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FINAL REPORT //

Territorial Analysis of Decentralised Energy Markets (TANDEM)

Scientific Report // August 2025

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Disclaimer

This document is a final report.

The information contained herein is subject to change and does not commit the ESPON EGTC and the countries participating in the ESPON 2030 Cooperation Programme.

The final version of the report will be published as soon as approved.

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Introduction

1 Introduction

1.1 Background and context

In legislative terms, it is important to underline how the Clean Energy for All Europeans Package signalled the EU's strong shift for the role of citizens from passive consumers to active participants in the energy transition. EU legislation acknowledged, for the first time, the role community energy ownership can play in the EU meeting its climate and energy objectives while at the same time driving local social innovation. Enshrined in the Package, the recast Directive 2018/2001 (Renewable Energy Directive II, or REDII)[1] and the recast Directive 2019/944 (the Internal Electricity Market Directive, or IEMD)[2] legally established CECs (Citizens Energy Communities) and RECs (Renewable Energy Communities) as the two legal definitions covering energy communities, and gave them rights to participate across the energy market.

RECs and CECs bring together natural persons, local authorities, and businesses together in a legal entity to organise different activities in and around renewable energy production. The two definitions are composed of a set of criteria, or 'principles-based' elements, that must be met to be considered an energy community such as:

- Establishing a legal entity organised around specific ownership and governance principles that promote democratic decision making among members;[3] and
- A primary purpose to participate in the energy market to deliver environmental, social and economic benefits for members and the local community, rather than profit for shareholders.[4]

There are some differences between the RECs and CECs definitions[5]. However, despite their differences, RECs and CECs share the same root conceptual basis, namely that they represent a particular way to organise collective ownership around a particular energy-related activity.

EU Member States were required to transpose the provisions of the REDII and the IEMD by 30 June 2021 and 31 December 2020, including the definitions of energy communities, alongside the development of concrete enabling frameworks allowing for their market participation without discrimination in regard to other market actors.[6] Most Member States transposed some EU rules on energy communities, including around the definitions. Due to various approaches taken across different countries, a diverse and even growing number of different types of energy communities are being realised across the EU. Member States are also required to assess the potential and barriers to the development of RECs at the national level,[7] while national regulatory authorities for electricity have a duty to monitor the removal of unjustified obstacles to and restrictions on the development of consumption of self-generated electricity, energy sharing, renewable energy communities and citizen energy communities.[8]

[1] Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources (recast), OJ L 328, 21.12.2018, p 82 (REDII)

[2] Directive (EU) 2019/944 of the European Parliament and of the Council of 5 June 2019 on common rules for the internal market for electricity and amending Directive 2012/27/EU (recast), OJ L158, 14.6.2019, p 125 (IEMD)

[3] Article 2(16)(a) REDII requires RECs to be based on open and voluntary participation, autonomous from individual members and other traditional market actors that participate in the community as members or shareholders, or who cooperate through other means such as investment, Article 2(11) IMED requires CECs to be based on open and voluntary participation.

[4] In this respect both Article 2(16) RED II and Article 2(11) IMED are both identical.

[5] RECs are intended to be rooted in the local or regional ownership and "effective control" of renewable energy production (not limited to electricity), although they are allowed to undertake other activities. CECs, on the other hand, do not need to be rooted in a specific geographical context, and operate only in electricity. Participation in a REC is also limited to small and medium enterprises (SMEs), while CECs do not place a limit on the size enterprise, as long effective control still remains with entities that qualify as a small enterprise.

[6] Article 22 paragraph 4 REDII and Article 16(1), respectively.

[7] Article 22(3) REDII.

[8] Article 59(12)(z) IMED revised through Directive (EU) 2024/1711, Article 2(12)(a)(ii).

Many Member States still have yet to put in place enabling frameworks to promote the growth of RECs and CECs at the national level. As these policy frameworks continue to be developed, it will be important to ensure that they are justified based on the delivery of the political ambition that was expressed in the creation of energy communities, namely an inclusive energy transition where citizens and local communities are empowered and benefit.

The literature on energy communities acknowledges challenges as the concept evolves around Europe. Although territorial development is often one of the direct effects of energy communities, academic literature has pointed to their need to evolve and incorporate additional activities for the strengthening of such role.[9] While social benefits engendered in energy communities' activities should remain the principal objective of established RECs and CECs, as they evolve they may no longer be seen as solely providing an energy generation/consumption service as their only social purpose. Several examples from across the EU demonstrate the engagement of energy communities in different market services, such as flexibility and grid stability. Additionally, different European regions face different challenges when accessing funds and despite governmental support being a key in supporting the upfront capital investments, the situation still is unbalanced.

1.2 Research questions

Building on the above, the following key research gaps (and thus objectives of the study) were identified:

- The need for evidence on the extent and forms to which energy communities promote social inclusiveness and what conditions driver/hinder such efforts.
- Understanding and characterising the enabling factors for the emergence of energy communities within the EU, alongside other contextual factors integral to their establishment.
- Discussion and potential trade-offs on how energy communities balance the commercial aspect of markets with their inherent non-profit and social character.
- Recommendations on how and to what extent energy communities can contribute towards territorial development and, vice-versa, how (integrated) territorial approaches can support the development of energy communities.

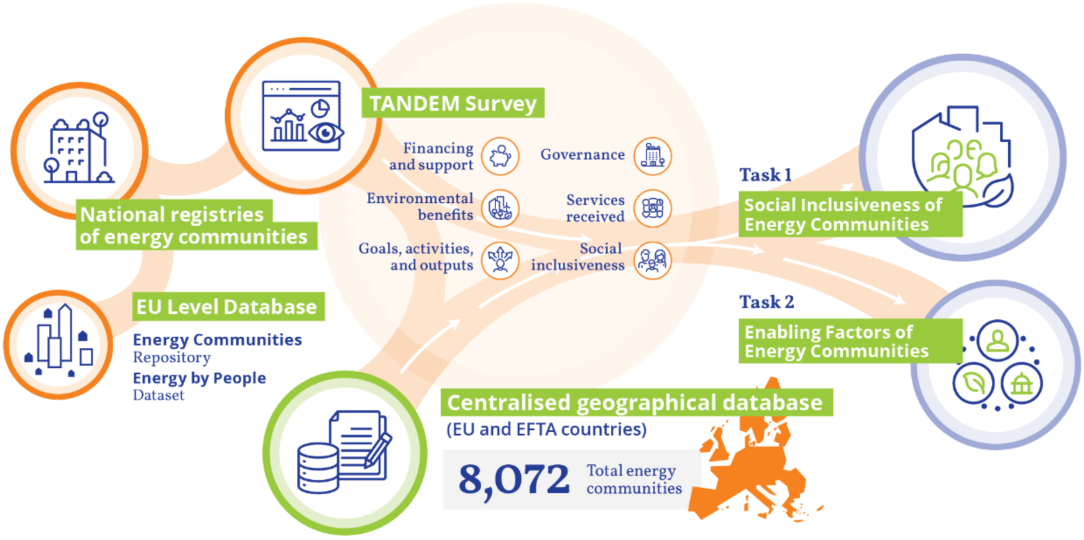
Table 1.1 presents an overview of the research questions that guided the research to address the gaps presented above. It also includes the tasks in which the questions were addressed.

