EUR]	Weekly [EUR]	Monthly [EUR]	Annual [EUR]
85	139,5	46,7	17,3	0,2	0,0
105	233,7	109,2	81,2	67,3	5,5
120	331,3	195,8	181,5	176,3	130,5

The Table 4.2 indicates annual cost component of the consumer's electricity consumption amounted to 722,23 €, while the sale of surplus generated electricity on the wholesale market generated 699,74 € in revenue. These figures correspond to the calculation under the net-billing system. Upon entering the CfD scheme, the prosumer is additionally settled for the difference between the target price and the reference price. When participating in a one-sided Contract for Difference scheme, the consumer received up to 331,3 € per year through the CfD mechanism in the most favourable scenario, where the target price equals 120 €/MWh and the reference price is calculated based on hourly intervals, also seen on Figure 4.4 below.

D5.2. Support for the creation of Renewable Energy Communities in Rural Areas

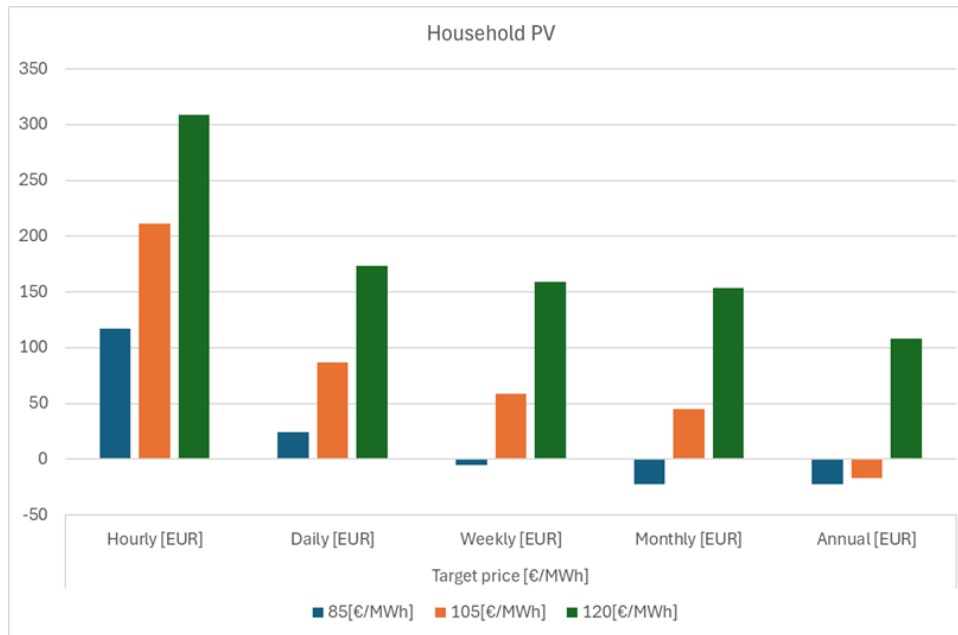


Figure 4.4: Household PV additional CfD mechanism support

For all target prices, the consumer received lower support when the averaging interval used to determine the reference price was extended. This approach reduces or eliminates payouts by 46.7 € (from daily to annual averaging) at a target price of 85 €/MWh. Meanwhile, shifting from a daily to an annual reference price at target prices of 105 €/MWh and 120 €/MWh represents a reduction in support of 104 € and 65 €, respectively.

Table 4.3 below presents the prices of forward products on the basis of which the PPA calculations were conducted. Q1 represents the period from 1 January to 31 March, Q2 from 1 April to 30 June, and so on. Prices are expressed in EUR/MWh. In addition to the base price, the table also shows prices multiplied by factors of 1,02, 1,07, and 1.12, which were actually used for the calculation of the CfD mechanism.

Table 4.3: PPA quarterly prices and factors

HUDEX	Quarterly price [EUR/kWh]	+ 2 % [EUR/kWh]	+ 7 % [EUR/kWh]	+ 12 % [EUR/kWh]
Q1	110	112	117	123
Q2	115	117	123	129
Q3	90	92	97	101
Q4	103	105	110	115

Table 4.4: Yearly revenues with PPAs

Single tariff rate (ST) [€/kWh]	0,2025
Annual electricity cost [€]	722,2
Annual sales revenue, 2% [€]	952,97
Annual sales revenue, 7% [€]	999,68
Annual sales revenue, 12% [€]	1046,4
Annual balance: purchase (ST) + sales 2% (PPA) [€]	221,03
Annual balance: purchase (ST) + sales 7% (PPA) [€]	267,75
Annual balance: purchase (ST) + sales 12% (PPA) [€]	314,46

As already stated, the same input data (self-consumption and the purchase price of electricity from the grid) were used as in the CfD scheme calculations and the differences are not significant. In our case, the earnings under the PPA scheme are lower compared to the CfD schemes, but the associated risk is consequently lower as well, which is an important factor for small producers when making an investment decision. Compared to the CfD scheme, the PPA scheme is less sensitive to short-term drastic changes in electricity prices.

4.3.2. Stand Alone PV installation

Additional calculations were carried out for a 100 kWp PV installation by analysing a commercial-scale system in which a company invests in a large solar power plant (e.g. agrivoltaics) and sells all generated electricity to the grid, without self-consumption. Based on preliminary calculations (using the same methodology as for the 10kWp system), the annual electricity production was estimated at 121.50 MWh. In the CfD scheme, this energy is delivered to the grid, while under the PPA scheme, it is sold directly to an energy company. The production profile was obtained by extrapolating the previously derived 10 kWp PV generation profile. Within the CfD framework, identical configurations as in the small-scale case were analysed, except for the absence of self-consumption. The results show that market-based electricity sales alone generate 9988.8 € annually, while the inclusion of a one-sided CfD significantly increases profitability by almost 50% (EUR 4,347.2) at a target price of 120 €/MWh under hourly reference pricing. However, even when applying a deadband mechanism, profits remain substantially elevated, suggesting that a one-sided CfD mechanism may be less appropriate for large, commercially mature PV installations due to the strong profit amplification effect. Similar to the smaller PV system, profitability decreases as the reference period lengthens, leading to lower effective revenues or the target price is set lower, reducing the subsidy effect.

D5.2. Support for the creation of Renewable Energy Communities in Rural Areas

The one-way mechanism (without clawbacks) offers the highest revenues but is not suitable for broad market implementation, as it shifts all the risk from the producer to the state budget. The introduction of a band gap reduces extreme revenue variations, making the mechanism more manageable and cost-effective. However, the overall financial impact remains limited, and the fundamental cost-benefit balance of the CfD scheme remains unchanged.

The PPA analysis was conducted in the same manner as for the 10kWp PV system. As shown in Table 4.5 and Figure 4.5 below, revenues under the PPA scheme are comparable to those under the two-way CfD mechanism, even slightly higher than in the highest strike price scenario, when considering both market sales and revenues from the CfD mechanism. Therefore, PPA remains a lower-risk and profit higher option compared to CfD, making it an attractive alternative.

Table 4.5: 100 kWp PV unit yearly revenues

Adjustment factor (PPA)	Revenue [€/Year]				
2%	12,225.2				
7%	12,824.5				
12%	13,423.8				
Target Price (CfD)	Revenue [€/Year]				
	Hour	Day	Week	Month	Year
85 EUR/MWh	9,878.9	8,460.4	8,430.6	8,567.3	8,252.4
105 EUR/MWh	11,874.5	10,464.7	10,290.8	10,168.7	9,988.8
120 EUR/MWh	13,374.4	11,825.7	11,667.8	11,581.2	11,101.1

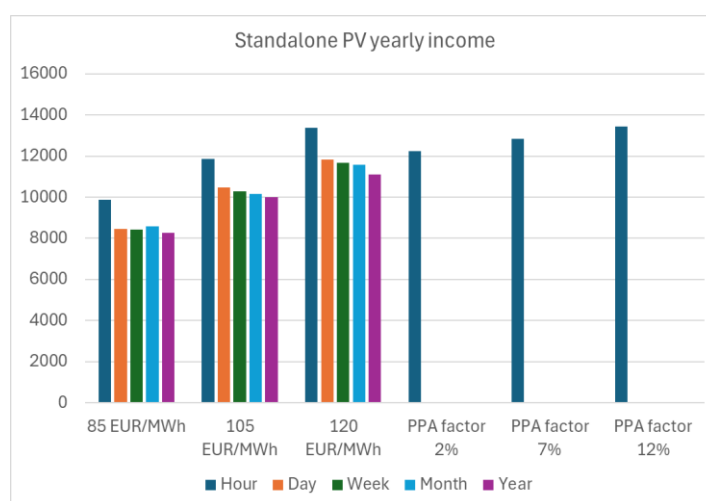


Figure 4.5: Stand alone PV yearly revenues on CfD or PPA support schemes

4.3.3. Biomass production unit

The analysed scenario yields an annual production of 4,092 MWh. Under the CfD scheme, the producer sells electricity on the market, generating a yearly profit of 430,460 EUR. The two-way CfD mechanism supplements this income based on the strike price and reference period. A sufficiently high strike price results in additional earnings, while a lower strike price may trigger clawback payments, reducing profits. In general, higher strike prices increase revenue, whereas longer reference periods reduce both gains and losses. As shown in Table 4.6 below, differences between reference periods are minimal, primarily due to the stable generation profile of biomass power plants.

As an alternative to the CfD, the PPA mechanism was also evaluated. Under a PPA, electricity is sold directly to a designated buyer rather than on the wholesale market. For prosumers, the main advantage is reduced risk, as PPAs protect against short-term market price fluctuations. Profitability results are presented in table below. Compared to the CfD scenario with the highest strike price and an hourly reference period, the PPA delivers similar financial outcomes. Considering the structure of both mechanisms, including risk exposure, cost implications, and market dependence, the PPA appears to be the more favourable option for stakeholders.

Table 4.6: 1MW Biomass production unit yearly revenues

Adjustment factor (PPA)	Revenue [EUR/Year]				
2%	430290				
7%	459775				
12%	481260				
Target Price (CfD)	Revenue [EUR/Year]				
	Hour	Day	Week	Month	Year
85 EUR/MWh	- 74385,1	- 73165,2	-73263	- 68896,6	- 61738,3
105 EUR/MWh	-1077,7	-350	-5307,8	-5934,3	0
120 EUR/MWh	53004,5	50256	46042,6	45006,8	39547,5

The analysis shows that the economic viability of CfD and PPA schemes is highly context-dependent and strongly influenced by contract parameters, particularly the strike price in CfD arrangements. When the objective is to reduce investor risk, the strike price should reflect average

generation costs and market volatility. If the goal is to stimulate new investment, a more favourable strike price may be required as seen on Figure 4.6.

For bioenergy projects, which provide stable and dispatchable generation, PPAs are especially suitable, as they ensure predictable revenues aligned with market conditions and support long-term contractual relationships between producers and off-takers. Encouraging the use of PPAs in this sector could contribute to a more balanced renewable energy portfolio and reduce excessive reliance on variable sources such as wind and solar.

While support mechanisms may not always yield the highest economic returns, particularly under minimum production constraints or periods of negative pricing, their main value lies in enhancing investment security and revenue stability. Properly designed contractual frameworks can facilitate more efficient deployment of dispatchable renewable technologies in increasingly complex electricity markets.

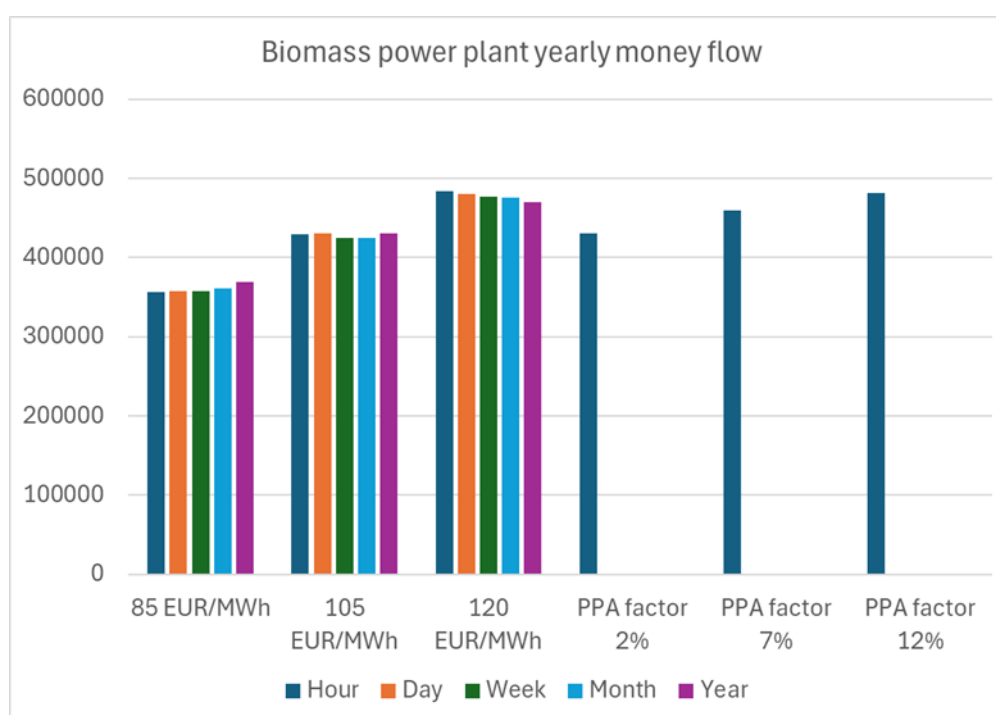


Figure 4.6: 1MW Biomass power plant yearly revenue comparison

5. Social aspects of Rural Energy Communities - engagement campaigns

Rural Energy Communities (RECs) are not only technical or financial arrangements for renewable energy production and sharing; they are collective governance projects embedded in specific territorial and social contexts. Their configuration depends on how local actors organise participation, distribute decision-making power, communicate objectives and negotiate benefits and responsibilities over time. In rural settings marked by close social ties, heterogeneous capacities and proximity to land and infrastructure, engagement becomes a structuring condition that shapes project design, implementation and durability. Understanding how engagement is organised—who is involved, through which mechanisms, and under what governance safeguards—is therefore central to analysing the robustness and equity of Rural Energy Communities.

In the context of the ECOLOOP project, engagement processes emerge under different structural conditions than those typically described for RECs. The four pilot sites—Spain, Estonia, Slovenia and Bulgaria—are primarily driven by technological integration, industrial actors or institutional partnerships rather than by citizen-led governance. As a result, engagement does not originate from collective ownership structures but must be actively constructed around existing energy, agricultural and industrial systems. This shifts the analytical focus from participation as a founding principle to engagement as a facilitating mechanism, involving farmers, landowners, companies, researchers and public actors in varying configurations. Examining how these actors are mobilised across pilots—whether through resource provision, knowledge exchange, demonstration activities or stakeholder involvement—provides a grounded perspective on how engagement can operate in rural energy transitions beyond ideal-type REC models.

5.1. Importance of social engagement in Rural Energy Communities

Social engagement is widely recognised as a foundational dimension of Energy Communities (ECs), particularly in rural contexts where trust, local identity and social relations shape project development [7][19]. Rather than a secondary component, engagement is understood as a

prerequisite for legitimacy, viability and long-term sustainability [8][10][16]. Social acceptance directly influences planning processes, implementation timelines and operational continuity, especially for projects with visible impacts [8][14][23]. Early, transparent and continuous participation—combined with clear communication and defined community benefits—plays a key role in reducing conflict and maintaining support [14][23]. In rural settings, where initiatives rely on voluntary participation, ongoing interaction and inclusive information-sharing are essential to build trust and foster a sense of ownership [9][10][16][24].

Participation is embedded in the legal foundations of RECs and CECs, which require open membership, effective control and a primary focus on community benefits [13][18][22]. Democratic governance, often based on one-member-one-vote principles, ensures equitable decision-making and reinforces legitimacy [12][29][29]. More broadly, engagement transforms citizens from passive consumers into active participants in energy systems, involved in production, consumption and governance [18][27][29]. High levels of participation observed in practice confirm its structural role, while weak engagement is associated with difficulties in sustaining initiatives over time [18][19].

Engagement also performs important economic functions. Trust and participation facilitate access to finance, support community-based investment models and align financial returns with local benefits [12][27]. Opportunities for citizen investment can reduce opposition to projects and strengthen their integration within local contexts [12][16]. Community ownership, supported by NGOs, local organisations and municipalities, further enhances legitimacy and mobilisation capacity, particularly where trusted intermediaries play an active role [7][22][24].

Beyond implementation, engagement contributes to wider socio-political outcomes. ECs are framed as mechanisms for democratising energy systems, strengthening local governance and promoting behavioural change [18][27][28][29]. Participation enhances energy literacy, encourages efficiency and can help address energy poverty [11][27][29]. A significant share of initiatives explicitly target social challenges such as inequality and rural development, reflecting their broader societal role [18]. Engagement processes, ranging from assemblies and workshops to collaborative planning, support social cohesion, inclusion and local solidarity [16][29][29]. Trust remains the central enabling condition: where it is weak, collective action and perceptions of fairness are undermined [28]. In this sense, participatory structures function not only as governance mechanisms but also as spaces for rebuilding trust and ensuring that the energy transition delivers both environmental and social outcomes [28][29].

In the ECOLOOP pilots (see Table 3.1), these engagement dynamics take different forms depending on the structure of each system. In Spain, engagement is closely linked to farmers and agricultural stakeholders involved in feedstock provision, land use and validation activities, requiring trust-building around new production models such as Agri-PV and biogas integration. In Estonia, engagement centres on landowners, forestry actors and industry partners, where participation is

mediated through data collection, modelling and decision-support tools rather than collective governance structures. The Slovenian pilot involves industrial stakeholders within an energy-intensive site, where engagement relates to operational coordination, system optimisation and potential interaction with external users through district heating. In Bulgaria, engagement extends more explicitly to local actors—including farmers, researchers and stakeholders participating in workshops and regulatory discussions—creating a hybrid space where technological demonstration intersects with more participatory processes. Across these cases, engagement is less about formal membership and more about stakeholder mobilisation, knowledge exchange and alignment of interests, highlighting alternative pathways through which social dimensions can support rural energy system development.

5.2. Target groups in rural engagement strategies

Rural engagement strategies in energy communities target a diverse set of actors (See Figure 5.1), with consistent emphasis on local residents, farmers, SMEs and municipal authorities as core groups [7,10,11,12,14,16,23,29]. Local households form the primary social base, acting as beneficiaries, co-investors and prosumers, with participation strengthening financing capacity and benefit distribution [7,14,16,19,29]. SMEs and local businesses also play key roles as members, consumers and governance partners within community structures [7,11,12,16,18,22,24,29]. Farmers and landowners are particularly significant in rural contexts due to their control over land and resources, especially in bioenergy systems requiring feedstock and logistical coordination [7,10,14,19,23,29].

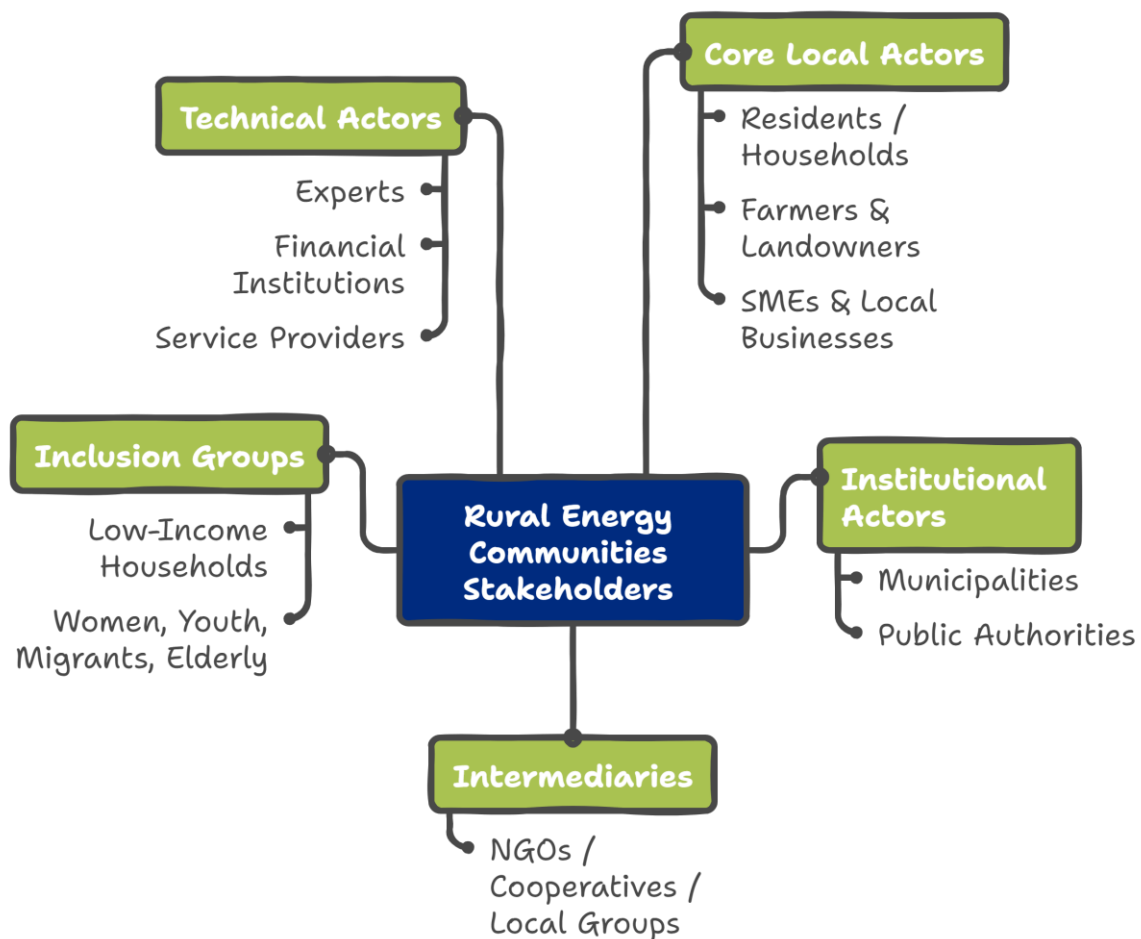


Figure 5.1: Key stakeholder groups to be involved in Rural Energy Communities

Municipalities emerge as central institutional actors, acting as intermediaries and strategic partners that provide legitimacy, administrative support, infrastructure and financial contributions [7,8,9,10,12,14,16,18,23,24,29]. Their involvement is often linked to smoother permitting processes, while their absence can hinder implementation [9,16,23]. They may assume multiple roles: facilitator, promoter, partner, consumer or producer within Rural Energy Communities [18]. Broader public administrations, regulatory bodies and project developers are also involved in coordinated implementation processes [12,23].

The literature highlights the need to account for heterogeneity within rural communities and ensure inclusive participation [8,19]. Although formal segmentation is limited [9,19], engagement strategies typically distinguish between core members, the wider community and influential local actors such as community leaders and mayors [9,10,23]. Local organisations, including NGOs, cooperatives, associations and supra-municipal entities play important intermediary roles, particularly in mixed governance arrangements [7,22,23,29]. NGOs are especially relevant in vulnerable contexts, supporting outreach and inclusion of disadvantaged groups [7,28,29].

Specific attention is given to vulnerable and under-represented populations. Households affected by energy poverty, low-income groups and socially marginalised communities require targeted engagement to avoid exclusion and unequal cost burdens [7,12,24,28,29]. Women, young people and other under-represented groups are identified as needing dedicated support through training, leadership opportunities and education [11,24,28,29]. Migrants, minorities and elderly populations are also recognised, both as groups facing participation barriers and as potential contributors in certain contexts [29].

Engagement strategies further involve technical and professional actors necessary for implementation. External experts, service providers, financial institutions and energy producers contribute to system design, operation and financing [10,16,24]. Regulatory frameworks define eligible members, typically individuals, SMEs and local authorities, sometimes with additional criteria such as proximity or voting limits [13,22]. In practice, diverse actor constellations, including households, businesses, cooperatives and public entities participate in structured governance and investment models [22]. Overall, effective engagement requires coordinating citizens and institutional stakeholders across levels, recognising their differentiated roles in resources, governance, financing and benefit distribution [8,19,23,24].

In the ECOLOOP pilots, the composition and hierarchy of target groups diverge from the typical REC configuration. Households which are central in the literature are not the primary actors in most cases, while farmers, landowners and industrial stakeholders assume a more prominent role. In the Spanish pilot, farmers and agricultural organisations are key actors due to their involvement in feedstock provision, land use and validation of agronomic practices. In Estonia, landowners, forestry actors and industrial partners dominate, with engagement structured around biomass production, data collection and modelling activities. The Slovenian pilot is centred on industrial SMEs and energy operators within the biomass centre, where engagement focuses on system optimisation, flexibility services and potential external users such as district heating customers. In Bulgaria, a broader constellation emerges, including farmers, researchers, local stakeholders and policy actors, reflecting the pilot's explicit inclusion of workshops, regulatory analysis and business model development. Across all pilots, technical experts, research institutions and private companies play a central role, often acting as coordinators or drivers of engagement processes. This reconfiguration highlights a shift from citizen-centred participation towards multi-actor stakeholder engagement, where roles are defined less by formal membership and more by functional contribution to system implementation and operation.

5.3. Key elements of an engagement campaign in RECs.

Effective engagement campaigns in rural energy communities are framed as structured, continuous and participatory processes rather than one-off communication efforts [7][8][19]. Early involvement of community members—starting at the planning stage—combined with transparent communication of objectives, impacts and benefits is essential for building trust and sustaining participation [7][8][14][23]. Clear definition of roles, responsibilities and decision-making procedures, alongside democratic governance principles such as one-member-one-vote, underpins long-term engagement [9][10][19][24][16][22][24][29]. Accountability mechanisms, including transparent reporting, defined revenue allocation and equitable benefit-sharing schemes are also central to maintaining legitimacy [14][24][29].

Operationally, engagement relies on regular and structured interaction mechanisms, particularly in early phases. These include kick-off meetings, follow-up sessions, participatory assemblies and co-decision processes, all designed to maintain momentum and translate discussions into concrete actions [9][10][29]. Continuity is especially important during slow administrative phases to avoid disengagement [16], while flexibility allows adaptation to regulatory or contextual changes [9]. Where required, formal consultation processes must be integrated [12], and structured support schemes, such as those provided by Offices for Community Transformation combine mobilisation, legal support and technical assistance within defined timelines [18].

Capacity-building and energy literacy are key components of engagement strategies. Campaigns typically include workshops, training sessions and educational activities covering technical, financial and administrative aspects, as well as broader awareness of energy systems and climate challenges [7][8][22][28][29]. Early stages often involve resource assessment, citizen training and the formation of a core driving group to lead the initiative [22][29]. Outreach activities, ranging from local sessions to school-based initiatives and peer learning exchanges, help address knowledge gaps and strengthen community involvement [12][16][22][28][29].

Inclusiveness and social cohesion function as cross-cutting principles. Engagement strategies aim to ensure broad representation through inclusive participation spaces, targeted outreach and mechanisms that support gender balance and representation of diverse groups [10][24][29]. Collaboration with municipalities, NGOs, cooperatives and other local actors enhances credibility, while mapping stakeholders and leveraging existing networks supports legitimacy and learning [16][24][29].

Communication strategies extend beyond internal processes to include confidence-building and mobilisation tools. Clear investment propositions, combined with accessible financial mechanisms

such as crowdfunding or microfinance, lower participation barriers and align economic and social benefits [12][28][29][29]. Community events and cultural activities further reinforce collective identity and sustained engagement [29].

Finally, effective campaigns proactively address environmental and social concerns—such as land use, local impacts or mistrust—through transparent communication, participatory planning and mitigation measures [16][23][28][29]. The transition from initial mobilisation to implementation is marked by the consolidation of shared vision into concrete project elements, including feasibility studies, financing structures and governance frameworks [29].

Effective engagement in Rural Energy Communities is then best understood as a structured and iterative process that evolves from initial mobilisation to long-term participation and governance. As outlined above, it combines early-stage awareness-raising, continuous interaction, capacity-building and inclusive decision-making mechanisms, all underpinned by transparency and accountability. These elements do not operate in isolation but form an interconnected sequence that sustains trust, participation and project viability over time (see Figure 5.2).

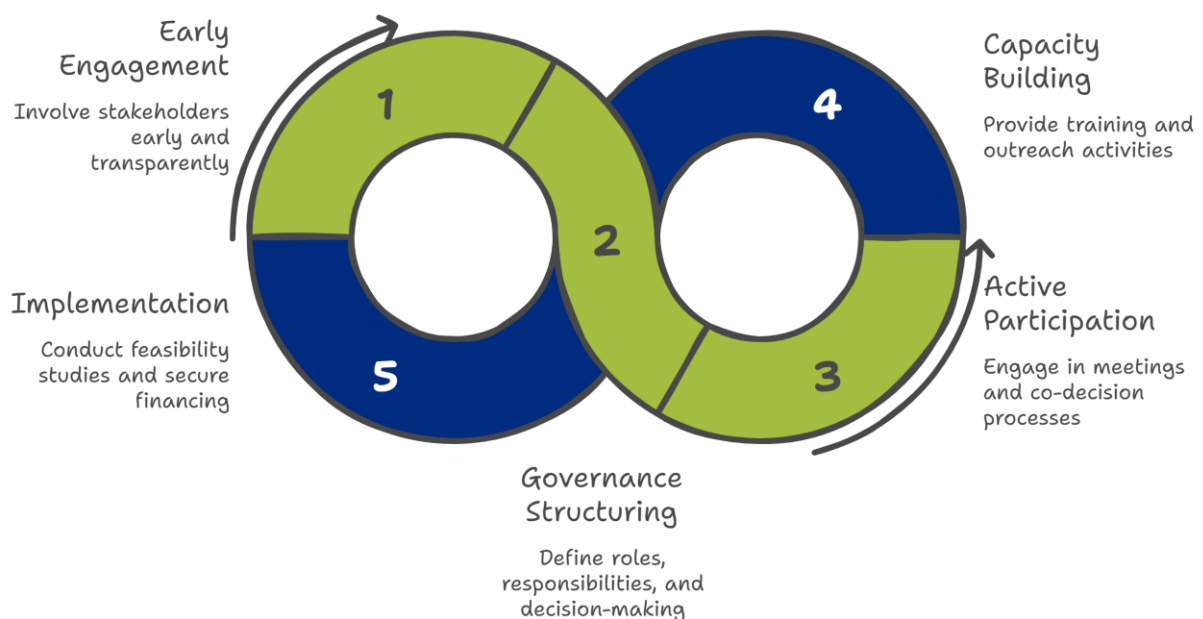


Figure 5.2: Conceptual framework of engagement processes in Rural Energy Communities

In the ECOLOOP pilots, the current engagement is generally not structured as formal campaigns but embedded within core project activities such as demonstrations, technical validation and stakeholder coordination. In Spain, it takes place through direct interaction with farmers, supporting the adoption of Agri-PV systems, biogas integration and bioproduct validation via continuous feedback. In Estonia, engagement is linked to data collection and modelling, involving landowners and forestry actors through technical collaboration. The Slovenian pilot follows a

highly operational approach, centred on system optimisation and coordination among industrial actors, while Bulgaria shows a more structured model with workshops and stakeholder meetings aligned with the literature. Across pilots, capacity-building and knowledge transfer are central, whereas collective decision-making spaces and community investment schemes are less prominent. This reflects a shift from engagement as mobilisation towards an operational function within technological implementation.

In parallel, ECOLOOP includes a dedicated effort to design more formalised and replicable engagement approaches, aimed at structuring the adoption of ECOLOOP solutions. This involves the development of methodologies to organise stakeholder involvement, define participation mechanisms, support capacity-building and articulate clearer value propositions for different actor groups. Within this framework, the Spanish pilot is positioned as a reference case for testing and refining engagement best practices, due to its closer interaction with end-users and agricultural actors. The development of this dedicated engagement strategy, which has greatly benefited from the insights gained during the preparation of this document, is the focus of Task 8.3 within the ECOLOOP project and is described in detail in the corresponding deliverables.

5.4. Communication tools and channels

Communication in rural energy initiatives is understood as context-sensitive, trust-based and structured across both internal and external dimensions [7][8][9][19]. In rural contexts, locally embedded and face-to-face channels, such as community meetings, municipal platforms and local associations, are particularly effective in ensuring accessibility and building trust [7][8][16][29]. Communication strategies should prioritise clarity and adaptability to local capacities, focusing on explaining technical and organisational aspects in accessible ways rather than relying on specific tools [8][19]. While in-person interaction is central for trust-building and consensus, digital tools play a complementary role in supporting transparency and continuity [7][8][29].

In the ECOLOOP pilots, communication structures tend to combine local interaction with technically mediated information flows. In Spain, communication is primarily embedded in the coordination of biomass value chains, where interaction between agricultural actors, intermediaries and industry structures information flows related to feedstock collection, processing and energy use. In Estonia, communication is closely linked to research-driven processes, where modelling outputs and pilot site demonstrations support knowledge transfer to landowners and forestry actors. In Bulgaria, communication combines internal digital systems—such as SCADA-based monitoring—with external engagement involving farmers and research partners in activities related to agri-waste and biogas potential. In Slovenia, communication is embedded in system operation and coordination within the industrial zone, relying on real-time monitoring and optimisation of energy flows.

Internal communication includes shared platforms, joint communication channels and assemblies that facilitate coordination and collective decision-making [9][22][24]. Externally, communication involves awareness-raising events, educational activities, stakeholder engagement and media outreach to promote participation and disseminate knowledge [9][16][24][28]. Local language use and direct engagement are especially important in rural areas, alongside collaboration with local networks to reach dispersed populations [9][23]. Informal diffusion mechanisms, such as inter-municipal exchange, site visits and community networks further support learning and replication [29].

Across the pilots, these mechanisms are reflected in different forms of knowledge exchange and replication. In Estonia, networks of pilot sites enable distributed learning across different soil types and management conditions. In Slovenia, replication is approached through the development of modular biomass systems transferable to smaller industrial or agricultural settings. In Bulgaria, planned workshops and stakeholder activities support outreach to farmers and local actors, particularly in relation to biogas production and Agri-PV applications, while in Spain replication is linked to the transferability of biomass valorisation models across agricultural value chains.

Digital and structured dissemination tools complement these processes. Websites, social media, newsletters and guidance materials contribute to transparency and information sharing, while online platforms support debate, project development and community financing mechanisms such as crowdfunding [12][18][24][28][29]. These tools not only communicate project objectives but also facilitate participation and investment [16][24]. In the ECOLOOP pilots, digitalisation is particularly relevant for operational transparency and decision-support, including modelling tools in Estonia, real-time optimisation systems in Slovenia and monitoring infrastructures in Bulgaria.

Institutional support structures play a key communicative role. Energy offices, advisory centres and one-stop-shop services provide ongoing information, technical guidance and support for citizens, SMEs and local authorities [18][22][23][29]. Municipalities further enhance communication by sharing data, disseminating information on tariffs and subsidies, and facilitating interaction between stakeholders [22][29]. Additional tools such as digital permitting systems, GIS-based mapping and reporting frameworks strengthen transparency and informed decision-making [23][29]. In the pilots, these functions are often assumed by project consortia and technical partners, particularly research institutions and industrial actors involved in implementation.