[9] Biresselioglu et al., 2021; Mendicino et al., 2021

Table 1.1
Research objectives and policy questions

Energy communities with and without market ser-vices	1. What is the distribution of energy communities in EU territories and their spatial characteristics? 2. What is the size of energy communities in the EU/EFTA territories? 3. Are energy communities socially inclusive? What are the drivers and barriers of their social inclusiveness (i.e., public investments, policies, opportunities, legislation)? 4. What are the enabling factors that facilitate the emergence of the energy communities? 5. How can non-profit/social benefit seeking aspects of energy communities co-exist with market services? 6. Do cross-border regions have a specific role in the development of energy communities?
EU/EFTA territories without energy communities	7. Do EU/EFTA territories have the potential for the emergence of energy communities? If yes, what is the role of policies and structural conditions for such uptake? 8. How can CECs/RECs and market services synergize for an efficient and inclusive uptake of energy communities?
Territorial development	9. How do integrated approaches in territorial development support the uptake of energy communities? 10. Considering the local ownership aspect of energy communities, does territorial development play an important role in the energy communities' uptake?

Figure 1.1
Evidence-basted analysis



To answer detailed questions on the social inclusiveness and other characteristics of energy communities, and to perform meaningful analysis, we needed robust data. Therefore, we launched an EU-wide survey (including EFTA countries: Iceland, Liechtenstein, Norway and Switzerland) to gather insights. To understand regional and enabling characteristics, we also required a clear overview of the number of energy communities at the NUTS 2 level. This led us to develop a comprehensive EU-wide energy community database. Both the survey and the database are described in more detail below.

1.2.1 Survey of Energy Communities

We conducted a comprehensive survey targeting energy communities across the EU to complement our analysis with large-scale data. This was essential for performing inferential statistical analyses and reliably aggregating data at the regional level as well as providing key insights into the social inclusiveness of energy communities (see chapter 2). The survey, directed at energy community representatives, explored the contexts in which these communities emerge and operate. Approximately 8% of Europe's energy communities responded. The findings informed the statistical analyses in Chapter 2 on the social inclusiveness of energy communities and contributed to the policy recommendations (Chapter 5) ultimately supporting the broader adoption and effectiveness of energy communities within sustainable and decentralised energy markets. Chapter 2 provides more information on the survey.

1.2.2 Energy Communities Database

We developed a centralised geographical database covering energy communities across the EU and EFTA countries to identify and explain development patterns. This database was compiled by merging data from multiple sources:

- national registries of energy communities,
- EU level databases (including Energy By People dataset and Energy Communities Repository, and
- the TANDEM survey.

The database was finalised in September 2024 and underwent a quality review in collaboration with the partners of Citizen Energy Advisory Hub (CEAH)10. It includes a total of 8,072 energy communities (see Chapter 3).

[10] About the Citizen Energy Advisory Hub - European Commission

To compile the database, TANDEM relied on a number of mapping initiatives that, depending on the country, included National Agencies, the Energy Regulator or another public body, System Operators, and non-governmental organisations. When conducting the quality check on the data from these national databases, we found that national monitoring systems for energy communities are still emerging and use divergent methodologies for collecting data on energy communities. Furthermore, most national monitoring systems for energy communities do not have quality assurance or concrete criteria to track data on the number of energy communities

A number of factors impact the ability to collect comparable data and information from energy communities across so many countries. This includes:

- the lack of a sufficiently concrete legal definition of REC or CEC adopted in all Member States;
- the lack of a dedicated responsibility at the national level to an appropriate oversight body (e.g. regulator, agency, etc); and
- insufficient resources to develop a robust and regularised quality checks whether data provided by energy communities complies with the EU definitions.

Chapter 3 provides more details on the composition of the database.

2

Social Inclusiveness of Energy Communities

2 Social Inclusiveness of Energy Communities

2.1 Methodology

2.1.1 Model and empirical strategy

The central question in this chapter is: **how socially inclusive are European energy communities and what are the drivers and barriers of their social inclusiveness?** In the literature, social inclusiveness can mean different things. It can pertain to pursuing gender, age, as well and other characteristics of diversity such as bridging income-related gaps, for instance for those that experience vulnerability or energy poverty. For the purposes of TANDEM, we focus on the latter – through the idea that RECs and CECs pursue social inclusiveness so low-income and vulnerable households do not get left behind. Hence, we define social inclusiveness as the share of disadvantaged households in the energy community compared to the wider region.

To answer the research question, a dedicated survey of energy communities across Europe was conducted in 2024 through an online questionnaire. The survey data offer a novel, self-reported snapshot of how energy communities perceive their social impact and inclusiveness.

2.1.2 Measuring social inclusiveness

In the questionnaire, multiple questions were asked about the inclusion of disadvantaged groups in the energy community, because it was expected that not all energy communities would be able to provide specific data. For example, only 85 responding energy communities were able to provide data on the number of households below a certain income level. However, many more respondents (296) were able to answer the question "What is the social status of households in your energy community, compared to the wider region (Lower, equal or higher)?"

This self-reported measure serves as a proxy for the degree of inclusiveness: we treat a community that answered "lower social status" as one that has succeeded in attracting a higher proportion of vulnerable or lower-income households. We thus assume that the answer option "lower social status" reflects a higher degree of social inclusiveness. This metric captures one aspect of inclusiveness (the socio-economic profile of households) and does not reflect other aspects such as services to disadvantaged groups that are not members of the energy community.

2.1.3 Hypotheses

To support the answering of the central question in this chapter, five hypotheses have been formulated (see Figure 2.1). The hypotheses are grounded in the current scientific debate on energy communities and their inclusiveness.

Figure 2.1
Five Hypotheses to support the central question

2.1.4 Model specification

We estimated a logistic regression model where the dependent variable equals 1 if the community's households have – on average – lower socio-economic status than the regional average (i.e. the community is relatively inclusive of lower-status households), and 0 if status is equal or higher. In mathematical terms, the model equation is as follows:

$$\text{logit}\,(P) = log\left(\frac{P}{1-P}\right) = \beta_0 + \beta_1 X_1 + [\beta_n X_n] + \varepsilon$$

where P equals the odds of an energy community having members with – on average – lower socio-economic status than the regional average.

The model coefficients (β) indicate which characteristics of the energy community and its environment increase or decrease the odds that the community's households have lower socio-economic status than the regional average.

2.1.5 Data

The survey gathered information on community characteristics (legal form, size, years of operation), goals and activities, benefits provided, and policies or measures related to vulnerable groups. In total, 641 energy communities responded to the survey, of which 250 completed the questionnaire. In addition, different respondents were unable to answer different questions. Due to the model specification, which does not permit missing entries, this reduces the number of usable observations to a maximum of 230.

We checked each case against the EU definition of an energy community, focusing on effective control and primary purposes of the community. First, effective control by entities such as large companies, NGOs, public bodies (excluding local governments), and utility companies was assessed. If respondents indicated "daily management," "has veto rights," or "has majority share" for any of these entities, they were considered to be under effective control and therefore excluded. Second, the primary purpose of the energy community was selected environmental, social, or economic goals as their primary purpose were included; those who selected only "other" were excluded from the analysis.