Overall, communication in rural energy communities operates through a multi-layered system (see Figure 5.3) combining proximity-based interaction, institutional support, participatory processes and digital tools, all of which contribute to sustained engagement and informed participation [7][8][29].

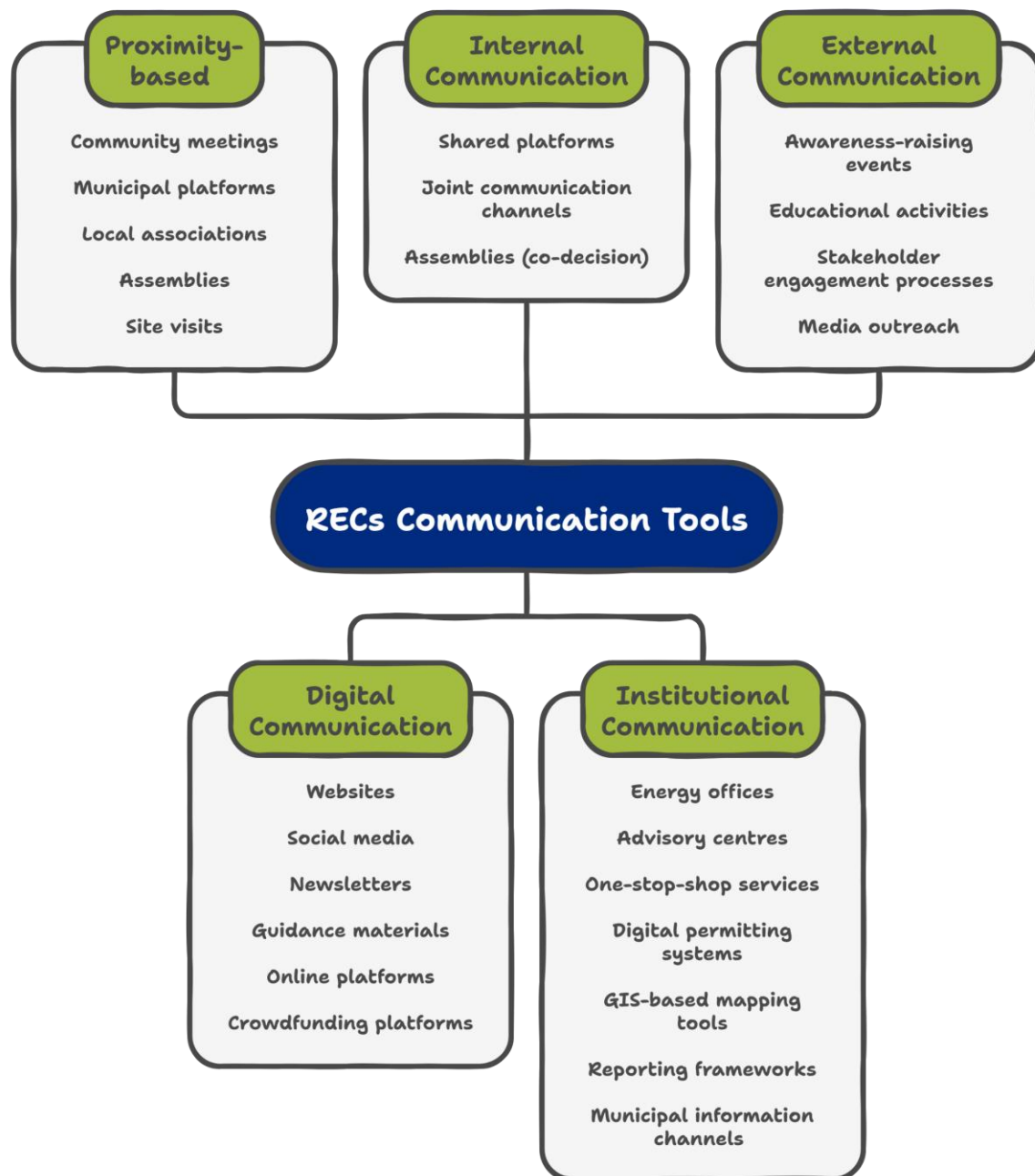


Figure 5.3: Typology of communication tools in rural energy communities

Taken together, the ECOLOOP pilots illustrate how communication in rural energy systems extends beyond conventional participatory formats and becomes embedded in operational, technical and value-chain structures. Rather than relying solely on deliberative processes, information flows are often mediated through data systems, industrial coordination and applied research activities, reflecting the hybrid nature of these initiatives. This highlights a shift from purely community-based communication models towards more complex configurations, where engagement, coordination and decision-making are increasingly intertwined with technological infrastructures and sector-specific dynamics.

5.5. Governance and long-term engagement

Long-term engagement in RECs depends fundamentally on governance arrangements that ensure democratic control, transparency and equitable benefit distribution over time [7][8][10][11][12][14][19][22][27][28][29]. Sustained participation is closely linked to local ownership, collective decision-making and clear organisational structures, including defined roles, regular interaction and continuous monitoring of progress [7][9][10][12][19][24]. Democratic principles—such as equal voting rights, limits on ownership concentration and legal safeguards for local control—are central to maintaining autonomy in line with EU frameworks [12][13][18][27][29]. Formal legal structures, predominantly associations and cooperatives, provide institutional stability, while mixed governance models may also involve municipalities as key actors [18][22].

Transparency, shared benefits and reinvestment mechanisms are essential for long-term trust and continuity. These include structured benefit-sharing schemes, reinvestment of revenues into community initiatives and robust financial management to ensure operational stability across the asset lifecycle [7][11][14][23][29]. Financial sustainability is further supported by diversified funding structures, recurring public support and strong municipal involvement, extending engagement beyond initial project phases [12][18][29]. Long-term participation is often embedded in extended timeframes through concession-based arrangements for land and infrastructure use [22].

In practice, governance quality is critical to sustaining engagement. Regular communication, feedback mechanisms and inclusive participation processes help maintain interest and trust, particularly during administrative delays [8][16][28][29]. Governance structures also shape conflict resolution, responsibility allocation and organisational adaptability under changing conditions [19][29]. Cooperative models with multi-stakeholder participation, rotating leadership and continuous training contribute to resilience and long-term continuity [24].

Institutional ecosystems and multi-level coordination further reinforce engagement. Public administrations play a key role by aligning resources, supporting local capacity and facilitating coordination [23]. Networks such as Offices for Community Transformation, federations and intermediary organisations enable replication, knowledge exchange and scaling strategies, including federated models or inter-community cooperation [16][18][27][29]. At the same time, risks such as leadership fatigue, concentration of responsibilities and procedural complexity remain significant [28][29]. Mitigation strategies—such as continuous dialogue, integration into broader networks and preservation of community autonomy—are essential to maintaining long-term commitment and ensuring that social and environmental objectives remain central [28][29][29].

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Taken together, long-term engagement in Rural Energy Communities depends not on participation alone but on the sustained alignment between governance, financial stability, institutional support and social trust. As illustrated in Figure 5.4, durable engagement emerges where democratic control is effectively operationalised, benefits are visible and fairly distributed, and communities retain organisational capacity and autonomy over time.

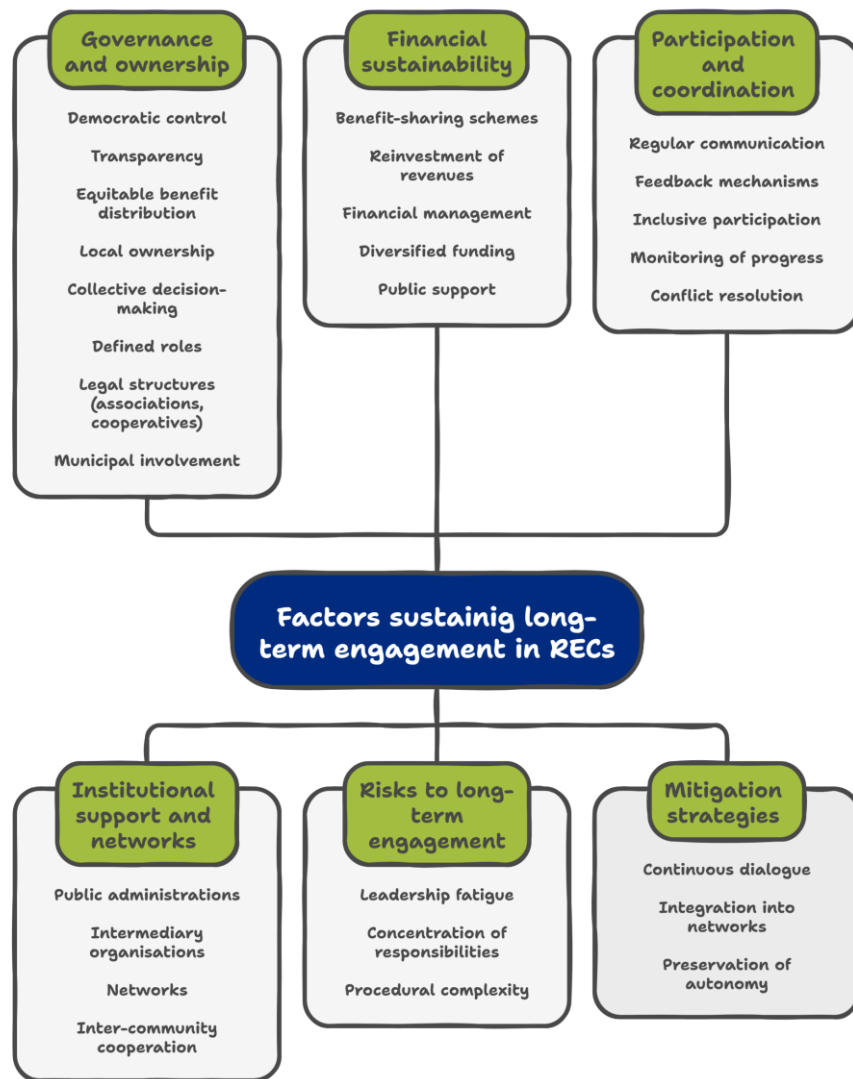


Figure 5.4: Factors sustaining long-term engagement in Rural Energy Communities (RECs)

Engagement should therefore be understood not as a project phase, but as an ongoing socio-institutional process underpinning the stability, scalability and resilience of RECs within evolving energy systems.

While the literature emphasises democratic governance, local ownership and participatory structures as key conditions for sustaining long-term engagement in Rural Energy Communities, the ECOLOOP pilots reveal alternative governance configurations in practice. In these cases, continuity and long-term commitment are primarily ensured through stable institutional

arrangements, operational coordination and long-term resource management rather than through formal participatory governance. Engagement is sustained via ongoing involvement of key actors: companies, research institutions and sectoral stakeholders, whose roles are embedded in production systems, supply chains and technical operations. This suggests that, in practice, long-term engagement in rural energy systems can also emerge from organisational stability, functional interdependencies and economic continuity, even in the absence of fully developed community-based governance structures.

5.6. Analytical gaps in the engagement literature on Rural Energy Communities

European institutional guides and practice-oriented resources converge on the importance of social engagement, democratic governance and inclusive participation in Rural Energy Communities (RECs), framing engagement as a prerequisite for legitimacy, financial viability and long-term sustainability [7][8][18][27][29]. However, a cross-analysis of these sources reveals several analytical limitations.

First, the literature is largely normative and success-oriented. While best practices are well documented, less attention is given to structural tensions, internal conflicts or power asymmetries. Formal democratic principles—such as one-member-one-vote and open membership [13][18][22]—are often treated as sufficient guarantees of equity, despite limited examination of the gap between formal rights and actual influence. The concentration of responsibilities within a small active group is acknowledged but rarely explored in depth [28][29].

Second, participation is generally framed as inherently beneficial, with limited consideration of associated transaction costs, including coordination, administrative burden and reliance on voluntary engagement. In rural contexts with constrained capacities, these factors may significantly affect organisational resilience.

Third, rural areas are often treated as homogeneous, with insufficient differentiation in terms of social capital, institutional capacity or demographic conditions, raising concerns about the transferability of engagement models.

Fourth, although engagement is linked to positive outcomes such as cohesion and equity [18][27][29], there is limited use of systematic evaluation frameworks or measurable indicators, and causal relationships between participation and project success are often assumed rather than demonstrated.

Finally, processes of scaling and professionalisation—through federations or hybrid structures [16][27][29]—are presented as opportunities, but their implications for local autonomy and democratic control remain underexplored.

Taken together, these gaps do not diminish the contributions of the literature but highlight the need for a more reflexive and structurally grounded approach to engagement. The following section addresses this by proposing a conceptual framework that builds on existing insights while incorporating these overlooked dimensions.

5.7. A Conceptual Framework for Robust Rural Engagement in Energy Communities

Based on the consolidated literature and the critical gaps identified, a structured framework for robust engagement in Rural Energy Communities (RECs) can be articulated around five interdependent pillars. This framework integrates enabling principles widely documented in the literature with governance safeguards and evaluative mechanisms that address underexplored dimensions (see Figure 5.5).

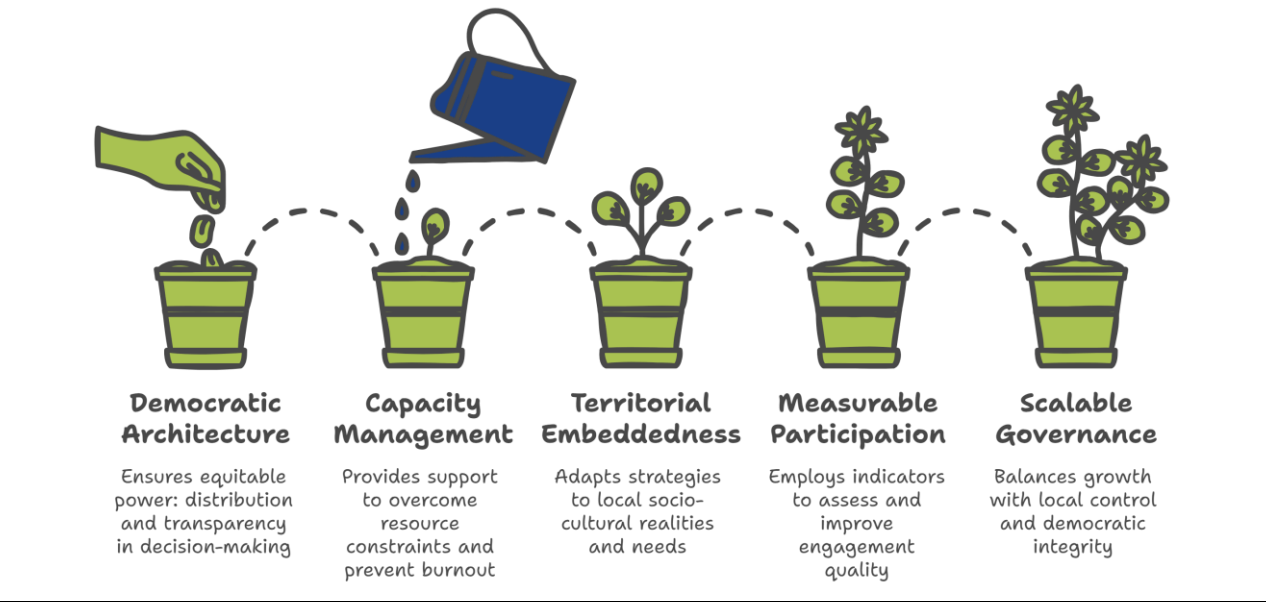


Figure 5.5: A structured governance design for calibrated engagement in rural energy communities.

This proposal does not presuppose high levels of civic capacity or sustained individual engagement. Instead, it seeks to design governance architectures that reduce participatory

overload and distribute responsibilities in a differentiated and realistic manner. The five pillars of this framework elaborate as follows:

➤ **Pillar 1 - Democratic Architecture and Power Transparency**

At the structural core of engagement lies a clearly defined democratic architecture grounded in open and voluntary membership, effective member control and equitable voting principles as required under EU frameworks distinguishing RECs and CECs [13][18][22][27][29]. However, formal statutes alone are insufficient.

- A robust engagement model requires:
- Explicit mapping of decision-making authority.
- Transparency regarding agenda-setting and information control.
- Rotational or term-limited leadership structures.
- Clear allocation of roles between citizens, municipalities and technical experts.

This pillar addresses the gap between formal participation and effective influence, ensuring that democratic design translates into practical power distribution.

➤ **Pillar 2 - Capacity, Resource and Transaction-Cost Management**

The literature emphasises participation and voluntarism as strengths [7][16][24][29], yet sustained engagement in rural contexts depends on realistic recognition of capacity constraints.

A robust model therefore integrates:

- Tiered participation levels (information, consultation, co-decision, operational roles).
- Professional technical support to reduce cognitive and administrative burden.
- Inter-municipal or federated shared services.
- Succession planning and leadership renewal mechanisms.

This pillar mitigates burnout risks, concentration of responsibilities (often 1–10% of members) [22][25], and participatory fatigue, enhancing long-term organisational resilience. Capacity management is not conceived as increasing individual burdens, but as institutionalising support structures that compensate for uneven skills, time availability and technical expertise.

➤ **Pillar 3 - Territorial Embeddedness and Context Sensitivity**

The literature consistently highlights trust, local identity and proximity [7][19], but often treats rural contexts as homogeneous.

A strengthened framework incorporates:

- Preliminary territorial diagnostics (social capital, demographic structure, institutional capacity).
- Adaptation of communication channels to local socio-cultural realities [8][19].
- Technology-sensitive engagement strategies (e.g. higher deliberative intensity for high-impact installations such as bioenergy or biomethane plants [16][23]).
- Inclusion strategies tailored to vulnerable or under-represented groups [11][24][29][29].

This pillar ensures transferability without assuming uniform rural conditions.

➤ **Pillar 4 - Measurable Participation and Equity Outcomes**

Engagement is frequently associated with legitimacy, cohesion and sustainability [18][27][28][29], yet systematic evaluation indicators remain limited.

A robust framework embeds measurable criteria such as:

- Diversity and socio-demographic distribution of membership.
- Leadership rotation rates.
- Participation intensity across governance levels.
- Distribution of financial returns and benefit-sharing mechanisms [14][24][29].
- Retention rates and long-term member engagement.
- Inclusion of vulnerable households and mitigation of energy poverty risks [7][12][28][29].

By operationalising participation quality, this pillar moves beyond normative assertions towards evidence-based assessment.

➤ **Pillar 5 - Scalable Governance with Autonomy Safeguards**

Expansion mechanisms—federations, second-degree cooperatives, aggregation strategies [10][21][25]—enhance financial viability and replication potential. However, scaling introduces risks of professionalisation-driven centralisation and potential dilution of local control.

A resilient governance model therefore incorporates:

- Subsidiarity principles preserving local decision-making.
- Caps on ownership or voting concentration [12][13].
- Transparent managerial accountability structures.
- Clear reinvestment and surplus allocation rules [7][11][29].
- Mechanisms preventing corporate capture or mission drift [29].

This pillar balances growth with democratic integrity.

As a whole, these five pillars operate as an interdependent governance system: democratic architecture provides legitimacy; capacity management ensures feasibility; territorial embeddedness secures contextual fit; measurement underpins accountability; and scalable safeguards guarantee institutional durability. Together, they reposition engagement from a normative aspiration to a structured governance design variable capable of comparative and evaluative analysis across rural contexts. In this sense, engagement is recalibrated rather than intensified.

Although the ECOLOOP pilot sites are not designed as Rural Energy Communities, they provide useful insights into the conditions that shape engagement in rural energy systems. In particular, they highlight that participation does not emerge automatically from the deployment of renewable technologies or circular bioeconomy solutions. Across the pilots, system complexity, technological integration and industrial leadership concentrate decision-making and operational control within a limited set of actors, while broader community involvement remains limited or indirect. This suggests that, in contexts where community-based models are pursued, engagement

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cannot be treated as an implicit outcome of project development but must be explicitly designed, structured and supported. Furthermore, the pilots illustrate how increasing technical sophistication may raise barriers to participation, reinforcing the need for governance arrangements that mediate between expert-driven systems and inclusive community involvement. In this sense, rather than serving as examples of engagement, the pilots function as contrastive cases that help clarify the conditions under which meaningful participation in Rural Energy Communities can be achieved.

6. Farmer and Forester Readiness Assessment for Renewable Energy Adoption

6.1. Questionnaire Development and Methodology

6.1.1. Theoretical Framework and Design Principles

The ECOLOOP Farmer and Forester Readiness Assessment was designed to provide a comprehensive, multi-dimensional evaluation of rural stakeholders' preparedness for renewable energy adoption and energy community participation. The theoretical foundation integrates the Triple Layer Business Model Canvas (TLBMC) framework, which examines economic, environmental, and social dimensions of business model innovation in the context of the rural energy transition.

The assessment framework was developed to address three core research questions: (1) What is the current level of readiness among farmers and foresters to adopt renewable energy solutions? (2) What are the primary barriers and enablers influencing adoption decisions? (3) What is the potential for establishing rural energy communities across the four pilot countries?

The questionnaire design follows established survey methodology principles, including progressive complexity (from factual demographic questions to attitudinal assessments), mixed question formats (single-choice, multiple-choice, Likert scales, and open-ended responses), and cultural adaptation through translation into Bulgarian, Estonian, Slovenian, and Spanish. The questionnaire and the summary statistics are included as annexes to this report.

6.1.2. Survey Structure and Distribution

The final instrument comprises 48 questions organised across eight thematic sections.

Table 6.1: Survey structure by section

Section	Theme	Items	Content
A	Respondent Profile	7 questions	Demographics, farm characteristics, education, experience
B	Current Energy Situation	4 questions	Energy needs, costs, concerns, current RES use
C	RES Awareness and Readiness	5 questions	Technology familiarity, preferences, motivations, barriers, investment willingness
D	Energy Community Interest	6 questions	Energy community (EC) awareness, interest, motivations, concerns, preferred role, network
E	Information and Support Needs	4 questions	Information priorities, trusted advisors, preferred formats, support types
F	Impact Assessment	3 questions	Economic factor importance, environmental importance, social impact expectations
G	Future Orientation	4 questions	Investment timeline, decision accelerators, success stories, 10-year vision
H	Engagement and Follow-up	4 questions	Biggest fears, follow-up willingness, contact information

Distribution was conducted through multiple channels: email invitations to farmer associations, direct outreach via agricultural extension services, dissemination through partner networks, and printed versions for areas with limited digital access. Data collection ran from October 2025 through February 2026, yielding 114 raw submissions.

6.1.3. Data Quality and Validation

A rigorous three-phase data processing pipeline was applied: (1) consolidation of four language-specific datasets into a unified database with numeric coding and standardised variable names; (2) comprehensive quality control including completeness analysis, duplicate detection,

consistency checks, straight-lining detection, and open-ended response quality assessment; and (3) computation of composite indices and segmentation.

Two submissions were removed as near-empty records (1.6% completion), and one respondent was flagged for sensitivity analysis due to systematic straight-lining across all Likert batteries. The final validated sample comprises N = 112 respondents with a mean completion rate of 92.1%.

6.1.4. RES Readiness Index Methodology

The RES Readiness Index (RRI) is a composite score on a 0-100 scale, calculated as a weighted average of three dimensions.

Table 6.2: RES Readiness Index composition

Dimension	Weight	Component Variables
Economic	40%	Energy cost concern (B3), investment willingness (C5), investment timeline (G1), economic factor importance (F1.1), revenue interest (F1.2)
Technical	30%	Technology familiarity (C1), current RES use (B4), information engagement (E2)
Social	30%	EC awareness (D1), EC interest (D2), preferred role (D5), network effect (D6), environmental importance (F2.1), social impact expectation (F3.1), follow-up willingness (H3)

The Economic dimension receives the highest weight (40%) reflecting the centrality of financial considerations in adoption decisions, as consistently identified in the literature and confirmed by our barrier analysis. Each sub-component is normalised to a 0-100 scale before aggregation. The resulting RRI classifies respondents into four segments.

Table 6.3: Readiness segmentation framework and sample distribution

Segment	Score Range	N (%)	Intervention Strategy
Ready	≥ 75	5 (4.5%)	Fast-track support candidates; potential community champions for pilot energy communities
Preparing	50-74	82 (73.2%)	Core target audience requiring targeted training, financial guidance, and administrative support
Exploring	25-49	24 (21.4%)	Awareness-building phase; need demonstration projects, peer examples, and basic information
Unaware	< 25	1 (0.9%)	Fundamental education required; peer influence and direct engagement strategies needed

6.2. Respondent Profiling and Characterisation

6.2.1. Sample Overview

The validated sample of 112 respondents spans the four ECOLOOP pilot countries with the following distribution: Slovenia (56, 50.0%), Estonia (23, 20.5%), Bulgaria (17, 15.2%), and Spain (16, 14.3%). While the Slovenian subsample is the largest, all country groups exceed the minimum threshold for meaningful statistical comparison.

Table 6.4: Sample overview and key characteristics by country

Characteristic	Overall	BG	SI	ES	EE	Key Finding
N	112	17	56	16	23	4 countries
Farm owners	76%	88%	88%	44%	61%	Owner-dominated

University+	64%	71%	45%	56%	39%	Well-educated
> 20 yr experience	53%	29%	57%	56%	57%	Experienced sector
Current RES users	48%	24%	70%	31%	26%	SI leads adoption
Mean RRI	58.7	55.0	62.9	54.6	54.3	SI highest

6.2.2. Current Energy Situation

Annual energy expenditure varies considerably across the sample. The modal category is €1,000-5,000 (26.8% of respondents), followed by €5,000-10,000 (21.4%). Estonian respondents show the widest cost distribution, with 26% reporting costs exceeding €50,000, reflecting the prevalence of larger farm operations in the sample. Energy cost concern is moderate overall (mean 2.87/5), with Spanish respondents expressing the highest concern levels.

Nearly half the sample (48.2%) already uses some form of renewable energy, predominantly solar PV. This figure is heavily driven by the Slovenian subsample, where 69.6% report current RES use. In contrast, current adoption rates in Bulgaria (23.5%), Estonia (26.1%), and Spain (31.3%) remain substantially lower, indicating that these countries represent the primary opportunity space for new adoption.

6.2.3. Investment Capacity and Timeline

Investment willingness clusters in the €5,000-20,000 range (44.6% of respondents), representing a realistic entry point for small-to-medium scale installations such as rooftop solar PV. A substantial minority (15.1%) indicates willingness to invest €50,000 or more, suggesting capacity for larger community-scale projects. Only 7.1% state they would invest nothing, while 9.8% indicate their investment depends on available subsidies and conditions.

The investment timeline reveals encouraging near-term momentum: 24.1% have already invested in RES, 8.9% plan to invest within the next year, and 35.7% within one to three years. Combined, 68.7% of respondents have either invested or plan to do so within three years. Only 3.6% indicate they will never invest in RES, confirming broad receptivity.

6.3. RES Readiness Segmentation Analysis

6.3.1. Overall Index Results

The RES Readiness Index across the full sample yields a mean of 58.7 (Standard deviation (SD) = 11.3) on the 0-100 scale, with scores ranging from 20.0 to 79.8. This places the average respondent firmly in the “Preparing” segment, indicating a population that is broadly aware of and interested in renewable energy but requires targeted support to move toward adoption. The Energy Community Potential Index (ECPI) captures the structural capacity of farms to participate in collective renewable energy schemes, including infrastructural, organisational, and resource-based conditions.

Table 6.5: Descriptive statistics for RES Readiness dimensions

Dimension	Mean	SD	Min	Q25	Median	Q75	Max
Economic	60.8	12.7	14.0	52.8	61.3	68.6	91.3
Technical	62.2	17.0	5.6	50.0	66.7	75.0	100.0
Social	52.5	15.5	19.0	41.4	53.2	62.9	84.3
RES Readiness Index (RRI)	58.7	11.3	20.0	51.7	59.7	66.3	79.8
EC Potential Index (ECPI)	51.9	15.4	4.3	42.2	53.4	63.3	85.8

The Technical dimension shows the highest mean score (62.2), driven primarily by strong information engagement (T3 = 74.7) and current RES use (T2 = 70.7), partially offset by moderate technology familiarity (T1 = 42.0). The Economic dimension (60.8) benefits from high perceived importance of economic factors (E4 = 80.4) and moderate revenue interest (E5 = 62.8). The Social dimension is the weakest (52.5), primarily constrained by low Energy Community awareness (S1 = 36.2) and limited perception of peer network interest (S4 = 32.5).

6.3.2. Segmentation Distribution

The segmentation reveals a population concentrated in the central “Preparing” category, with smaller groups at either end of the readiness spectrum:

Ready (4.5%, n=5): These five respondents score above 75 on the RRI and represent the most immediate candidates for pilot energy community initiatives. Three are from Slovenia, one from Bulgaria, and one from Estonia. They are characterised by existing RES installations, near-term investment plans, active EC interest, and willingness to engage as technology providers or community leaders.

Preparing (73.2%, n=82): The dominant segment comprises respondents scoring 50-74. They express interest in RES and moderate EC engagement but require targeted financial guidance, administrative simplification, and confidence-building through subsidies and peer examples. This segment represents the primary policy target.

Exploring (21.4%, n=24): Scoring 25-49, these respondents demonstrate limited technical familiarity and lower investment commitment. They need foundational awareness programmes, demonstration visits, and accessible information materials before advancing to adoption planning.

Unaware (0.9%, n=1): A single respondent from Spain falls below 25, indicating minimal awareness and no current engagement. The near absence of this category suggests that baseline awareness of RES has penetrated even the least engaged segments of the agricultural community.

6.3.3. Cross-Country Comparison

Table 6.6: Mean dimension scores by country

Country	Economic	Technical	Social	RRI	ECPI	Top Seg.
Bulgaria (n=17)	56.0	51.6	56.9	55.0	54.0	Preparing
Slovenia (n=56)	64.1	68.1	55.9	62.9	54.7	Preparing
Spain (n=16)	58.2	56.5	48.0	54.6	51.1	Preparing

Estonia (n=23)	58.0	59.7	44.2	54.3	45.0	Preparing
OVERALL (N=112)	60.8	62.2	52.5	58.7	51.9	Preparing

Slovenia leads across Economic (64.1) and Technical (68.1) dimensions, reflecting its higher baseline of current RES adoption (70% of respondents) and stronger institutional support frameworks. Bulgaria demonstrates the strongest Social dimension score (56.9), indicating relatively higher community orientation and EC interest despite lower technical readiness. Estonia shows the weakest Social dimension (44.2), driven by the lowest EC awareness and network perception in the sample. Spain occupies an intermediate position across all dimensions.

6.4. Country-Specific Readiness Profiles

6.4.1. Bulgaria

Bulgaria's 17 respondents are predominantly farm owners (88%) with university education (71%), operating small farms (59% under 20 ha). The sample is relatively young in farming terms, with 35% having less than 10 years of experience. Annual energy costs cluster in the €1,000-5,000 (35%) and €10,000-25,000 (29%) brackets.

Current RES adoption is low at 23.5%, but 76.5% express interest in adoption. Only one respondent reaches the "Ready" threshold, while 59% fall into "Preparing" and 35% into "Exploring." The relatively high Social dimension score (56.9, second highest after Slovenia) suggests strong community orientation, but Technical readiness (51.6) is the lowest in the sample, indicating a knowledge deficit.

Key opportunity: Bulgaria's combination of strong community orientation, low current adoption, and predominantly small farms makes it ideal for cooperative-based energy community models focused on shared solar PV installations. The primary intervention needed is technical capacity building combined with accessible subsidy information.

6.4.2. Slovenia

Slovenia contributes the largest subsample (56 respondents) and exhibits the most advanced readiness profile. Farm owners dominate (88%), with predominantly medium-sized operations (45% between 5–50 ha) and extensive experience (57% over 20 years). Education levels are mixed, with 45% holding university degrees.

Slovenia leads in current RES adoption at 69.6%, by far the highest rate in the sample. Its Technical dimension score (68.1) reflects this established experience base. The country achieves the highest RRI (62.9) with 80% of respondents classified as “Preparing” and 5.4% as “Ready.” EC awareness is moderate (52% have heard of or are familiar with energy communities), and 21% express strong interest in joining.

Key opportunity: Slovenia’s high baseline adoption and three “Ready” respondents make it the prime candidate for a first-mover pilot energy community. The focus should shift from basic awareness to practical community formation support: governance templates, legal registration guidance, and financial planning tools for collective investment.

6.4.3. Spain

Spain’s 16 respondents show the most diverse professional profile: only 44% are farm owners, with the remainder split across managers, family members, and other roles. Farm sizes are widely distributed, from under 5 ha to over 100 ha. Experience levels skew high (56% over 20 years), while education includes both primary (19%) and university (56%) levels.

Spain records the lowest Social dimension score (48.0) and is the only country with a respondent in the “Unaware” category. However, investment willingness is robust, with the highest proportion of respondents willing to invest €20,000-50,000. The country’s 10-year energy vision is notably uncertain: 56% selected “Don’t know,” suggesting a need for concrete scenario planning and economic projections.

Key opportunity: Spain’s strong investment capacity combined with high uncertainty about the future suggests that targeted economic feasibility studies and ROI demonstrations would be the most effective intervention. The diverse professional profile also means engagement strategies must accommodate varying levels of technical literacy.

6.4.4. Estonia

Estonia’s 23 respondents operate the largest farms in the sample: 35% exceed 100 ha, and 22% fall in the 20–50 ha range. The respondent group is highly educated (39% postgraduate) and experienced (57% over 20 years). Annual energy costs reflect larger operations, with 26% reporting expenditure above €50,000.

Estonia presents a distinctive pattern of high technical capacity but low social engagement. While the Technical dimension (59.7) is adequate, the Social dimension (44.2) is the lowest in the sample. EC awareness is particularly weak, with 65% of respondents indicating they need more information before forming an opinion on energy communities. “Uncertain ROI” is the dominant barrier (74% of Estonian respondents), far exceeding the sample average of 42%.

Key opportunity: Estonia's large farm sizes and high energy costs create a compelling economic case for RES adoption, but respondents need hard evidence. The priority is detailed financial modelling with farm-scale ROI projections, combined with introductions to the energy community concept through concrete case studies from other Nordic and Baltic contexts.

6.5. Barriers and Enablers Identification

6.5.1. Adoption Barriers

Barrier analysis reveals a hierarchy dominated by financial concerns, followed by regulatory and informational obstacles.

Table 6.7: Barriers to RES adoption (multi-select, ranked by frequency)

Barrier	N	%	BG	SI	ES	EE	Note
High initial investment	65	58.0%	13	40	12	0	Universal, #1 barrier
Complex admin procedures	52	46.4%	7	28	9	8	SI and ES hardest hit
Uncertain ROI	47	42.0%	2	28	0	17	EE extremely high (74%)
Grid connection issues	46	41.1%	4	28	5	9	Infrastructure barrier
Lack of information	36	32.1%	4	21	5	6	Knowledge gap
No financing options	33	29.5%	3	13	4	13	EE strongest (57%)
Already planning	21	18.8%	1	18	2	0	Positive signal
Lack of technical support	19	17.0%	1	14	3	1	SI concentration

Land use conflicts	16	14.3%	0	13	2	1	Mainly SI
Maintenance concerns	15	13.4%	1	11	2	1	Minor barrier

The barrier profile reveals three distinct clusters. Financial barriers (investment cost, uncertain ROI, no financing) form the primary cluster, affecting 30-58% of respondents. Regulatory and administrative barriers (complex procedures, grid connection) form the second cluster. Informational barriers (lack of information, lack of technical support) represent the third. Notably, 18.8% of respondents indicate they are already planning adoption, demonstrating that a significant minority has moved past the barrier identification stage.