Table 2.1
Energy community alignment with EU definition

	Effective control – No	Effective control – Yes
Primary purpose - No	7	1
Primary purpose - Yes	20	202

After filtering out the non-complying cases, the remaining sample size equals 202 energy communities. This sample covers a diverse range of energy communities, from small grassroots projects to large established cooperatives, and includes communities from various EU regions. However, most responses come from Western Europe, and Eastern Europe being relatively underrepresented. A detailed breakdown per country is available in Annex 1. The table below presents the characteristics of the variables for the 193 responses where data is available for all these characteristics.

Table 2.2
Descriptive statistics

Variable	Unit	N	Mean	SD	CV	Min	Max	Source
Lower social Status household within the community compared to the wider region	Dummy 0/1	193	0.145	0.353	2.434	0	1	TANDEM Survey
Years since founding	Number of Years	193	7.487	15.035	2.008	1	125	TANDEM Survey
Community is a cooperative	Dummy 0/1	193	0.544	0.499	0.918	0	1	TANDEM Survey
Generates energy	Dummy 0/1	193	0.606	0.49	0.808	0	1	TANDEM Survey
Active within a city	Dummy 0/1	193	0.389	0.489	1.258	0	1	TANDEM Survey
Community has social goals	Dummy 0/1	193	0.751	0.433	0.577	0	1	TANDEM Survey
Financial support received	Dummy 0/1	193	0.694	0.462	0.665	0	1	TANDEM Survey
Community engages in outreach	Dummy 0/1	193	0.756	0.43	0.569	0	1	TANDEM Survey
Offers financial & technical support	Dummy 0/1	193	0.705	0.457	0.649	0	1	TANDEM Survey
Paid dividends in 2023	Dummy 0/1	193	0.181	0.386	2.13	0	1	TANDEM Survey
Offers lowered energy costs	Dummy 0/1	193	0.104	0.306	2.949	0	1	TANDEM Survey
Energy community size > 500	Dummy 0/1	193	0.363	0.482	1.329	0	1	TANDEM Survey
Non-financial support received	Dummy 0/1	193	0.187	0.391	2.094	0	1	TANDEM Survey
Local or regional energy-poverty policy in place	Dummy 0/1	193	0.311	0.464	1.493	0	1	TANDEM Survey
Regional GDP per capita by NUTS2	Euro	193	36206.552	14102.531	.39	11939.8	80380	Eurostat
Poverty rate at NUTS2 level	%	193	18.459	6.989	.379	5.9	43.1	Eurostat
EU of low-carbon projects per 100,000 citizens by NUTS2	Number of projects	193	2.572	6.427	2.499	0	47.142	Kohesio
EU social-inclusion projects per 100,000 citizens by NUTS2	Number of projects	193	1.175	2.073	1.764	0	11.617	Kohesio

Variable	Unit	N	Mean	SD	CV	Min	Max	Source
Average ESF, ERDF and CF expenditure per capital by NUTS2d	Euro	193	79.829	120.464	1.509	0	500.285	Kohesio
Country in Western Europe	Dummy 0/1	193	2.988	2.092	0.7	0	6.217	UN classification
IEA national energy-poverty policy index	Number of policies	193	5.534	2.907	.525	1	11	IEA Energy poverty policy

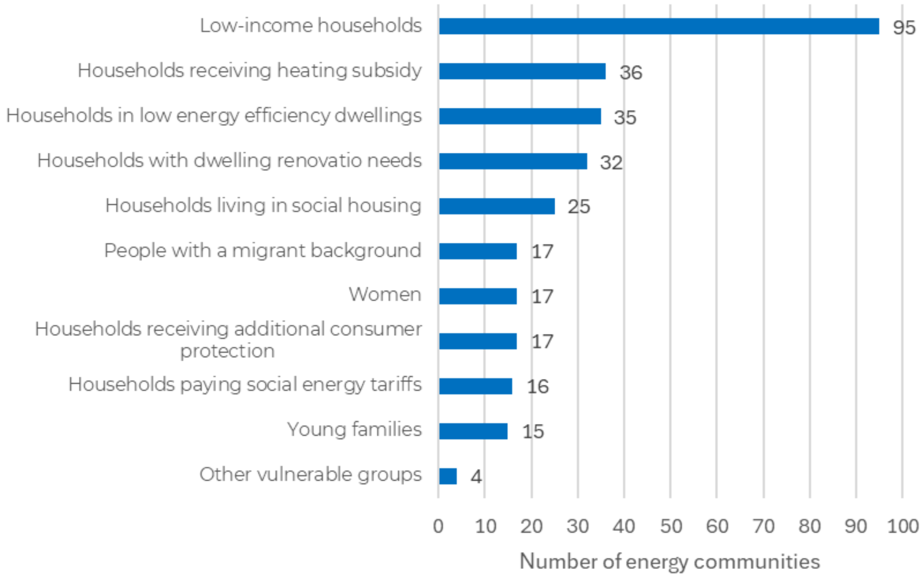
2.2 Results

2.2.1 Social inclusiveness policies and outcomes

Although 74% of energy communities have social goals, these do not always include specific policies for vulnerable groups. The survey asked: "Does your energy community have a policy for vulnerable groups?". For example, a community might have a written policy or specific program to include low-income households, people in social housing, older people or similar vulnerable groups. The responses indicate that 41% of energy communities reported "Yes" (i.e. they do have such a policy), while 59% said "No", they do not.

Who are the vulnerable groups that energy communities focus on? Energy communities with a policy have been asked to specify which groups they target (from a list of categories with multiple possible answers). Figure 2.2 below summarises the responses.

Figure 2.2
Types of vulnerable groups targeted by energy communities (N=123)



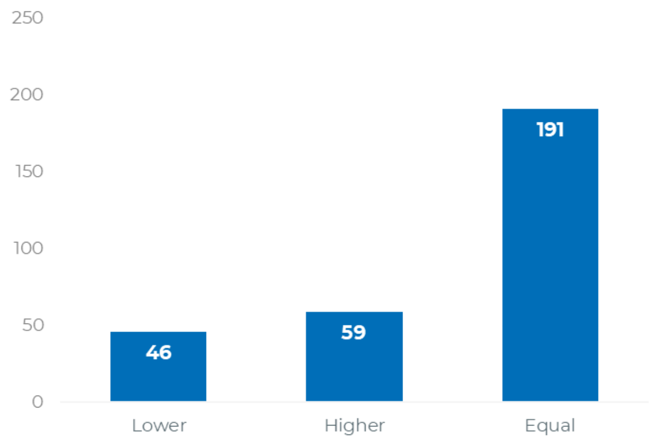
Low-income households are targeted most often, about 77% of communities with a vulnerable-group policy indicate low-income households as a priority. This aligns with the notion that tackling energy poverty (which is largely income-driven) is a key aim for many energy communities. Around 20–29% also indicated targeting households receiving special social tariffs or heating subsidies, which in turn is generally linked to household income. Other frequently cited target groups are those living in poorer housing condition: for instance, approximately 29% target households living in inefficient dwellings (unfavourable energy labels) and 26–28% target households that need renovations or those living in social housing. These categories often overlap with low-income status, but they highlight a focus for households suffering from inadequate housing.

A smaller subset of communities extend their inclusiveness policies to demographic groups: about 14% (also) explicitly target women (e.g. addressing gender inclusiveness in energy) and again about 14% target young families. About 12% mentioned people with a migrant background as a target group. Additionally, 14% answered "other group". These included, for example, older people. Nevertheless, the focus of socially inclusive targeting overwhelmingly tends to be on economic vulnerability. This could be because economic hardship is more directly linked to energy poverty, or because initiatives for gender or migrant inclusion in energy require different approaches that fewer communities have explored. It is also worth noting that a handful of communities (a few percent) with a policy for vulnerable groups indicated "None of the above", meaning their policy does not target a specific subgroup but may take a general approach.

2.2.2 Social inclusiveness as outcome

As Figure 2.3 illustrates, the majority of energy communities do not significantly differ from their surrounding population in socio-economic terms. About two-thirds (65%) of communities reported that their members' social status is, on average, about equal to the regional average. Meanwhile, about 16% of communities indicated that their member households have a lower social status than the wider region. These are the communities we consider as particularly socially inclusive, as they have managed to engage relatively more households from disadvantaged backgrounds. However, this is a relatively small segment, only about 1 out of 6 communities falls into this category.

Figure 2.3
Social status of households in energy communities, compared to wider region (N=296)



Note: based on assessment by energy communities. Source: ESPON TANDEM survey (2024)

Around 20% of communities reported their members are of higher status than the regional average. This indicates that in about one fifth of cases, energy communities might actually be somewhat exclusive, attracting mostly middle-class or affluent members (for example, those who can afford the time and money to invest in solar panels or join innovative projects). This is likely not an intended outcome for most (given that 74% of the energy communities have social goals), but it can happen perhaps due to self-selection - those with more resources are more likely to join or start an energy community.

Importantly, the survey data suggest that this pattern of social inclusiveness is fairly similar across different countries and locales. While one might expect differences between, energy communities in wealthier countries vs. those in less wealthy countries, or between urban vs. rural communities, the share of communities in each category (lower/equal/higher status) did not vary dramatically by geography. Crosstab analyses (available upon request) were conducted, for instance comparing communities active in cities, towns, or rural areas. The results indicated no strong systematic difference. For example, urban energy communities were not significantly more or less likely to be socially inclusive than rural ones.

Another perspective on the degree of inclusiveness comes from looking at the percentages of vulnerable households within those communities that do target them. For example, communities that targeted low-income households were asked what percentage of their members are low-income. The data (though many did not respond) show that even among communities with a policy for vulnerable groups, the share of such households in the membership tends to be modest. For instance, the energy communities with a policy for low-income households, reported on average that 22% of their members are low-income households. Similarly low shares were reported for other categories of vulnerable groups, such as households living in dwellings with low energy efficiency labels. There are no (vulnerable) target groups that have a majority share in European energy communities. A energy community with social goals will include some vulnerable households (around 10–30% of its members) but still have a mix that includes many non-vulnerable households as well.

In conclusion, the degree of social inclusiveness across energy communities is generally moderate and fairly consistent: most communities reflect the average socio-economic status of their area, a minority has a notably higher inclusion of vulnerable groups, and about an equally sized minority is skewed toward higher-status members.

2.2.3 Model of social inclusiveness

To assess the relationship between the social inclusiveness of energy communities and other characteristics of energy communities, a regression model was developed. Correlations among the explanatory variables were examined to test for multicollinearity. The results can be found in Annex I. No two variables are very strongly correlated. The highest correlation is about 0.65. Most correlations are weak: generally between -0.3 and 0.3. This indicates low multicollinearity, meaning each factor captures a distinct aspect and can be included in the model without redundancy.

2.2.3.1 Logistic regression model

A logistic regression as specified in section 2.1.1 was performed to identify which characteristics of energy communities are associated with social inclusiveness. Table 2.2 provides the model results. It depicts various specifications that were tried out, as explained in the first row. The final model is the one with the highest pseudo R^2. The model's explanatory power is modest (pseudo $R^2 = 0.25$) and is statistically significant overall at the 1% level (Chi-square $p \approx 0.0018$). The model identifies several significant predictors of inclusiveness.

Three variables emerge as significant ($p<0.05$): receiving financial support, receiving non-pecuniary support and the number of EU Kohesio projects aimed at Low Carbon Economy. In addition, higher regional income level (GDP per capita) was associated with marginally significantly lower inclusiveness ($p<0.1$). We interpret each of these findings below.

Table 2.3
Results logistic regression model

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Years since founding	0.018	0.019	0.02	0.02	0.021	0.021	0.021	0.02
	-0.019	-0.019	-0.019	-0.019	-0.023	-0.023	-0.023	-0.022
Community is a cooperative	-0.044	0.016	-0.011	0.005	0.12	0.117	0.127	0.202
	-0.516	-0.525	-0.527	-0.53	-0.567	-0.57	-0.58	-0.593
Generates energy	0.261	0.321	0.42	0.405	-0.052	-0.057	-0.056	0.052
	-0.493	-0.516	-0.528	-0.528	-0.55	-0.543	-0.542	-0.567
Active within a city	0.014	-0.205	-0.266	-0.268	-0.311	-0.301	-0.298	-0.326
	-0.518	-0.535	-0.524	-0.525	-0.628	-0.629	-0.626	-0.623
Community has social goals	-0.024	-0.095	-0.179	-0.156	0.04	0.016	0.04	0.051
	-0.677	-0.679	-0.679	-0.676	-0.694	-0.7	-0.686	-0.692
Financial support received	2.591***	2.676***	2.762***	2.781***	2.899***	2.869***	2.875***	2.834***
	-0.726	-0.726	-0.735	-0.744	-0.945	-0.934	-0.935	-0.876
Community engages in outreach	0.207	0.351	0.084	0.145	0.369	0.387	0.383	0.332
	-0.59	-0.569	-0.607	-0.603	-0.615	-0.617	-0.616	-0.625
Offers financial & technical support	-0.075	-0.228	-0.055	-0.114	-0.044	-0.058	-0.061	-0.115
	-0.592	-0.551	-0.608	-0.57	-0.56	-0.56	-0.557	-0.545
Paid dividends in 2023	-0.357	-0.307	-0.319	-0.293	-0.478	-0.465	-0.459	-0.463
	-0.782	-0.811	-0.818	-0.834	-0.828	-0.833	-0.837	-0.83
Reduced energy prices for vulnerable groups	0.708	0.553	0.466	0.486	0.578	0.532	0.517	0.579
	-0.554	-0.571	-0.593	-0.585	-0.602	-0.63	-0.632	-0.638
Has a policy for vulnerable groups	0.629	0.486	0.276	0.262	0.176	0.168	0.169	0.152
	-0.503	-0.527	-0.545	-0.549	-0.522	-0.519	-0.517	-0.513
Energy community size > 500	-1.643	-1.591	-1.453	-1.47	-1.921	-1.968	-1.992	-2.135
	-1.146	-1.198	-1.118	-1.161	-1.18	-1.237	-1.261	-1.309
Non-financial support received	-.885*	-1.118**	-1.031**	-1.071**	-1.239**	-1.223**	-1.231**	-1.353**
	-0.477	-0.49	-0.492	-0.501	-0.555	-0.551	-0.549	-0.643
Local/regional energy-poverty policy	0.466	0.555	0.341	0.385	0.445	0.461	0.456	0.411
	-0.5	-0.544	-0.525	-0.556	-0.59	-0.606	-0.601	-0.616
Log GDP at NUTS2		-0.897		-0.388	-1.51*	-1.524*	-1.559*	-1.8*
		-0.657		-0.765	-0.859	-0.868	-0.878	-0.981
Log poverty rate at NUTS2			1.473**	1.231	0.996	0.967	0.905	0.751