6.5.2. Motivations for RES Adoption

Table 6.8: Motivations for RES adoption (multi-select, ranked by frequency)

Motivation	N	%	BG	SI	ES	EE
Reduce energy costs	76	67.9%	14	48	14	0
Energy independence	74	66.1%	13	36	8	17
Environmental responsibility	52	46.4%	6	32	3	11
Sustainability image	42	37.5%	6	25	2	9
Additional income	41	36.6%	5	23	4	9
Modernise operations	15	13.4%	4	2	2	7
Meet regulations	9	8.0%	1	3	3	2

Motivations are overwhelmingly pragmatic and intrinsic. Cost reduction (67.9%) and energy independence (66.1%) dominate, confirming that economic self-interest is the primary adoption driver. Environmental responsibility ranks third (46.4%), with notably strong expression in Slovenia (57% of Slovenian respondents). Regulatory compliance ranks last (8.0%), indicating that top-down mandates are far less effective than bottom-up economic and environmental motivations.

6.6. Energy Community Potential Assessment

6.6.1. Energy Community Awareness and Interest

Energy Community awareness presents a significant gap in the sample. Only 13.4% of respondents are familiar with the EC concept, 45.5% have heard of it but lack detailed knowledge, and 41.1% have never heard of energy communities. This awareness deficit is most pronounced in Estonia (where respondents were not asked about EC awareness through the same mechanism) and least severe in Slovenia.

Despite limited awareness, interest in joining an energy community is notably higher: 13.4% are very interested, 21.4% are somewhat interested, and 52.7% need more information before deciding. Only 8.9% indicate probable or definite disinterest. This gap between low awareness and relatively high conditional interest represents a clear intervention opportunity: awareness-building activities are likely to convert a substantial portion of the “need more information” group into active interest.

6.6.2. Energy Community Potential Index

The ECPI combines EC-specific variables (awareness, interest, preferred role, network effect, follow-up willingness) with economic readiness indicators (investment willingness and timeline proximity). The resulting mean of 51.9 (SD = 15.4) indicates moderate overall potential, with significant cross-country variation.

Table 6.9: Energy Community Potential Index distribution by country

Country	High Potential	Moderate Potential	Low Potential	Not Ready	Mean ECPI
Bulgaria (n=17)	2	11	3	0	54.0
Slovenia (n=56)	8	29	12	1	54.7
Spain (n=16)	3	6	4	1	51.1
Estonia (n=23)	1	12	8	2	45.0

Slovenia and Bulgaria show the highest mean ECPI scores (54.7 and 54.0 respectively), driven by stronger community orientation and EC interest. Estonia’s lowest score (45.0) reflects the

combination of limited EC awareness and the weakest social dimension scores. The 14 respondents classified as “High Potential” across all countries represent the immediate nucleus for pilot community formation efforts.

6.6.3. Preferred EC Roles

When asked about their preferred role in a potential energy community, the largest group (32.4%) selected “technology provider,” indicating interest in contributing energy-generating capacity rather than passive consumption. “Active leader” was selected by 21.3%, “energy consumer” by 17.6%, and “passive member” by 13.0%. Only 9.3% expressed no interest in any role.

This preference distribution has important governance implications. A community composed predominantly of technology providers and active leaders would require a governance model emphasising democratic participation and shared decision-making, rather than a centralised utility-style structure. The relatively low demand for passive membership suggests that EU directive requirements for active citizen participation align well with farmer preferences in the ECOLOOP pilot regions.

6.7. Support Needs Prioritisation

6.7.1. Information Priorities

Respondents rated the importance of eight information categories on a 1–5 Likert scale. Results reveal a clear hierarchy dominated by financial and regulatory information.

Table 6.10: Information need ratings by country (mean, 1-5 Likert scale)

Information Topic	Overall	BG	SI	ES	EE	Priority
Available subsidies	4.29	3.88	4.38	4.36	4.30	HIGH
Payback period	4.19	3.69	4.16	4.54	4.39	HIGH
Investment costs	4.15	3.59	4.23	4.53	4.13	HIGH
Technical requirements	4.14	3.60	4.34	4.00	4.09	HIGH
Regulatory requirements	4.07	3.33	4.19	4.31	4.14	HIGH

Maintenance	4.06	3.60	4.25	4.00	3.95	HIGH
Environmental impact	3.64	3.20	3.92	3.54	3.29	MEDIUM
Success stories	3.37	2.79	3.63	3.46	3.05	MEDIUM

The top three information needs (available subsidies (4.29), payback period (4.19), and investment costs (4.15)) confirm the strongly financial orientation of the target audience. These are pragmatic decision-makers who need concrete economic evidence. Success stories rank lowest (3.37), suggesting that while social proof has value, it is secondary to hard financial data. Spanish respondents show the highest overall information demand, consistent with their greater uncertainty about future energy trajectories.

6.7.2. Trusted Information Sources

The trust hierarchy reveals a striking preference for independent and peer-based advice over institutional sources. Independent consultants are the most trusted source (27.7%), followed by other farmers/peers (19.6%) and farmer associations (18.8%). Universities and research institutions command moderate trust (14.3%), while government agencies are trusted by only 6.2% of respondents.

This trust deficit toward governmental institutions has critical implications for policy delivery. Support programmes channelled through government agencies alone are likely to reach only a fraction of the target audience. Effective dissemination strategies should prioritise independent advisory services, farmer-to-farmer networks, and professional associations as primary delivery channels, with governmental entities providing the enabling framework rather than front-line communication.

6.8. Technology Preference Mapping

Technology preference analysis reveals a clear hierarchy across the sample, with strong consensus on the leading technology and meaningful regional variation for secondary choices.

Table 6.11: Technology preferences by country (multi-select)

Technology	N	%	BG	SI	ES	EE
Solar PV (rooftop)	92	82.1%	15	49	11	17

Biomass (agri residues)	41	36.6%	4	19	4	14
Agri-PV (ground)	36	32.1%	5	12	8	11
Geothermal	25	22.3%	0	13	0	12
Wind turbines	23	20.5%	2	12	1	8
Biogas (livestock)	19	17.0%	0	11	3	5
Small hydro	7	6.2%	0	6	0	1

Solar PV on rooftops dominates at 82.1%, confirming it as the entry-level technology for rural RES adoption. This preference aligns with the investment capacity of the sample (€5,000-20,000 range), the absence of land use conflicts, and relatively straightforward permitting. Biomass from agricultural residues (36.6%) and ground-mounted Agri-PV (32.1%) represent the secondary technology tier, both offering potential for community-scale shared installations.

Geographic specificity is evident in geothermal preferences (concentrated in Slovenia and Estonia, reflecting geological conditions), small hydro (almost exclusively Slovenian), and biomass (strongest in Estonia at 61%, reflecting large farm scales, predominantly foresters and abundant residues). These patterns suggest that technology recommendations within energy community roadmaps must be tailored to local resource endowments rather than applying uniform technology portfolios.

6.9. Cross-Cutting Insights

6.9.1. Readiness Determinants

Cross-tabulation of the RES Readiness Index with respondent characteristics reveals several significant patterns:

- **Current RES use is the strongest readiness predictor.** Respondents already using RES score 65.5 on the RRI, compared with 54.7 for those interested but not yet using, and 38.5 for those not interested. The 27-point gap between users and non-interested respondents confirms that hands-on experience is the most powerful readiness driver.

- **Mid-sized farms (20-50 ha) show the highest readiness (RRI 64.5).** This “sweet spot” reflects sufficient scale for economically viable installations, adequate financial capacity, and typically higher management sophistication. Both the smallest farms (<5 ha, RRI 51.4) and the 50-100 ha bracket (RRI 55.4) score notably lower.
- **10-20 years of experience correlates with peak readiness (RRI 63.1).** This mid-career group combines established operational stability with openness to innovation. Those with over 20 years of experience score moderately lower (58.5), potentially reflecting greater conservatism.
- **Education has a modest but consistent effect.** Primary education holders score 46.8 versus 59.9 for postgraduate holders, which is a 13-point gap. However, the difference between secondary (58.5) and university (59.3) levels is negligible, suggesting that basic agricultural education is sufficient for readiness, with advanced degrees providing limited additional benefit.

6.9.2. The Awareness–Interest Gap

One of the most policy-relevant findings is the disconnect between EC awareness and EC interest. While awareness scores average only 36.2/100 (with 41% of respondents having never heard of energy communities), interest in joining an EC averages 59.2/100 when the concept is explained in the survey context. This 23-point gap represents the single largest opportunity for targeted intervention.

The practical implication is that awareness-raising programmes focused on the energy community concept are likely to generate substantial conversion from passive interest to active engagement. The existing EU directive framework (Directive 2018/2001 and Directive 2019/944) provides the legal foundation, but the bottleneck is information rather than regulation.

6.10. Conclusions

The ECOLOOP Farmer and Forester Readiness Assessment provides the first multi-country, multi-dimensional empirical baseline of RES adoption and energy community readiness among European agricultural stakeholders. Based on 112 validated responses across Bulgaria, Estonia, Slovenia, and Spain, the assessment reveals a population that is broadly receptive to renewable energy but requires targeted, evidence-based support to convert interest into action.

1. **The agricultural sector is ready to engage, but not yet ready to act independently.** With 73.2% of respondents in the “Preparing” segment and a mean RRI of 58.7/100, the majority expresses clear interest and moderate capacity but lacks the specific financial, technical, and administrative knowledge needed to initiate adoption autonomously.
2. **Financial barriers dominate, but the solutions are informational.** While 58% cite high initial investment as the primary barrier, 44.6% are willing to invest €5,000-20,000 and 68.7% plan

investment within three years. The constraint is not absolute lack of capital but lack of confidence in returns, driven by insufficient information about subsidies (4.29/5 priority), payback periods (4.19/5), and investment costs (4.15/5).

3. Energy community potential exceeds awareness. The 23-point gap between EC awareness (36.2/100) and EC interest (59.2/100) represents the most actionable finding. Targeted awareness campaigns explaining the EC concept in concrete economic terms are likely to generate significant conversion from passive interest to active participation.

4. Delivery channels must match trust patterns. Government agencies command only 6.2% of trust, while independent consultants (27.7%), peers (19.6%), and farmer associations (18.8%) are the preferred information sources. Support programmes must be delivered through trusted intermediaries rather than top-down governmental channels.

5. Country-specific strategies are essential. Slovenia requires community formation support, Bulgaria needs technical capacity building, Spain demands economic feasibility evidence, and Estonia requires ROI demonstration combined with EC concept introduction. A uniform approach across all four countries would be significantly less effective than tailored national strategies.

7. Energy Community Formation Guidelines

This chapter provides comprehensive guidelines for establishing energy communities in rural and agricultural contexts, with particular focus on the legal frameworks, formation processes, and support mechanisms relevant to the ECOLOOP pilot countries: Bulgaria, Estonia, Slovenia, and Spain. The European Union's Clean Energy Package has created unprecedented opportunities for farmers, foresters, and rural communities to become active participants in the energy transition, moving beyond their traditional role as passive consumers to become prosumers who generate, share, and benefit from renewable energy production [43][44]. These guidelines are informed by the empirical findings of the ECOLOOP Farmer and Forester Readiness Assessment (Chapter 6), which surveyed 112 farmers and foresters across the four pilot countries and identified both the readiness levels and the specific support needs of the target population. The assessment revealed that 73.2% of respondents fall into the "Preparing" segment — broadly receptive to renewable energy but requiring targeted guidance on legal structures, financial planning, and administrative procedures to move toward active participation in energy communities.

The guidelines presented here draw upon extensive analysis of EU regulatory requirements, national transposition measures in each pilot country, and emerging best practices from early energy community implementations across Europe [48][49][59]. They are designed to support community leaders, local and national authorities, agricultural advisors, and potential members in navigating the complex regulatory landscape while building economically sustainable and socially inclusive energy communities.

Understanding the distinction between different types of energy communities under EU law is essential for proper formation. The Clean Energy Package established two complementary frameworks [45][47]:

- Renewable Energy Communities (RECs) under the Renewable Energy Directive - focused exclusively on renewable energy sources with geographic proximity requirements
- Citizen Energy Communities (CECs) under the Internal Electricity Market Directive - covering all electricity types without geographic restrictions but with stricter membership rules

While these concepts share common principles of democratic governance and community benefit, they differ in important ways regarding membership eligibility, geographic scope, and permitted activities. Communities must carefully consider which framework best suits their objectives and ensure their governance structures comply with the relevant requirements [48][49].

Energy communities can deliver multiple benefits simultaneously when properly established [50][59][74]:

- Reducing energy costs for members through collective purchasing and self-consumption
- Generating local economic value and strengthening community social capital
- Contributing to climate objectives through renewable energy deployment
- Empowering citizens to participate actively in the energy transition
- Addressing energy poverty through inclusive membership structures

7.1. Legal and Regulatory Framework

7.1.1. EU Directive Requirements

The European Union has established the legal foundation for energy communities through two complementary directives that form part of the broader Clean Energy Package [44][45]. These directives require Member States to create enabling frameworks that support community energy initiatives while ensuring appropriate governance and consumer protection.

The Renewable Energy Directive (EU) 2018/2001 (RED II) introduced the concept of Renewable Energy Communities as legal entities with specific characteristics [45]:

- Open and voluntary participation for eligible members
- Effective control by shareholders or members located in proximity to renewable energy projects
- Primary purpose of providing environmental, economic, or social community benefits rather than generating financial profits
- Autonomy from individual members and traditional market actors

The directive was subsequently strengthened by Directive (EU) 2023/2413, which raised the EU's binding renewable energy target to at least 42.5% by 2030 and introduced additional provisions to promote energy communities [46][66]. Member States were required to transpose most provisions by May 2025 [51].

RECs are authorized to engage in various activities under Article 22 of RED II [45]:

- Produce, consume, store, and sell renewable energy
- Share renewable energy within the community subject to maintaining members' rights as customers
- Access all relevant energy markets both directly and through aggregation
- Manage community-level distribution networks where national law permits

D5.2. Support for the creation of Renewable Energy Communities in Rural Areas

The Internal Electricity Market Directive (EU) 2019/944 established a parallel framework for Citizen Energy Communities (CECs), which differs from RECs in several important respects [47][49]:

- Not limited to renewable energy - may engage with any form of electricity
- No geographic proximity requirement - can operate across wider areas
- More restrictive membership: only natural persons, local authorities, and small enterprises may participate
- Large enterprises entirely excluded rather than merely excluded from control positions

Both types of communities must be effectively controlled by their members, meaning that governance structures must ensure genuine democratic participation rather than nominal membership with control concentrated elsewhere [48][50][75]. Article 22(4) of RED II specifies that Member States must provide an enabling framework ensuring that unjustified barriers are removed, procedures are fair and transparent, and distribution system operators cooperate with communities [45][49].

Table 7.1: Key Differences Between Renewable Energy Communities and Citizen Energy Communities

Criterion	Renewable Energy Community (REC)	Citizen Energy Community (CEC)
Legal Basis	Renewable Energy Directive (EU) 2018/2001, Article 22	Internal Electricity Market Directive (EU) 2019/944, Article 16 [4]
Energy Scope	Renewable energy sources only	All electricity types including conventional and RES
Geographic Scope	Members must be in proximity to community's renewable energy projects	No geographic proximity requirement, can operate across wider areas
Eligible Members	Natural persons, SMEs, local authorities, large enterprises may participate	Natural persons, local authorities, small enterprises only
Permitted Activities	Production, consumption, storage, sale of renewable energy, energy sharing, market access, distribution network management	Generation, distribution, supply, consumption, aggregation, storage, EV charging services, energy efficiency services

Autonomy Requirement	Must remain autonomous from individual members who participate as shareholders	Effectively controlled by members who are not engaged in large-scale commercial activity
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7.1.2. National Transposition in Pilot Countries

The transposition of EU energy community provisions into national law varies significantly among the four ECOLOOP pilot countries, reflecting different legal traditions, energy sector structures, and policy priorities [51][64]. Understanding these national frameworks is essential for communities seeking to establish compliant legal structures and access available support mechanisms. Table 7.2 provides a comparative overview of key indicators across the four countries.

Table 7.2: Comparative Overview of Energy Community Development in ECOLOOP Pilot Countries

Indicator	Spain	Slovenia	Estonia	Bulgaria
Active Energy Communities (2024)	659	~20	<10	<5
Transposition Status	Complete	Complete	Partial	Partial
Dedicated Funding Programme	Yes (CE Implementa)	Yes (Eco Fund)	Limited	Limited
Support Offices/Programs	Yes (OTCs)	Limited	No	No
Legal Form Clarity	High	High	Medium	Medium
Grid Access Procedures	Streamlined	Standard	Complex	Complex
Community Readiness Level	Advanced	Developing	Early	Early

The comparative indicators in Table 7.2 are complemented by the ECOLOOP survey findings (Chapter 6), which assessed farmer and forester readiness at the individual level. The Energy Community Potential Index (ECPI, Chapter 6, Section 6.6) confirms the country-level patterns: Slovenia achieves the highest mean ECPI score (54.7/100) with eight respondents classified as “High EC Potential,” consistent with its more developed regulatory infrastructure. Bulgaria shows a comparable ECPI (54.0) driven by strong community orientation despite limited institutional

support, suggesting that bottom-up social capital can partially compensate for top-down framework deficits. Spain's ECPI (51.1) reflects moderate potential constrained by high uncertainty about energy futures, while Estonia's lowest score (45.0) aligns with its early-stage regulatory development and the weakest EC awareness in the sample (Chapter 6, Section 6.6.1). These individual-level readiness data provide a demand-side perspective that complements the supply-side institutional analysis presented below.