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
			-0.726	-0.871	-0.92	-0.937	-0.97	-1.017
Log EU low-carbon projects per capita					-.395**	-.417**	-.411**	-.479**
					-0.156	-0.19	-0.194	-0.234
Log EU social inclusion projects per capita					0.187	0.183	0.193	0.2
					-0.188	-0.186	-0.196	-0.202
Log of Cohesion expenditure per capita at NUTS2						0.042	0.038	-0.061
						-0.148	-0.153	-0.206
Country in Western Europe							0.212	0.18
							-1.021	-1.039
Log of number national energy-poverty policies IEA								0.564
								-0.797
_cons	-4.493***	4.885	-8.499***	-3.811	8.196	8.329	8.703	11.133
	-1.091	-6.477	-2.562	-9.38	-10.261	-10.306	-10.409	-11.42
Observations	204	198	193	193	193	193	193	193
Pseudo R^2	0.18	0.189	0.201	0.203	0.245	0.246	0.246	0.25

2.2.3.2 Non-financial support

Surprisingly, receiving non-financial support (such as free technical advice, training, or other in-kind assistance) was associated with lower inclusiveness. Energy communities that obtained such support were four times less likely to have many low-income members than other energy communities. A possible reason is that well-connected, resource-rich communities are more able to secure technical help, while communities composed of very disadvantaged people may lack access to those support networks. In this way, non-pecuniary support may be a marker of a more privileged community rather than a direct driver of inclusion. Not all support has the same effect: financial aid clearly helps inclusion, whereas technical assistance alone does not guarantee engagement of vulnerable households.

2.2.3.3 Kohesio projects on low-carbon economy

The results indicate that a higher number of Kohesio projects focused on the low-carbon economy is associated with lower levels of social inclusiveness. This may seem counterintuitive, but Kohesio-funded initiatives often target less-developed regions, rural areas, and islands, where improving energy access and promoting social inclusion are particularly pressing challenges. Initially levels of social inclusion are lower in the regions where Kohesio projects are targeted. It would, however, require a panel (time series) analysis to determine whether social inclusiveness increases after the implementation of low-carbon economy projects.

2.2.3.4 Control variables

The regional economic context proved to be important. Communities in wealthier regions were significantly less inclusive: higher regional GDP per capita was linked to lower odds of having predominantly low-income members. In affluent areas, community membership likely skews toward people with greater financial means (since joining often requires some investment), and there may be less urgency to include vulnerable households. Conversely, in regions with lower average incomes, energy communities may form with the aim of addressing energy poverty, naturally involving more low-income households. Notably, the poverty rate at NUTS2 level is only significant when regional GDP per capita is excluded from the model. This suggests that socio-economic conditions within regions matter with GDP per capita as a possible proxy.

2.2.3.5 Robustness of findings

We tested the robustness of these results with alternative models, which can be found in Annex I. Re-running the regression on only communities serving households (excluding those mainly serving businesses), and on only communities in EU Member States, produced similar findings: the same key factors remained significant, (likely due to smaller sample sizes).

Using an alternative regional classification, dividing Europe into Northern, Eastern, Southern, and Western regions, reveals that countries in Northern Europe tend to have higher levels of social inclusiveness within energy communities. Northern European countries often have a stronger legacy of cooperative ownership models, social trust, and policy frameworks that actively support community participation and inclusion.

Additionally, in the model specification using the alternative regional distribution, very large energy communities (cooperatives with over 500 members) had a significantly lower likelihood of being inclusive. The odds of having predominantly lower-income membership were roughly 95% lower for such large communities compared to smaller ones. One explanation is that smaller, grassroots communities – often closely tied to a local area – are better able to engage vulnerable populations, whereas very large groups might have higher barriers to entry or attract a more affluent membership base.

We also explored potential interaction effects and the influence of specific funding types. For instance, we considered whether receiving financial support had different impacts in Western versus Eastern Europe, but there were too few unfunded Eastern communities to draw conclusions. Replacing the overall "financial support" variable with indicators for specific EU funding streams did not yield any new significant effects.

Overall, these tests confirm that the main findings are robust and underscore the importance of targeted regional support in fostering inclusiveness.

2.3 Discussion

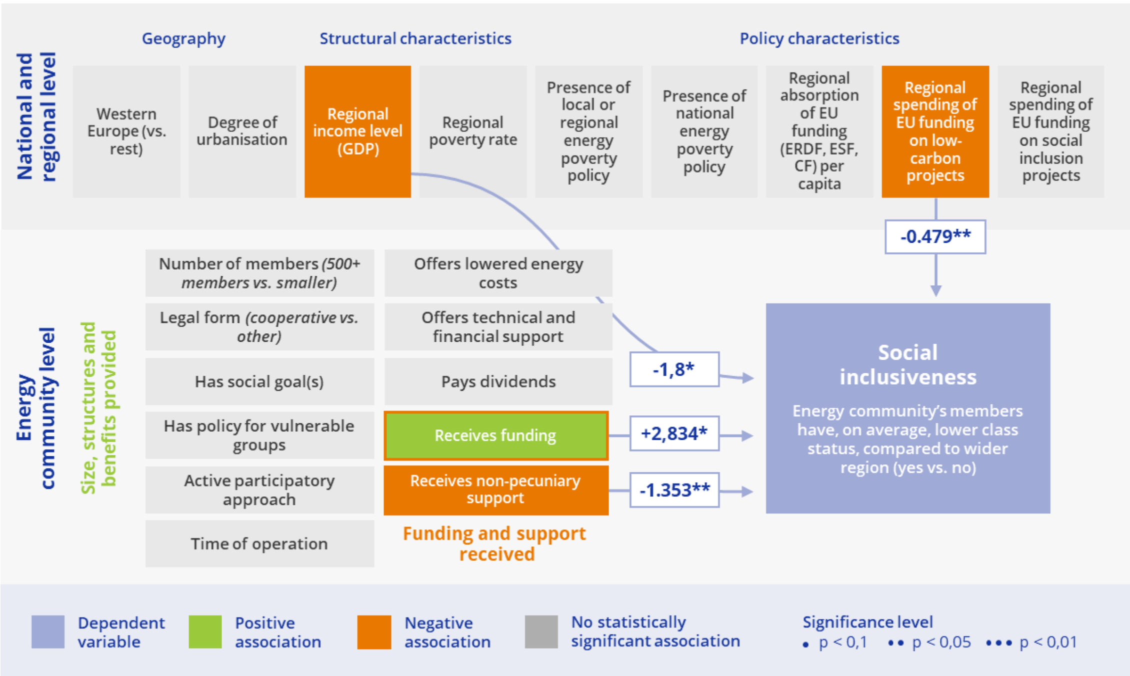
This chapter provides insight into the characteristics of European energy communities. In particular, our research sheds light on the degree of social inclusiveness of energy communities across Europe as well as driving forces behind this. The results align with previous research, which also shows by means of case studies that the majority of energy communities are not necessarily inclusive (see e.g. Hanke & Guyet, 2023; Bielig et al., 2022). We confirm this, through a quantitative, cross-sectional analysis of European energy communities.