Spain

Spain has emerged as a European leader in energy community development, with a comprehensive regulatory framework and substantial public support mechanisms [54][65][71]. According to the II Report on Energy Community Indicators published in June 2025 by the Observatorio Común de la Energía, Spain reached 659 active energy communities by the end of 2024, representing a 44% increase compared to the previous year, with 200 new communities registered in 2024 alone [54]

Key features of Spain's energy community framework include [55][65][71]:

- Comprehensive CE Implementa programme managed by IDAE, mobilizing over 100 million euros through the Recovery, Transformation and Resilience Plan to support community energy projects
- Network of Community Transformation Offices (Oficinas de Transformación Comunitaria, OTCs) providing localized technical assistance and support
- Favourable self-consumption regulations allowing collective arrangements with no grid fees on shared energy
- Simplified administrative procedures for small-scale renewable installations
- Comprehensive guidance materials including practical handbooks and case study compilations

The Spanish framework provides for both Renewable Energy Communities and Citizen Energy Communities, with clear definitions and procedures for registration and operation [67][71]. The geographic scope for RECs has been defined pragmatically, generally linked to municipal boundaries or distribution network configuration.

Slovenia

Slovenia transposed the Renewables and Electricity Market Directives in July and October 2021 through the Act on the Promotion of the Use of Renewable Energy Sources (ZSROVE, Act No. 2570) and the Electricity Supply Act (ZOEE, Act No. 3349) [52][57][58]. Key aspects of the Slovenian framework include [52][56][58]:

- Energy communities must be established as cooperatives according to the law governing cooperatives
- Local authorities, including municipalities, are explicitly eligible to participate as members
- Photovoltaic installations required on new buildings with roof areas exceeding 1,000 square meters
- Collective self-consumption permitted within multi-apartment buildings and across customers connected to the same low-voltage transformer station
- Implementing rules for collective self-consumption within RECs defined in March 2022

Slovenia has allocated significant funding for energy communities, with EUR 29.35 million specifically designated for “Promotion of local energy communities” under the 2021-27 programming period [76]. A 2025-2029 public call offers EUR 64.54 million in EU cohesion funding for solar or wind power generation facilities [76]. While the overall number of operational energy communities remains limited (approximately 20 initiatives in various stages), the regulatory framework provides solid foundations for growth [56].

Estonia

Estonia has established basic frameworks for energy communities through amendments to its Electricity Market Act, though implementation experience remains limited compared to more advanced Member States [51][63][64]. The European Commission has opened infringement procedures for incomplete transposition of the amended Renewable Energy Directive provisions [51][68]. Current characteristics of Estonia's energy community landscape [63][64]:

- Regulatory uncertainty during the ongoing transposition process
- Advanced digital infrastructure providing potential advantages for innovative energy sharing
- Limited awareness of community energy concepts among potential participants
- Absence of dedicated support programs for community formation
- Complex grid connection procedures creating barriers to development
- Strong tradition of cooperative organisation in other sectors providing foundation for future growth

Bulgaria

Bulgaria has faced significant challenges in transposing EU energy community provisions, with delays on certain elements [53][62][64]. Under the Law on Energy from Renewable Sources, the development of RECs and CECs is promoted through the removal of regulatory and administrative obstacles, though concrete implementation measures remain underdeveloped [53][62]. Key aspects of Bulgaria's current situation [53][64]:

- National legal basis for enabling frameworks exists but practical implementation support is limited
- Enabling framework provisions for CECs are identical to those for RECs, potentially allowing coherent support
- Grid connection permits required within two years (one year for facilities up to 150 kW)
- Ministry of Energy and Sustainable Energy Development Agency tasked with barrier assessment
- Significant untapped potential, particularly in rural areas with agricultural traditions and biomass resources
- Strong solar irradiation levels make photovoltaic installations attractive

7.2. Formation Process and Best Practices

The formation of an energy community typically proceeds through several distinct phases, each with characteristic activities, milestones, and challenges [59][60]. While the specific timeline varies depending on community context, regulatory environment, and project complexity, understanding the general process helps communities plan realistically and allocate resources appropriately. Table 7.3 illustrates the typical formation phases and their key characteristics.

Table 7.3: Energy Community Formation Process - Phases and Key Activities

Phase 1	INITIATION	3-6 months	• Identify leaders • Assess local interest • Initial feasibility scan • Establish working group
Phase 2	PLANNING	6-12 months	• Detailed feasibility study • Business model development • Legal structure selection • Governance design
Phase 3	FORMATION	3-6 months	• Legal entity registration • Founding assembly • Statutes adoption • Initial membership recruitment
Phase 4	IMPLEMENTATIO	6-18 months	• Financing arrangement • Equipment procurement • Grid connection • Installation and commissioning
Phase 5	OPERATION	Ongoing	• Energy production/sharing • Member services • Governance activities

- Continuous improvement

Source: Adapted from JRC (2020) and European energy community case studies [59][60]

7.2.1. Pre-Formation Assessment

Successful energy community formation begins with thorough assessment of local conditions, potential membership, and technical feasibility [59][60]. Communities that invest adequate time in this preparatory phase significantly increase their chances of long-term sustainability. Key assessment areas include:

- Local energy resources, such as solar irradiation, wind resources, biomass availability, suitable buildings or land
- Technical feasibility, such as grid connection possibilities, local consumption patterns, energy sharing potential
- Member interest, such as surveying residents, farmers, businesses, and institutions for willingness to participate
- Investment capacity, such as assessing financial resources available from potential members
- Regulatory requirements, such as identifying applicable national and local requirements and available support programs

Interest assessment among potential members is equally critical. Communities should survey local stakeholders to gauge willingness to participate and understand barriers to participation [50][74]. The ECOLOOP Readiness Assessment (Chapter 6) provides a replicable methodology for such assessment, comprising a RES Readiness Index (economic, technical, and social dimensions) and an Energy Community Potential Index. Applied across the four pilot countries, this assessment identified 14 respondents with “High EC Potential” and 5 in the “Ready” segment (Chapter 6, Section 6.3.2), representing the immediate nucleus for pilot community formation. Crucially, the assessment revealed a 23-point gap between EC awareness (mean 36.2/100) and EC interest (59.2/100), confirming that information provision alone can substantially expand the pool of willing participants (Chapter 6, Section 6.9.2). Experience suggests that communities with diverse membership bases combining households, farms, and small businesses often achieve greater stability and impact than those dominated by single member categories [59][60].

7.2.2. Governance Structure Design

Effective governance structures must balance democratic participation with operational efficiency, ensuring members have meaningful voice in community decisions while enabling timely responses to operational requirements [48][50][75]. The EU directives require that energy communities be effectively controlled by their members.

Key governance design decisions include [48][50][59]:

- Legal form selection - cooperatives are most common, offering established frameworks for democratic governance
- Membership criteria and admission procedures
- Voting rights allocation - per capita versus proportional to investment
- Decision thresholds for different types of decisions
- Board composition and selection procedures
- Management arrangements and delegation of authority
- Member communication and engagement mechanisms
- Conflict resolution procedures and provisions for member exit

The ECOLOOP survey provides empirical guidance on governance preferences among potential community members (Chapter 6, Section 6.6.3). When asked about their preferred role in a potential energy community, the largest group (32.4%) selected “technology provider” — indicating a preference for contributing energy-generating capacity rather than passive consumption. “Active leader” was selected by 21.3% of respondents, “energy consumer” by 17.6%, and “passive member” by only 13.0%. This distribution has direct implications for governance design: a community in which over half the members wish to play active or contributory roles requires genuinely participatory governance structures with distributed decision-making rather than a centralised management model. The relatively low demand for passive membership also suggests that EU directive requirements for effective member control (Article 22, RED II; Article 16, IEMD) align well with actual farmer preferences in the ECOLOOP pilot regions.

Attention should be given to ensuring that governance structures prevent domination by individual members or external actors, as required by EU directives [44][4][75]. This may involve caps on individual shareholdings, restrictions on proxy voting, or requirements for diverse board composition.

Table 7.4: Key Stakeholder Roles in Energy Community Formation

Stakeholder	Primary Roles	Key Contributions	Engagement Priority
Community Leaders	Initiative leadership, coordination, representation	Vision, persistence, local knowledge, trust-building	Essential
Local Authorities	Planning support, facility provision, institutional legitimacy	Permits, public spaces, co-investment, network access	High

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Farmers/Landowners	Land/roof provision, local knowledge, agricultural integration	Sites, biomass supply, agrivoltaic opportunities	High
Grid Operators	Grid connection, technical requirements, metering	Technical feasibility, connection agreements, data	High
Energy Advisors	Technical expertise, feasibility assessment, business planning	Studies, applications, technology selection	Medium-High
Financial Institutions	Financing, risk assessment, financial structuring	Loans, guarantees, financial advice	Medium
Regional Development Agencies	Funding programs, coordination, capacity building	Grants, training, networking, policy input	Medium
Academic/Research Institutions	Knowledge support, innovation, monitoring	Research, student projects, documentation	Low-Medium

7.2.3. Timeline and Milestones

Realistic timeline planning is essential for maintaining momentum and managing expectations throughout the formation process [59][60]. Table 7.5 presents typical milestones and timeframes based on European experience, though actual timelines vary significantly depending on regulatory complexity, community capacity, and project scope.

Table 7.5: Typical Formation Timeline and Milestones

Milestone	Typical Timeframe	Key Deliverables	Critical Success Factors
Initial Interest Assessment	Month 1-3	Stakeholder map, preliminary interest survey, leaders' identification	Local networks, community trust, visible opportunity

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Feasibility Study	Month 4-9	Technical assessment, financial projections, site identification	Quality data, realistic assumptions, expert input
Working Group Formation	Month 3-6	Core team established, roles defined, meeting schedule	Committed individuals, diverse skills, clear mandate
Business Model Finalisation	Month 8-12	Revenue model, cost structure, value proposition, pricing	Market research, member input, professional review
Legal Entity Registration	Month 10-15	Registered entity, adopted statutes, governance bodies	Legal expertise, regulatory compliance, member consensus
Financing	Month 12-18	Grant awards, loan agreements, member contributions collected	Strong application, member commitment
Installation	Month 15-24	Operational assets, grid connection, metering	Project management, contractor quality, permit compliance
Full Operation	Month 18-30	Stable energy production, member services active, governance functioning	Technical performance, member satisfaction, adaptive management

Formation timelines extending to 24-36 months from initial concept to full operation are common for communities pursuing substantial generation projects [59][60]. Key considerations for timeline management:

- Simpler initiatives may proceed more quickly than complex generation projects
- Communities should resist pressure to compress timelines that compromise quality
- Problems created by rushed formation often prove costly to address later
- Realistic expectations shall be communicated to prospective members
- Build in contingency shall be considered for common delays in permitting and grid connection

7.3. Financial Planning and Sustainability

7.3.1. Business Model Development

Sustainable energy communities require clear business models that generate sufficient value to justify member participation and ensure long-term operational viability [59][60]. Business model development should identify primary value creation mechanisms and ensure realistic financial projections.

Key financial parameters include [48][60][61]:

- Capital investment requirements - equipment costs, installation expenses, grid connection and metering
- Operating costs - ongoing maintenance, insurance, administrative and management costs
- Revenue streams - energy production estimates, self-consumption rates, grid feed-in volumes
- Support mechanisms - applicable tariffs, grants, and support payments
- Member arrangements - payment structures and benefit distribution

The ECOLOOP Readiness Assessment (Chapter 6, Section 6.2.3) provides concrete data on the investment capacity of potential community members. Investment willingness clusters in the €5,000–20,000 range (44.6% of respondents), representing a realistic equity contribution for small-to-medium scale community projects such as shared rooftop solar installations. A further 12.5% indicate willingness to invest €20,000–50,000, and 15.1% would consider investments exceeding €50,000, suggesting capacity for larger community-scale projects where sufficient membership is secured. The investment timeline is equally encouraging: 68.7% of respondents have either already invested in RES or plan to do so within three years (Chapter 6, Section 6.2.3). These findings suggest that member contribution-based financing models are viable for the ECOLOOP pilot communities, particularly when combined with the grant programmes described in Table 7.6. Business models should be designed around the dominant €5,000–20,000 contribution level, with provisions for higher-tier participation from the 27.6% willing to invest above €20,000. As business models were analysed in depth in *D5.1 Business models and financial instruments*, the template of the questionnaire, which is based on triple layer business model canvas is attached to this report as annex to serve as an example on how to define the business model foundations.

Value distribution among members should reflect both contribution levels and community values regarding equity and inclusion [50][74]. Some communities adopt pure proportionality, while others incorporate solidarity elements such as subsidized participation for low-income members.

The chosen approach should be clearly documented and communicated during the preliminary phase.

7.3.2. Financing Options

Energy community financing typically combines member contributions with external funding from public grants, bank loans, or community investment schemes [55][60][61]. Table 7.6 summarizes common financing sources and their characteristics.

Table 7.6: Energy Community Financing Options

Financing Source	Typical Share	Advantages	Challenges	Best Suited For
Member Contributions	20-40%	Democratic ownership, aligned incentives, no interest costs	Limited capital, excludes low-income participants	Initial equity, working capital
Public Grants	30-60%	No repayment, reduces risk, signals legitimacy	Competitive, complex applications, reporting requirements	Capital investment, feasibility studies
Bank Loans	20-50%	Larger amounts, established procedures	Interest costs, collateral requirements, risk transfer	Equipment purchase, infrastructure
Community Bonds	10-30%	Local investment, community engagement, flexible terms	Regulatory complexity, investor protection requirements	Expansion projects, second-phase development
Crowdfunding	5-15%	Broad participation, marketing value, low thresholds	Platform fees, uncertain outcomes, intensive communication	Awareness building, complementary funding

Important considerations for financing strategy [50][59][60]:

- Member contribution levels should balance capital needs with accessibility goals

- Payment plans or financing assistance can reduce barriers for members with limited resources
- Grant funding requires substantial effort and faces competitive selection with uncertain outcomes
- Communities should diversify funding strategies rather than depending entirely on grant success
- Community investment approaches require careful attention to regulations

7.4. Technology Options for Rural Energy Communities

Rural and agricultural energy communities have access to diverse renewable energy technologies, each with distinct characteristics affecting suitability for different community contexts [59][72][73]. Technology selection should consider local resource availability, community capacity, and alignment with member needs. The ECOLOOP survey (Chapter 6, Section 6.8) provides direct evidence on technology preferences among potential community members: solar PV on rooftops dominates at 82.1% of respondents, followed by biomass from agricultural residues (36.6%), ground-mounted agri-PV (32.1%), geothermal (22.3%), and wind turbines (20.5%). These preferences show notable geographic variation: biomass is particularly strong in Estonia (61% of Estonian respondents), reflecting larger farm scales and abundant residues; geothermal interest concentrates in Slovenia and Estonia, consistent with local geological conditions; while solar PV commands near-universal preference across all four countries. Communities should use these preference data alongside technical feasibility assessments to prioritise technology portfolios that match both resource availability and member expectations. Table 7.7 summarises the key characteristics of each technology option.

Table 7.7: Renewable Energy Technology Options for Community Projects

Technology	Typical Scale	Investment Range	Suitability for Rural Communities	Key Considerations
Rooftop Solar PV	10-500 kWp	Variable by market	Excellent - utilises existing buildings	Roof condition, orientation, shading, grid capacity
Ground-mounted Solar	100-5,000 kWp	Variable by market	Good - requires land availability	Land use conflicts, visual impact, agricultural integration

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Small Wind	10-500 kW	Higher than solar	Good - site dependent	Wind resource, noise, permits, maintenance access
Biomass/Biogas	50-1,000 kW	Significant investment	Excellent - agricultural feedstock	Feedstock supply, logistics, skills, permits
Small Hydro	10-500 kW	Site-specific	Limited - water resource dependent	Water rights, environmental permits, seasonal variation
Battery Storage	10-500 kWh	Declining rapidly	Good - enhances self-consumption	Cycling needs, integration, technology evolution
Heat Pumps (collective)	50-500 kW	Moderate	Good - heating networks	Heat demand density, building suitability, grid capacity

Note: Investment costs vary significantly by country, market conditions, and project specifics. Communities should obtain current local quotes for accurate financial planning.

7.4.1. Solar Photovoltaic Systems

Solar photovoltaic systems represent the most common technology choice for energy communities across Europe, offering proven technology, declining costs, and flexible deployment options [59][73]:

- Rooftop installations minimise land use impacts and utilise existing structures
- Ground-mounted systems offer greater scale but require available land and may face planning constraints
- Agrivoltaic systems combine solar panels with continued agricultural use, providing shade for livestock and dual income streams
- EU support programs increasingly recognize agrivoltaic potential with dedicated funding lines

7.4.2. Biomass and Biogas

Agricultural communities have unique access to biomass resources that can support heating, combined heat and power, or biogas production [59][72]:

- Convert agricultural residues, manure, and energy crops into useful energy
- Address waste management challenges while generating additional revenue
- Biogas from anaerobic digestion transforms manure management from cost center to value source
- Reduce methane emissions while producing renewable energy
- Require sustained feedstock supply, skilled operation, and larger investment

7.4.3. Energy Storage

Battery storage systems increasingly complement renewable generation [59][72]:

- Enable communities to increase self-consumption and provide grid services
- Storage costs have declined substantially, making community-scale batteries viable
- Can be deployed at individual premises, collective facilities, or through virtual aggregation
- Some jurisdictions offer specific support for storage combined with renewable generation

7.5. Risk Assessment and Management

Energy communities face various risks that careful planning and appropriate management structures can mitigate [59][60]. Understanding these risks during the formation phase enables communities to design governance mechanisms and operational procedures that enhance resilience.