The findings show that receiving financial support and regional income level as are drivers of social inclusiveness within energy communities. There is a clear financial orientation in these drivers – which confirms the notion that the business case for energy communities is often challenging, especially when energy communities are aiming to counteract energy poverty (see e.g. Peeters et al., 2025). This study confirms that that funding (e.g. subsidies and loans) to energy communities contributes to social inclusiveness. Also the case studies (provided in chapter 4) support this finding.

Non-financial support received by energy communities has a negative statistical relationship with the degree of social inclusiveness. It is, however, not possible to conclude that non-financial support is a barrier for social inclusion. It could be that non-financial support is a potential driver of social inclusiveness, but that the energy communities in our sample simply were not successful in utilising the non- financial forms of support that they received, such as expertise and guidance, to reach disadvantaged target groups.

In conclusion, it is partially confirmed by our findings that funding is a driving force of social inclusiveness of energy communities in Europe. In isolation, cost reductions for members do not increase social inclusiveness, nor do participatory approaches and pecuniary value for members and investors in the form of dividends. Future research could investigate whether the outcomes still hold true in more specific situations.

Figure 2.4
Visual overview of results



Limitations to considered when interpretating the results include: in the first place, we used a definition of social inclusiveness which is oriented towards socio-economic inclusion. Alternatively, future research could analyse the drivers and barriers of social inclusion from the perspective of, for example, demography or democracy.

Another limitation is the geographical balance within our survey sample. The (absolute) response rate in e.g. Eastern Europe turned out to be relatively low. This can be mostly explained by the smaller presence of energy communities in Eastern Europe (see also Chapter 3 for more information). Yet, a higher number of observations outside of Western Europe could provide a richer insight into geographical differences as an influence on energy communities and their social inclusiveness. By taking this opportunity up, future research could also arrive at a typology of European energy communities.

Future research could also be directed at deepening the knowledge regarding a couple of other topics. For example, the mechanism behind the negative impact of non-pecuniary support on social inclusiveness asks for further investigation – and likewise regarding the negative relationship with regional spending of EU-funds related to low-carbon economy. Longitudinal (time series panel) analysis can answer such questions of causality. A longitudinal database allows for a causal type of research where quasi counterfactuals can be created, which could not be achieved within this research. To this end, the TANDEM survey, could be repeated every one or two years. This will be useful as energy communities also evolve. Moreover, the current scope of the survey could be expanded to look into the activities of energy communities, e.g., whether they apply for projects which are tendered, or for any grants.

3

Enabling Factors of Energy Communities

3 Enabling Factors of Energy Communities

The primary objective of this chapter is to **quantitatively analyse the determinants contributing to the emergence of energy communities,** with a particular emphasis on access to public/private financing sources, availability/access to (renewable) energy and ICT infrastructure, and on the role of policy and institutional context as an enabler of these community-led initiatives. In addition, the task includes the analysis of the impact of socioeconomic and territorial contexts on the development of energy communities, such as for example the average household income, education and level of innovation. Our hypotheses are depicted in Figure 3.1.

Figure 3.1
Our Hypotheses

3.1 Methodology

We employed a **cross-sectional approach** due to the unavailability of time-series data on the number of energy communities, which precluded the use of longitudinal methods. To test the hypotheses introduced above, we estimated relationships between the dependent variable (the number of energy communities) and a set of key predictors, using **multiple linear regression analyses via Ordinary Least Squares (OLS),** while controlling for socioeconomic and territorial characteristics.

To account for the varying sizes of regions, we expressed the dependent variable as "Number of energy communities per 100,000 persons at the NUTS 2 regional level". Given the highly skewed distribution of energy communities to the right, we estimated log-log models. To allow for the computation of the logarithm in regions with no recorded energy communities, we added a small constant (0.01) to all observations. This transformation significantly improved the distribution of our dependent variable, rendering it more akin to a normal distribution.

3.1.1 Model and empirical strategy

As a starting point, we specified a linear regression model as a baseline for each of the four hypotheses that were introduced in Section 1.4:

$$\log(EC_i) = \beta_0 + \beta_1 \log(Pop\_D_i) + \beta_3 \log(HH\_inc_i) + \beta_3 \log(PAT_i) + \beta_4 \log(EDUC_i) + \beta_4 \log(COOP_i) + \beta_4 \log(SPAT_i)\, \varepsilon_i$$

Where:

- i indexes NUTS 2 regions
- Pop_D is population density

- HH_inc is households' income per capita
- PAT is patent applications per billion GDP
- $EDUC$ is the percentage of population with tertiary education
- $COOP$ is the partnership total budget per capita
- $SPAT$ are geographical controls either as heating/cooling degree days variable or categorical variables representing European regions, i.e., western, eastern, northern and southern European regions

To empirically test H1 hypothesis, we specified the following linear regression model:

$$\log(EC_i) = \beta_0 + \beta_1 X_i + \beta_2 \log(ERDF_i) + \beta_3 \log(RD\_exp_i) + \beta_4 \log(RDP\_exp_i) + \varepsilon_i$$

Where:

- i indexes NUTS 2 regions
- X_i represents a vector of control as described in the baseline model.
- ERDF represents access to public funding, i.e., the amount of ERDF funding per capita received by NUTS 2 regions.
- RD_exp represents total R&D expenditures as share of GDP,
- RDP_exp represent R&D spending by the private-sector

This model allows us to evaluate whether access to public (ERDF funds and/or RD expenditure) and private (R&D investments) financial resources is significantly associated with the presence of energy communities while controlling for economic, climatic, and innovation-related factors.

To test hypothesis **H2a**, we estimated the following regression model:

$$\log(EC_i) = \beta_0 + \beta_1 X_i + \beta_2 \log(Nr.Ener\ Facilities_i) + \beta_3 \log(Installed\ capacity_i) + \varepsilon_i$$

In this case, to assess the impact of energy infrastructure, we included variables representing the number of energy facilities and installed capacity. In addition, we further tested models with a disaggregation of the number of energy facilities and installed capacity by use of renewable sources and of non-renewable sources, respectively. These variables help evaluate whether access/availability to grid infrastructure facilities fosters the creation of energy communities.

The role of ICT infrastructure in enabling energy communities was analysed by considering ICT usage at both the household and individual levels. Specifically, we tested **H2b** by the following model:

$$\log(EC_i) = \beta_0 + \beta_1 X_i + \beta_2 \log(\text{ICT usage}_i) + \varepsilon_i$$

Where:

- i indexes NUTS 2 regions
- X_i represents a vector of control as described in the baseline model
- ICT usage was operationalised through the following indicators:
  - Percentage of households with broadband access
  - Percentage of individuals who ordered goods or services over the internet for private use
  - Percentage of households that have internet access at home
  - Percentage of individuals regularly using the internet

This approach allows us to assess whether higher ICT adoption levels facilitate the development of energy communities by enabling digital monitoring, coordination, and market participation.

Finally, to test the **H3** hypothesis, we estimated the following regression model:

$$\log(EC_i) = \beta_0 + \beta_1 X_i + \beta_2 Political\ Trust + \beta_3 Social\ Trust + \beta_3 Social\ Trust + \beta_4 Quality\ of\ government + \varepsilon_i$$

Where:

- i indexes NUTS 2 regions
- X_i represents a vector of control as described in the baseline model.
- Political trust, social trust and institutional strength are indexes informing on institutional context retrieved from Muringani et al. (202411) (see annex II for further information on these explicative variables).

3.1.2 Data

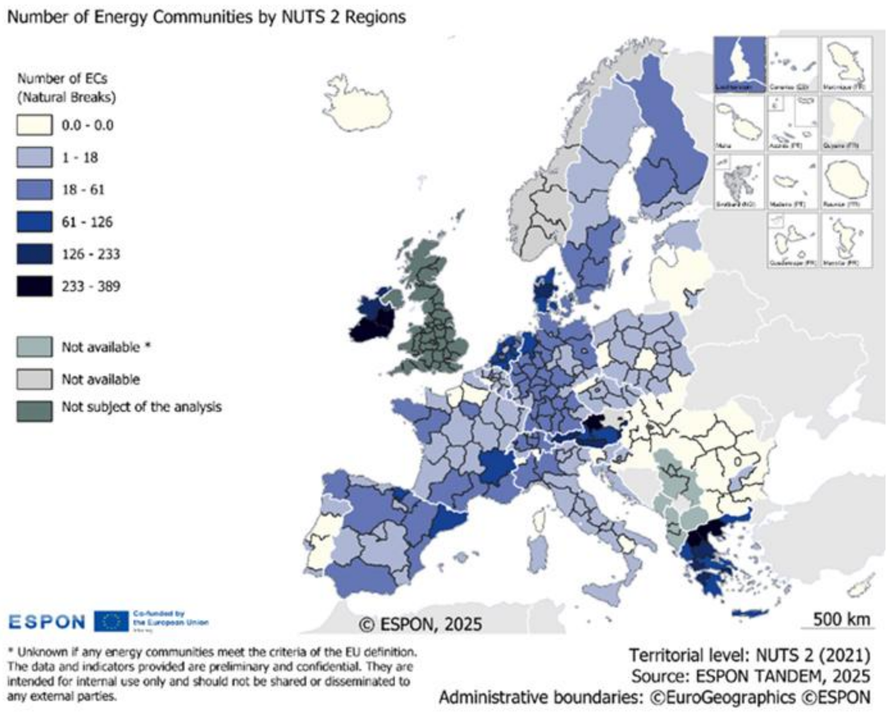
The study encompasses all EU countries plus the EFTA countries (Iceland, Switzerland, Norway, and Liechtenstein). Our dependent variable is the count of energy communities at the NUTS 2 regional level. We retrieved the data on energy communities from three distinct sources of information:

- **National registries of energy communities**: These are deemed as the most reliable sources of information because they are usually administered by national governments or sectoral associations. For our database, registries have been used that provide the situation as of 2024.
- **European datasets**: Two particular datasets are used for this case: the Energy by People dataset and the Energy Communities Repository dataset. These datasets include energy communities that were known to exist as of 2022.
- **TANDEM survey**: This is part of the TANDEM project, as described in Chapter 2. Survey results have been used to identify newly founded energy communities, energy communities which are not included in either the national registries of energy communities or the European datasets (Tier 1 and 2).

Map 3.1shows the geographical distribution of energy communities across European NUTS 2 regions.

[11] Muringani, J., Fitjar, R. D., & Rodríguez-Pose, A. (2024). Political trust and economic development in European regions. *The Annals of Regional Science*, *73*(4), 2059-2089.

Map 3.1
Number of Energy Communities by NUTS 2 Regions (2024)



We identified **211 regions with at least one energy community**. Conversely, we assigned "zero energy communities" to two categories of regions:

- Regions where the presence of energy communities was not confirmed (4 regions), which include Iceland, Cyprus, Liechtenstein and Malta.
- Regions within countries with confirmed national energy community presence but where no energy communities were identified in some regions through either the survey or national databases (36 regions). For example, despite Italy and Portugal having evidence of energy communities in some regions, no energy communities could be defined in other regions such as Valle d'Aosta (Italy) and Alentejo (Portugal), leading us to assume they have zero energy communities for those regions.

Table 3.1 provides descriptive statistics along with data sources for the variables included in this study. The reader can refer to the annex II for full description of variables.

Table 3.1
Descriptive statistics

Variable	Unit	N	Mean	SD	CV	Min	Max	Source	Database Code
Number of energy communities	Nr.	251	41,46	74,19	1,79	0,00	389,00	ESPON	-
Population density	pp/km2	251	343,56	832,73	2,42	3,19	7617,80	ARDECO	SNPTD
ERDF payment per capita	EUR PPS/pp	250	325,19	499,62	1,54	0,00	2828,22	Cohesiondata	-
Percentage of population with tertiary education	Percentage	249	32,89	10,07	0,31	12,68	59,84	ARDECO	edat_lfse_04
PCT patent applications	Index	249	70,97	38,90	0,55	0,00	148,18	RIS	-
R&D expenditure in the business sector	Index	249	79,87	36,95	0,46	0,00	157,40	RIS	-
Number of energy facilities per capita	Nr/pp	247	9,34	14,09	1,51	0,19	121,80	Global Energy Monitor	-
Number of non-renewable energy facilities per capita	Nr/pp	247	0,69	0,81	1,18	0,00	8,17	Global Energy Monitor	-
Number of renewable energy facilities per capita	Nr/pp	247	8,65	13,78	1,59	0,00	119,46	Global Energy Monitor	-
Energy installed total capacity per capita	MW/pp	247	803,96	2579,12	3,21	0,97	37682,72	Global Energy Monitor	-
Non-renewable energy installed total capacity per capita	MW/pp	247	0,69	0,81	1,18	0,00	8,17	Global Energy Monitor	-
Renewable energy installed total capacity per capita	MW/pp	247	8,65	13,78	1,59	0,00	119,46	Global Energy Monitor	-
Partnership total budget per capita	EUR PPS/pp	245	20,95	26,02	1,24	0,00	208,92	KEEP	-
Households net disposable income per capita	EUR PPS/pp	241	16727,481	4034,64	0,24	6240,94	26714,91	ARDECO	RUVNH
Cooling degree days	Index	235	117,60	152,07	1,29	0,01	762,90	EUROSTAT	nrg_chdd
Heating degree days	Index	235	2490,95	893,31	0,36	108,35	6166,39	EUROSTAT	nrg_chdd
R&D expenditure (share of GDP)	Percentage	226	1,72	1,38	0,80	0,09	11,39	EUROSTAT	rd_e_gerdreg
Institutional strength	Index	206	0,08	1,00	11,95	-1,98	1,71	Muringani et al. 2024	-
Social trust	Index	206	-0,08	0,47	-5,80	-2,53	0,84	Muringani et al. 2024	-
Political trust	Index	206	-0,14	0,68	-4,95	-3,82	1,09	Muringani et al. 2024	-
% of households with broadband access	Percentage	173	90,62	5,41	0,06	64,20	100,00	EUROSTAT	isoc_i
% of individuals who ordered goods over the internet	Percentage	172	70,12	14,60	0,21	33,77	95,40	EUROSTAT	isoc_i
% of households that have internet access at home	Percentage	172	93,62	3,65	0,04	82,40	100,00	EUROSTAT	isoc_i
% of individuals regularly using the internet	Percentage	172	91,28	5,61	0,06	74,55	100,00	EUROSTAT	isoc_i