Table 7.8: Energy Community Risk Assessment Matrix

Risk Category	Specific Risks	Likelihood	Impact	Mitigation Strategies
Technical	Lower than expected energy production, equipment failures, grid connection delays	Medium	High	Conservative projections, quality equipment, maintenance contracts, backup plans
Financial	Cost overruns, lower revenues, member	Medium	High	Contingency budgets, diversified income,

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	payment defaults, funding gaps			payment policies, phased investment
Regulatory	Policy changes, permit delays, unfavourable tariff revisions	Medium	Medium	Policy monitoring, regulatory engagement, flexible business models
Governance	Member conflicts, leadership burnout, decision-making paralysis	Medium	Medium	Clear procedures, succession planning, conflict resolution mechanisms, training
Market	Energy price volatility, competition from commercial operators	High	Medium	Long-term contracts, diversified services, value-added offerings
Social	Declining member engagement, community opposition, free-rider problems	Low- Medium	Medium	Regular communication, visible benefits, fair contribution structures

7.5.1. Technical Risk Management

Technical risks include lower than expected energy production, equipment failures, and grid connection issues [59][72]. Mitigation strategies:

- Use conservative production estimates based on quality resource assessment
- Select proven technology from reputable suppliers with strong warranties
- Establish maintenance contracts ensuring timely issue resolution
- Maintain contingency reserves for unexpected repairs or replacements
- Engage early with distribution system operators for grid connection

7.5.2. Financial Risk Management

Financial risks span capital cost overruns, operating cost increases, revenue shortfalls, and member payment issues [60][61]. Good financial management requires:

- Realistic budgeting with appropriate contingencies (typically 10-20%)

- Diversified revenue sources reducing dependence on any single income stream
- Clear member payment policies with enforcement mechanisms
- Regular financial monitoring enabling early identification of problems
- Long-term power purchase agreements where available to reduce price volatility exposure

7.5.3. Governance Risk Management

Governance risks include member conflicts, leadership burnout, and decision-making paralysis [48][50][75]. Prevention and mitigation approaches:

- Well-designed statutes and procedures documented clearly
- Training and support for board members and managers
- Succession planning to reduce vulnerability to individual departures
- Deliberately cultivating new leaders and documenting institutional knowledge
- Building broad member engagement beyond founding leaders

7.6. Support Resources and Networks

7.6.1. National Support Organisations

Each ECOLOOP pilot country has organisations providing support for energy community development, though the nature and extent of support varies significantly [55][64]:

- Spain: Network of Community Transformation Offices (OTCs) provides localised assistance; IDAE offers national-level resources including guidance documents and funding programs [55][65]
- Slovenia: Borzen (electricity market operator) and Eco Fund manage energy efficiency and renewable energy support programs [56][14]
- Estonia: Communities primarily rely on general business development services; EU-funded projects contribute capacity building resources [63][64]
- Bulgaria: Sustainable Energy Development Agency (SEDA) provides information; Ministry of Energy tasked with developing enabling measures [10][62]

7.6.2. European Networks and Resources

European networks provide valuable resources that complement national support [69][70]:

- REScoop.eu: European federation of citizen energy cooperatives offering guidance, training, and networking

- European Commission's Clean Energy for All Europeans initiative: extensive documentation on concepts and implementation
- Energy Communities Repository: guidance documents, best practice examples, and connections to support organizations
- Horizon Europe research projects: case studies, toolkits, and analysis accessible through project websites

7.6.3. Technical Assistance Providers

Professional technical assistance is valuable at multiple formation stages [59][60]. Key technical support needs include:

- Resource assessment and energy system design
- Financial modelling and business planning
- Legal structuring and regulatory compliance
- Grant application preparation
- Project management and procurement
- Ongoing operational support

Communities should carefully select technical advisors with relevant experience, checking references and understanding fee structures before engagement. Some support is available through public programs at reduced or no cost, while building internal capacity reduces long-term dependence on external support [48][60].

7.7. Conclusions and Recommendations

Energy communities represent a transformative opportunity for farmers, foresters, and rural communities to participate actively in the renewable energy transition while generating tangible economic and social benefits [48][50][59]. The European Union's Clean Energy Package has created legal frameworks that recognise and support community energy initiatives, establishing rights to produce, consume, store, share, and sell renewable energy [43][44][4].

Analysis of the four ECOLOOP pilot countries reveals a spectrum of development stages [64]:

- Spain: Most advanced with 659 registered communities (2024), comprehensive funding programme, and extensive support infrastructure [11][55]
- Slovenia: Solid regulatory foundations with cooperative requirement, municipal participation provisions, and EUR 29+ million allocated for community promotion [52][56][57][75]
- Estonia and Bulgaria: Basic frameworks established but facing transposition challenges and limited implementation experience [51][53][62][63]

Common success factors consistently emerge from research and case study analysis [49][50][60][61]:

- Strong local leadership from committed community leaders with technical understanding, communication skills, and persistence
- Clear business models with realistic financial projections developed through proper feasibility assessment
- Effective communication building understanding and trust necessary for democratic participation
- Supportive municipal authorities and institutions facilitating regulatory navigation
- Access to appropriate financing through member contributions, public grants, or external lending
- Diverse membership types combining households, farms, and small businesses for stability

Communities that invest adequate time and resources in thorough preparation during the formation phase position themselves for long-term sustainability and meaningful impact [59][60]. The timelines presented in these guidelines represent realistic expectations based on experience across diverse European contexts.

Key recommendations for communities considering energy community formation:

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- Begin with comprehensive assessment of local resources, member interest, and regulatory requirements
- Select appropriate legal form and governance structures for democratic control
- Develop realistic business models with conservative assumptions and appropriate contingencies
- Engage with support networks at regional, national and European levels for resources and peer learning
- Plan for timelines of 24-36 months from concept to operation
- Build internal capacity over time to reduce dependence on external support

The ECOLOOP project continues developing and refining support tools and methodologies through ongoing engagement with pilot communities and stakeholders across the four countries. Agricultural communities interested in exploring energy community formation are encouraged to engage with ECOLOOP partners and national support networks to access current resources and connect with practitioners who have navigated the formation journey.

8. Conclusions

This report consolidates the key outcomes of Work Package 5 related to KER 6, with a primary focus on the results of Task 5.3 (policy development and enabling frameworks) and Task 5.4 (support for renewable energy community formation). Together, these tasks form the backbone of the report, providing both the strategic and practical foundations for advancing renewable energy uptake in rural areas. By integrating economic, social, and governance perspectives, the report offers a coherent framework to support farmers, foresters, and rural stakeholders in engaging as prosumers, both individually and collectively through energy communities.

The findings confirm that renewable energy deployment in rural areas is not constrained by technology, but by the interplay of economic conditions, regulatory frameworks, and social readiness. While individual prosumer models, such as farm-based photovoltaic systems, can be economically viable, collective approaches through energy communities offer additional benefits, including risk sharing, improved access to financing, and stronger local value creation.

Economic analysis shows that the effectiveness of support mechanisms such as Contracts for Difference (CfDs) and Power Purchase Agreements (PPAs) depends strongly on their design. CfDs can enhance investment security and stabilise revenues, particularly when strike prices are aligned with generation costs and market conditions. However, their financial impact varies significantly depending on contract parameters. In contrast, PPAs emerge as a robust and often more attractive option, providing stable and predictable revenues with lower systemic risk, particularly for larger-scale and dispatchable technologies such as bioenergy. These findings highlight the importance of well-designed contractual frameworks that balance investor incentives with public cost efficiency.

The social dimension represents a critical enabling factor for renewable energy uptake. The readiness assessment indicates that farmers and foresters are generally willing to engage, but lack the necessary knowledge, confidence, and support to act independently. Financial barriers are closely linked to information gaps, particularly regarding investment costs, returns, and available support schemes. A significant opportunity lies in energy communities, where interest substantially exceeds awareness, suggesting that targeted communication and engagement strategies could unlock considerable participation potential. Trust in intermediaries such as advisors, peers, and farmer organisations further underlines the need for locally embedded and tailored support approaches.

Policy and governance frameworks play a central role in enabling this transition. While the EU regulatory framework provides strong support for energy communities, implementation varies across countries, reflecting different levels of institutional maturity and experience. Despite these differences, common success factors are evident, including strong local leadership, clear and realistic business models, effective communication, supportive local authorities, access to

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financing, and diverse membership structures. Adequate preparation and realistic timelines, typically 24 to 36 months, are essential for long-term success.

The Energy Community Formation Guidelines presented in this report translate these insights into practical steps, covering legal structures, governance, financial planning, stakeholder engagement, and implementation processes. Together with policy recommendations and roadmap elements, they provide actionable guidance for both decision-makers and rural actors. The report demonstrates that successful renewable energy uptake in agriculture and forestry requires the alignment of economic viability, supportive policy frameworks, and strong social engagement. By combining analytical insights with practical tools, it supports a transition towards resilient, decentralised, and community-based energy systems, enabling rural stakeholders to actively participate in and benefit from the renewable energy transition.

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9.2. Acronyms

Acronym	Description
Agri-PV	Agrivoltaics
BG	Bulgaria
CEC	Citizen Energy Community
CfD	Contract for Difference
CHP	Combined Heat and Power
DA	Day ahead
EAFRD	European Agricultural Fund For Rural Development
EC	Energy community
ECPI	Energy Community Potential Index
EE	Estonia
EE	Estonia
ERDF	European Regional Development Fund
ES	Spain

D5.2. Support for the creation of Renewable Energy Communities in Rural Areas

EU	European Union
HUDEX	Hungarian derivative exchange
KER	Key Exploitable Result
kWp	Kilowatt peak power rate
OTC	Oficinas de Transformación Comunitaria (Community Transformation Offices)
PPA	Power Purchase agreement
PV	Photovoltaic
Q1	Quarter product 1
REC	Renewable Energy Community
RECAH	Rural Energy Community Advisory Hub
RED	Renewable Energy Directive
RES	Renewable Energy Source
ROI	Return on Investment
RRI	RES Readiness Index
SD	Standard deviation
SEDA	Sustainable Energy Development Agency
SI	Slovenia
SME	Small and Medium sized Enterprise
TLBMC	Triple Layer Business Model Canvas
TWh	Tera Watt hours

D5.2. Support for the creation of Renewable Energy Communities in Rural Areas

UC	Use Case
ZOEE	Zakon o oskrbi z električno energijo
ZSROVE	Zakon o spodbujanju rabe obnovljivih virov energije

1. Annexes

1.1. ECOLOOP Survey Summary Statistics

ECOLOOP Survey – Summary Statistics

1. RESPONSE DISTRIBUTION BY COUNTRY

Country	N	%	ISO
Bulgaria	17	14,9	BG
Slovenia	57	50,0	SI
Spain	17	14,9	ES
Estonia	23	20,2	EE
TOTAL	114	100	

2. FARM SIZE (A3)

Category	BG	SI	ES	EE	Total	Total %
<5 ha	5	1	2	1	9	7,9
5-20 ha	5	25	4	1	35	30,7
20-50 ha	1	18	2	5	26	22,8

D5.2. Support for the creation of Renewable Energy Communities in Rural Areas

50-100 ha	2	6	2	3	13	11,4
>100 ha	2	6	3	8	19	16,7
N/A	2	0	2	2	6	5,3

3. EXPERIENCE (A5)

Category	BG	SI	ES	EE	Total	Total %
<5 yrs	2	0	1	2	5	4,4
5-10 yrs	6	8	3	3	20	17,5
10-20 yrs	4	16	3	5	28	24,6
>20 yrs	5	32	9	13	59	51,8

4. ENERGY COST CONCERN (B3)

Category	BG	SI	ES	EE	Total	Total %
Not concerned	5	5	1	1	12	10,5
Slightly	5	11	3	5	24	21,1
Moderate	5	25	5	9	44	38,6
Very	2	14	7	6	29	25,4
Extremely	0	1	0	1	2	1,8

D5.2. Support for the creation of Renewable Energy Communities in Rural Areas

5. CURRENT RES USE (B4)

Category	BG	SI	ES	EE	Total	Total %
Yes	4	39	5	6	54	47,4
No but interested	13	14	10	12	49	43,0
No, not interested	0	2	1	5	8	7,0

6. INVESTMENT WILLINGNESS (C5)

Category	BG	SI	ES	EE	Total	Total %
Nothing	0	3	2	3	8	7,0
<€5k	3	1	3	4	11	9,6
€5-20k	10	28	6	6	50	43,9
€20-50k	1	10	1	2	14	12,3
€50-100k	1	4	0	2	7	6,1
>€100k	1	6	1	2	10	8,8
Depends	1	3	3	4	11	9,6

7. HEARD OF ENERGY COMMUNITIES (D1)

Category	BG	SI	ES	EE	Total	Total %
Yes, familiar	2	8	2	3	15	13,2

D5.2. Support for the creation of Renewable Energy Communities in Rural Areas

Yes, no details	12	24	7	8	51	44,7
No, first time	3	24	7	12	46	40,4

8. INTEREST JOINING EC (D2)

Category	BG	SI	ES	EE	Total	Total %
Very interested	1	12	3	1	17	14,9
Somewhat	7	10	4	3	24	21,1
Need info	7	29	8	15	59	51,8
Probably not	2	3	0	2	7	6,1
Not at all	0	2	1	2	5	4,4

9. INVESTMENT TIMELINE (G1)

Category	BG	SI	ES	EE	Total	Total %
Already invested	4	16	3	4	27	23,7
<1 year	3	5	0	2	10	8,8
1-3 yrs	7	21	7	5	40	35,1
3-5 yrs	3	9	3	6	21	18,4
5-10 yrs	0	4	1	2	7	6,1
>10 yrs	0	1	0	2	3	2,6

D5.2. Support for the creation of Renewable Energy Communities in Rural Areas

Never	0	0	2	2	4	3,5
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10. ENERGY VISION 10YR (G4)

Category	BG	SI	ES	EE	Total	Total %
Fully self-sufficient	5	12	0	1	18	15,8
Partially	7	29	7	10	53	46,5
Part of EC	1	1	0	3	5	4,4
Energy supplier	0	3	0	1	4	3,5
Same as today	0	4	0	5	9	7,9
Don't know	4	4	9	3	20	17,5

11. FOLLOW-UP WILLINGNESS (H3)

Category	BG	SI	ES	EE	Total	Total %
Yes - both	3	11	2	3	19	16,7
Yes - interview	1	2	0	3	6	5,3
Yes - pilot	1	7	3	1	12	10,5
Maybe	7	28	6	7	48	42,1
No	4	4	5	9	22	19,3

D5.2. Support for the creation of Renewable Energy Communities in Rural Areas

12. LIKERT SCALE MEANS (1–5)

Variable	BG Mean	SI Mean	ES Mean	EE Mean	Overall Mean	Overall SD
C1: Solar PV	2,94	3,79	3,62	3,87	3,65	1,27
C1: Solar Thermal	2,92	2,49	1,86	2,76	2,51	1,35
C1: Wind	2,38	2,50	2,36	3,32	2,64	1,27
C1: Biomass	1,92	3,04	2,23	2,86	2,76	1,43
C1: Geothermal	1,90	2,19	1,64	3,50	2,38	1,32
C1: Small Hydro	2,27	2,10	1,43	1,55	1,91	1,16
E2: Investment Costs	3,59	4,23	4,53	4,13	4,15	1,10
E2: Payback Period	3,69	4,16	4,54	4,39	4,19	1,12
E2: Available Subsidies	3,88	4,38	4,36	4,30	4,29	1,01
E2: Technical Requirements	3,60	4,34	4,00	4,09	4,14	1,04
E2: Maintenance	3,60	4,25	4,00	3,95	4,06	1,10
E2: Success Stories	2,79	3,63	3,46	3,05	3,37	1,20
E2: Environmental Impact	3,20	3,92	3,54	3,29	3,64	1,24
E2: Regulatory Requirements	3,33	4,19	4,31	4,14	4,07	1,11
F1.1: Initial Investment	4,00	4,55	4,75	4,57	4,50	0,80
F1.1: Operating Costs	3,80	4,51	4,60	4,26	4,37	0,96

D5.2. Support for the creation of Renewable Energy Communities in Rural Areas

F1.1: Energy Sales	3,62	4,56	4,27	4,39	4,35	0,88
F1.1: Energy Savings	4,06	4,65	4,64	4,52	4,54	0,78
F1.1: Asset Value	3,93	4,06	3,79	4,09	4,01	1,02
F1.1: New Markets	3,73	3,56	3,62	3,55	3,59	1,15

1.2. Renewable Energy and Energy Community Readiness Assessment Questionnaire for Farmers and Forest Managers

Introduction

This questionnaire aims to assess your readiness to adopt renewable energy solutions and participate in energy communities. Your responses will help us develop practical support mechanisms and policy recommendations for rural renewable energy development.

Estimated completion time: 25-30 minutes

PART A: RESPONDENT PROFILE

This section helps us understand your background and context

A1. Country:

- ◆ Bulgaria
- ◆ Estonia
- ◆ Slovenia
- ◆ Spain

A2. Your primary role:

- ◆ Farm owner/operator
- ◆ Forest owner/manager
- ◆ Agricultural cooperative member
- ◆ Agricultural/forestry employee
- ◆ Rural landowner (non-farming)
- ◆ Other: _____

A3. Size of your operation:

- ◆ Less than 5 hectares
- ◆ 5-20 hectares
- ◆ 20-50 hectares
- ◆ 50-100 hectares
- ◆ More than 100 hectares
- ◆ Not applicable

A4. Main agricultural/forestry activities (select all that apply):

- ◆ Crop production
- ◆ Livestock farming

D5.2. Support for the creation of Renewable Energy Communities in Rural Areas

- ◆ Mixed farming
- ◆ Forestry/timber production
- ◆ Fruit/vegetable production
- ◆ Viticulture
- ◆ Other: _____

A5. Years of experience in agriculture/forestry:

- ◆ Less than 5 years
- ◆ 5-10 years
- ◆ 10-20 years
- ◆ More than 20 years

A6. Educational background:

- ◆ Primary education
- ◆ Secondary education
- ◆ Vocational/technical training
- ◆ University degree
- ◆ Post-graduate degree

A7. Number of employees (including seasonal):

- ◆ Solo/family operation only
- ◆ 2-5 employees
- ◆ 6-10 employees
- ◆ 11-50 employees
- ◆ More than 10 employees
- ◆ Seasonal workers only (specify number): _____

A8. Employment type:

- ◆ Full-time year-round
- ◆ Part-time year-round
- ◆ Seasonal only
- ◆ Mix of permanent and seasonal
- ◆ Family members only

A9. Specific agricultural production (check all that apply):

Crop Production:

- ◆ Cereals (wheat, barley, corn)
- ◆ Vegetables (greenhouse)
- ◆ Vegetables (open field)
- ◆ Fruits/orchards
- ◆ Vineyards/wine
- ◆ Industrial crops (sunflower, rapeseed)
- ◆ Other: _____

Livestock:

- ◆ Dairy cattle
- ◆ Beef cattle
- ◆ Pigs
- ◆ Poultry (eggs)
- ◆ Poultry (meat)
- ◆ Sheep/goats
- ◆ Other: _____

A10. Primary processing activities on-farm:

- ◆ None - raw products only
- ◆ Milk processing (cheese, yogurt)
- ◆ Meat processing
- ◆ Crop drying/storage
- ◆ Wine/oil production
- ◆ Packaging/sorting
- ◆ Other: _____

PART B: CURRENT ENERGY SITUATION

Understanding your current energy use and costs

B1. What are your main energy needs? (select all that apply)

- ◆ Electricity for equipment/machinery
- ◆ Heating for buildings/greenhouses
- ◆ Cooling/refrigeration
- ◆ Irrigation pumping
- ◆ Processing/drying
- ◆ Transportation fuel
- ◆ Other: _____

B2. What is your approximate annual energy cost?

- ◆ Less than €1,000
- ◆ €1,000 - €5,000
- ◆ €5,000 - €10,000
- ◆ €10,000 - €25,000
- ◆ €25,000 - €50,000
- ◆ More than €50,000

B3. How concerned are you about energy costs affecting your business?

- ◆ Not concerned
- ◆ Slightly concerned
- ◆ Moderately concerned
- ◆ Very concerned
- ◆ Extremely concerned

B4. Do you currently use any renewable energy sources?

- ◆ Yes (please specify): _____
- ◆ No, but interested
- ◆ No, not interested

PART C: RENEWABLE ENERGY AWARENESS AND READINESS

Assessing your knowledge and readiness for RES adoption

C1. How familiar are you with the following renewable energy technologies? (Rate from 1=Not familiar to 5=Very familiar)

Technology	1	2	3	4	5
Solar photovoltaic (PV)					
Solar thermal					
Wind energy					
Biomass/biogas					
Geothermal					
Small hydro					

C2. Which renewable energy sources would be most suitable for your operation? (select up to 3)

- ◆ Solar PV on rooftops
- ◆ Solar PV on land (agri-PV)
- ◆ Wind turbines
- ◆ Biomass from agricultural residues
- ◆ Biogas from livestock waste
- ◆ Geothermal heating/cooling
- ◆ Small hydropower
- ◆ Not sure

C3. What is your main motivation for considering renewable energy? (rank top 3)

- ◆ Reduce energy costs
- ◆ Energy independence
- ◆ Environmental responsibility
- ◆ Additional income source
- ◆ Modernise operations
- ◆ Meet regulatory requirements
- ◆ Improve farm sustainability image

C4. What prevents you from adopting renewable energy? (select all that apply)

- ◆ High initial investment costs
- ◆ Lack of information/knowledge

D5.2. Support for the creation of Renewable Energy Communities in Rural Areas

- ◆ Complex administrative procedures
- ◆ Uncertain return on investment
- ◆ Lack of technical support
- ◆ No suitable financing options
- ◆ Land use conflicts
- ◆ Grid connection issues
- ◆ Maintenance concerns
- ◆ Nothing - already planning to adopt

C5. How much would you be willing to invest in renewable energy?

- ◆ Nothing
- ◆ Less than €5,000
- ◆ €5,000 - €20,000
- ◆ €20,000 - €50,000
- ◆ €50,000 - €100,000
- ◆ More than €100,000
- ◆ Depends

on

financing

options

PART D: ENERGY COMMUNITIES POTENTIAL

Exploring collective renewable energy opportunities

D1. Have you heard of energy communities before this questionnaire?

- ◆ Yes, familiar with the concept
- ◆ Yes, but don't know details
- ◆ No, first time hearing about it

D2. Would you be interested in joining an energy community where farmers/foresters collectively invest in and share renewable energy?

- ◆ Very interested
- ◆ Somewhat interested
- ◆ Need more information
- ◆ Probably not interested
- ◆ Not interested at all

D3. What would motivate you to join an energy community? (select all that apply)

- ◆ Shared investment costs
- ◆ Technical support from the group
- ◆ Stronger negotiating power
- ◆ Learning from other members
- ◆ Social/community benefits
- ◆ Risk sharing
- ◆ Access to larger projects
- ◆ Professional management

D5.2. Support for the creation of Renewable Energy Communities in Rural Areas

D4. What concerns would you have about joining an energy community? (select all that apply)

- ◆ Loss of individual control
- ◆ Conflicts with other members
- ◆ Complex governance
- ◆ Financial risks
- ◆ Time commitment
- ◆ Legal uncertainties
- ◆ Unequal benefit distribution
- ◆ No concerns

D5. What role would you prefer in an energy community?

- ◆ Active participant in management
- ◆ Investor only
- ◆ Energy consumer only
- ◆ Host land/rooftop for installations
- ◆ Multiple roles
- ◆ Not interested in participating

D6. How many other farmers/foresters in your area might be interested?

- ◆ None that I know
- ◆ 1-5
- ◆ 6-10
- ◆ 11-20
- ◆ More than 20
- ◆ Don't know

PART E: SUPPORT NEEDS AND PREFERENCES

Identifying what help you need to adopt RES

E1. What type of support would be most helpful? (rank top 3)

- ◆ Financial subsidies/grants
- ◆ Low-interest loans
- ◆ Technical feasibility studies
- ◆ Help with permit applications
- ◆ Training/education programs
- ◆ Demonstration projects to visit
- ◆ Peer-to-peer learning
- ◆ Professional consulting services

E2. What information do you need to make a decision about renewable energy? (*Rate importance: 1=Not important to 5=Very important*)

Information Type	1	2	3	4	5
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D5.2. Support for the creation of Renewable Energy Communities in Rural Areas

Investment costs					
Payback period					
Available subsidies					
Technical requirements					
Maintenance needs					
Success stories from peers					
Environmental impact					
Regulatory requirements					

E3. How would you prefer to receive information about renewable energy? (select up to 3)

- ◆ Local workshops/seminars
- ◆ Online webinars
- ◆ Printed guides/brochures
- ◆ Mobile app
- ◆ One-on-one consultation
- ◆ Demonstration site visits
- ◆ Farmer association meetings
- ◆ Social media/online forums

E4. Who do you trust most for renewable energy advice?

- ◆ Government agencies
- ◆ Farmer associations/cooperatives
- ◆ Energy companies
- ◆ Independent consultants
- ◆ Other farmers/foresters
- ◆ Universities/research institutions
- ◆ NGOs
- ◆ Equipment suppliers

PART F: BUSINESS MODEL CONSIDERATIONS

Understanding economic, environmental, and social aspects

F1. ECONOMIC LAYER

F1.1 How important are the following economic factors for your renewable energy decision?

(Rate: 1=Not important to 5=Very important)

Factor	1	2	3	4	5
Initial investment cost					

D5.2. Support for the creation of Renewable Energy Communities in Rural Areas

Operating costs					
Revenue from energy sales					
Energy cost savings					
Asset value increase					
Access to new markets					

F1.2 Would you be interested in these revenue models? (Yes/No/Maybe)

- ◆ Selling excess energy to the grid: ____
- ◆ Direct sales to local consumers: ____
- ◆ Carbon credit trading: ____
- ◆ Leasing land for energy installations: ____
- ◆ Energy-as-a-service provision: ____

F2. ENVIRONMENTAL LAYER

F2.1 How important are environmental benefits to you?

- ◆ Not important
- ◆ Slightly important
- ◆ Moderately important
- ◆ Very important
- ◆ Extremely important

F2.2 Which environmental aspects concern you most? (select up to 3)

- ◆ Carbon footprint reduction
- ◆ Soil quality impacts
- ◆ Water resource management
- ◆ Biodiversity effects
- ◆ Landscape changes
- ◆ Waste management
- ◆ Circular economy practices

F3. SOCIAL LAYER

F3.1 How would renewable energy affect your community relationships?

- ◆ Very positively
- ◆ Somewhat positively
- ◆ No change
- ◆ Somewhat negatively
- ◆ Very negatively

F3.2 What social benefits are important to you? (select all that apply)

- ◆ Job creation in rural areas
- ◆ Knowledge sharing with peers
- ◆ Improved community resilience

- ◆ Youth retention in rural areas
- ◆ Enhanced farm reputation
- ◆ Contribution to national energy goals
- ◆ Setting example for others

PART G: FUTURE OUTLOOK AND TIMELINE

Understanding your implementation timeline

G1. When might you consider investing in renewable energy?

- ◆ Already invested
- ◆ Within 1 year
- ◆ 1-3 years
- ◆ 3-5 years
- ◆ 5-10 years
- ◆ More than 10 years
- ◆ Never

G2. What would accelerate your decision? (open answer - max 100 words)

G3. What specific policy changes would help you most? (select up to 3)

- ◆ Simplified permit procedures
- ◆ Higher subsidies
- ◆ Guaranteed energy purchase prices
- ◆ Tax incentives
- ◆ Free technical assessments
- ◆ Grid connection support
- ◆ Regulatory stability
- ◆ Energy community legislation

G4. How do you see your energy situation in 10 years?

- ◆ Fully energy self-sufficient
- ◆ Partially self-sufficient
- ◆ Part of an energy community
- ◆ Energy provider to others
- ◆ Same as today
- ◆ Don't know

PART H: ADDITIONAL INSIGHTS

Your additional thoughts and suggestions

H1. What success story or example would inspire you to adopt renewable energy? (open answer - max 100 words)

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H2. What is your biggest fear about renewable energy adoption? (open answer - max 50 words)

H3. Would you be willing to participate in a follow-up interview or pilot project?

- ◆ Yes - interview
- ◆ Yes - pilot project
- ◆ Yes - both
- ◆ No
- ◆ Maybe - need more information

H4. Contact information (optional):

- Name: _____
- Email: _____
- Phone: _____
- Preferred contact method: _____

Thank You!

Your responses will help shape renewable energy policies and support programs for farmers and foresters across Europe.

Data Usage Note:

All responses will be anonymized and used only for research purposes within the ECOLOOP project. Personal contact information, if provided, will be used solely for follow-up research activities and will not be shared with third parties.

1.3. Triple layer bussines model questionnaire

The aim of this questionnaire is to describe the business models for the ECOLOOP pilots. The Business Model Canvas is a strategic tool that streamlines the process of defining and organizing key business activities and components. By visually mapping out elements such as value propositions, customer segments, revenue streams, and key resources, it provides a clear overview of how a business creates, delivers, and captures value. This holistic perspective helps businesses identify their core operations, align objectives, and ensure all components work cohesively. It also supports decision-making by highlighting interdependencies and enabling iterative adjustments to optimize business strategies. The triple layered approach to the BMC will be base

Table 1.1: Economic aspect of proposed business model

Component	desc.	Info
Key Partners	1. Who are the key partners and suppliers essential for your business operations? 2. How do you prioritize and maintain strong relationships with these partners? 3. What strategies do you use to manage risks and secure resources through partnerships?	
Key Activities	4. What are the critical activities required to deliver your value propositions successfully? 5. How do you ensure these activities help you reach your target markets and maintain customer relationships? 6. What processes contribute directly to your revenue generation?	
Key Resources	7. What physical, financial, intellectual, and human resources are essential for your business model? 8. How do these resources support the creation of value propositions, market reach, and customer retention? 9. How do you manage and allocate these resources effectively?	
Bussines Value proposition	10. What unique value does your product or service offer to customers? 11. How is your value proposition innovative or enhanced with new features? 12. Why do customers choose your product or service over competitors?	
Customer relationship	13. How would you describe the nature of your relationships with customers (e.g., personal, automated)? 14. What methods do you use to build and maintain strong customer relationships? 15. How do you identify critical routes for engagement and manage associated risks?	

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Customer segments	16. Who are your primary customer groups, and how do you segment them? 17. What common needs, behaviours, or attributes define your customer segments? 18. How do you ensure your offerings meet customer needs in a competitive market?	
Channels	19. What are the main communication, distribution, and sales channels you use to reach customers? 20. How do you ensure these channels effectively deliver your value proposition? 21. What strategies do you employ to optimize customer interaction through these channels?	
Cost structure	22. What are the key costs associated with operating your business model? 23. How do you calculate and manage costs related to value creation, customer relationships, and revenue generation? 24. How do Key Resources, Activities, and Partnerships influence your cost structure?	
Revenue streams	25. What are your primary revenue streams, and how are they linked to your customer segments? 26. How do you determine the value of your product or service to generate these revenue streams? 27. What mechanisms (e.g., fixed pricing, bargaining, volume dependency) do you use to define and manage revenue streams?	

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Table 1.2: Environmental aspect of proposed business model

Component	desc.	Info
Functional Value	1. What is the functional value of your product or service, and how is it measured (e.g., product lifespan or annual service delivery)? 2. How do you use functional value as a baseline to explore and optimize alternative business models? 3. How do you ensure the functional value aligns with sustainability goals?	
Materials	4. What critical or scarce materials are central to your product or service, and how do you manage their sourcing challenges? 5. How do you assess the environmental impact of the materials you use? 6. What strategies do you employ to minimize risks and streamline production while managing material use?	
Production	7. Which production activities have the most significant environmental impact or pose high risks? 8. How do you incorporate sustainability analysis into your production processes? 9. What measures have you implemented to reduce the environmental footprint of manufacturing or service delivery?	
Supplies and Outsourcing	10. What non-core activities or supplies (e.g., utilities like electricity or water) are outsourced in your business model? 11. How do these outsourced elements influence the environmental performance of your operations? 12. What criteria do you use to select suppliers and partners for outsourced activities to align with sustainability goals?	
Distribution	13. How do you manage the physical delivery of your product or service to minimize environmental impact? 14. What factors (e.g., transportation modes, distances, weight of goods, packaging) are considered in your distribution strategy? 15. What initiatives have you implemented to reduce the environmental footprint of logistics?	
Use Phase	16. How do customers typically use your product or service, and what is the environmental impact during this phase? 17. What maintenance or repair requirements contribute to material and energy demand during the Use Phase? 18. How do you address and minimize the environmental impact of the Use Phase in your business model?	
End-of-Life	19. What strategies do you have for managing your product's End-of-Life phase (e.g., recycling, remanufacturing, or disposal)? 20. How do you comply with regulations, such as EU policies, for the End-of-Life phase? 21. What new business opportunities have you identified related to End-of-Life planning?	
Environmental Impacts and Benefits	22. How do you measure and evaluate the environmental costs (e.g., CO2 emissions, resource depletion) of your business activities? 23. What actions have you taken to minimize or reverse negative environmental impacts? 24. How do positive environmental outcomes support your sustainability goals and market competitiveness?	

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Table 1.3: Social aspect of proposed business model

Component	desc.	Info
Social Value	1. How does your organization contribute to societal well-being beyond financial gains? 2. What specific actions or initiatives demonstrate your commitment to enhancing sustainability and strengthening your reputation? 3. How do you measure the societal benefits your organization delivers?	
Employees	4. How does your organization contribute to societal well-being beyond financial gains? 5. What specific actions or initiatives demonstrate your commitment to enhancing sustainability and strengthening your reputation? 6. How do you measure the societal benefits your organization delivers?	
Governance	7.  What governance structure does your organization follow (e.g., cooperative, nonprofit, for-profit), and how does it influence decision-making? 8. How do your governance policies ensure transparency and fair profit-sharing? 9. How does your decision-making process align with the organization's goals and societal responsibilities?	
Communities	10. How does your organization engage with local communities and stakeholders? 11. What strategies do you use to build mutual benefits and reduce risks in supplier relationships? 12. How do you incorporate community feedback into your operations and risk management?	
Societal Culture	13. How does your organization influence societal norms and, in turn, adapt to societal expectations? 14. What roles do partnerships with NGOs or other organizations play in gaining societal acceptance? 15. How do you ensure alignment between your business practices and the values of the communities you serve?	
Scale of Outreach	16. What is the scope of your stakeholder relationships, from local to global? 17. How do you address cultural and ethnic diversity in your outreach efforts? 18. What long-term strategies do you have for building integrative relationships that support growth across different regions?	
End-users	19. Who are the primary end-users of your products or services, and how do you tailor offerings to meet their needs? 20. How do you ensure your value propositions improve the quality of life for end-users and promote inclusivity? 21. What measures do you take to understand and respond to the diverse needs of your customer base (e.g., age, income, education)?	
Social Impacts and Benefits	22. How do you assess the positive and negative social impacts of your operations, including working conditions and community engagement? 23. What initiatives do you have in place to enhance personal development opportunities for employees and other stakeholders? 24. How does your organization contribute to societal benefits such as improved health, safety, and inclusivity?	