3.2 Results

In this section, we describe first the effects of various factors that do not directly relate to access to finance, energy infrastructure and institutional context (the control variables) on the emergence of energy communities. These effects are estimated in the baseline model. Afterwards we present the results of empirical models to test the hypotheses H1, H2a, H2b and H3, respectively. Please see Annex II for numerical results.

3.2.1 Baseline model 0 – testing control variables

Most of socioeconomic and geographic factors influence the presence of energy communities across different regions. **Higher population density is generally associated with fewer energy communities**. Urban areas may face several challenges in establishing energy communities, including limited physical space for renewable energy installations such as solar panels and wind turbines (van Zalk & Behrens, 2018[12]). Additionally, the sense of community in highly urbanised settings may be weaker, reducing collective motivation to engage in community-driven energy projects (Koirala et al., 2016[13]). Regulatory complexities, such as stringent building codes and zoning laws, can also act as barriers to EC formation in densely populated regions (Wächter et al., 2012[14]). However**,** when controlling for the density of grid infrastructure facilities (see section 3.2.3), social dynamics emerge more clearly. Higher population density may actually facilitate energy communities by increasing opportunities for social interaction, collective action, and the sharing of local energy resources.

Regions with higher household net disposable income per capita exhibit a higher number of energy communities. This suggests that wealthier regions, where households have higher disposable income, are better positioned to support the creation and participation in energy communities. The financial capacity of residents likely facilitates the high upfront investments often required for these initiatives, such as renewable energy installations or grid integration technologies. However, this also raises potential concerns about inclusivity: if a certain income threshold is implicitly required to participate in energy communities, lower-income households may be excluded from these opportunities.

A statistically **significant relationship was found between the percentage of population with tertiary education and energy communities**. This suggests that regions with a more educated population may be better positioned to engage in the planning, management, and technical aspects of energy communities. Higher education levels are often associated with increased awareness of environmental issues, greater social capital, and stronger capacity to navigate regulatory and financial processes—factors that can facilitate the development of community energy initiatives.

In contrast, the total budget of interregional partnerships, representing the degree of regional cooperation, was significant only when controlling for geographic areas (e.g., Western, Northern, or Southern Europe). This indicates that the effectiveness of cooperation mechanisms in supporting energy communities may vary by regional context, potentially reflecting differences in institutional support, policy frameworks, or socio-political cohesion across European regions.

Similarly, patent activity, used as a proxy for regional innovation, was found to be significant only in the model that controls for weather conditions. This suggests that the role of innovation in enabling energy communities may be context-dependent, becoming more apparent when accounting for spatial and climatic differences across regions. HDD and CDD primarily serve as spatial-geographic controls rather than direct drivers of EC formation. Regions with high HDD, typically in Northern and Eastern Europe, often have older and more centralized heating systems reliant on traditional energy sources. This can create structural barriers to EC formation, as legacy infrastructure may not be easily adaptable to decentralized, community-led solutions. Conversely, regions with

[12] Van Zalk, J., & Behrens, P. (2018). The spatial extent of renewable and non-renewable power generation: A review and meta-analysis of power densities and their application in the US. *Energy Policy*, *123*, 83-91.

[13] Koirala, B. P., Koliou, E., Friege, J., Hakvoort, R. A., & Herder, P. M. (2016). Energetic communities for community energy: A review of key issues and trends shaping integrated community energy systems. *Renewable and Sustainable Energy Reviews*, *56*, 722-744.

[14] Wächter P, Ornetzeder M, Rohracher H, Schreuer A, Knoflacher M. Towards a sustainable spatial organization of the energy system: backcasting experiences from Austria. Sustainability 2012;4:193–209.

high CDD (predominantly in Southern Europe) face infrastructure challenges such as limited grid capacity for renewables, which may hinder the growth of energy communities. While these regions have high solar potential, the lack of institutional readiness and policy support may serve as stronger limiting factors than climatic conditions themselves (see section 3.2.5). Regions with milder climates (low HDD and CDD) tend to have lower and more predictable energy demands, which can make decentralized energy solutions more viable, as energy needs can be met with smaller-scale renewable installations without extensive storage requirements.

An alternative approach, using a regional taxonomy, leads to similar findings. Western European regions (i.e., milder climates) are best positioned for EC development, followed by Northern, Southern, and Eastern Europe. Beside climate aspects, Western Europe's advantage may also stem from well-developed policy frameworks, strong financial support mechanisms, and higher levels of social and institutional trust in cooperative energy initiatives. Northern regions, while facing infrastructural constraints related to heating systems, also exhibit strong governance and innovation capacity, enabling EC development. Southern regions, despite their solar potential, may encounter economic and policy barriers. In Eastern Europe, the development of energy communities appears to be more limited, which may reflect specific institutional contexts and/or the lack of policies to support energy communities (Spasova et al. 2021[15]).

3.2.2 Model H1 – Access to finance

On average **ERDF payments per capita are negatively related to the number of energy communities** (models 1.1, 1.2 and 1.3)[16]. This evidence may reflect the fact that ERDF funds are often allocated to less developed regions that may lack the social, technological, or institutional infrastructure to support energy communities effectively. In addition, it may also be the case that ERDF primarily supports large-scale infrastructure and energy projects, rather than small-scale, community-driven energy solutions.

However, further analysis (models 1.4 and 1.5) reveals regional variation. In Western Europe, ERDF payments are positively associated with energy community formation, possibly due to stronger institutional frameworks and better alignment between funding mechanisms and community energy initiatives. In Northern and Southern Europe, the relationship is not significant, suggesting a neutral effect. Conversely, in Eastern Europe, ERDF payments are negatively associated with energy communities (~0.25).

To explore whether these differences reflect underlying institutional capacity, we interacted ERDF payments with an institutional strength indicator. Results (model 1.5) confirm that **ERDF support is more effective in regions with higher institutional quality**. This suggests that well-functioning governance structures can enhance the effectiveness of public funding, facilitating EC formation by ensuring transparency, reducing bureaucratic barriers, and fostering trust in cooperative energy initiatives.

Regarding R&D spending, energy community formation appears to be closely tied to innovation ecosystems driven by the public, academic, and non-profit sectors, rather than by private business sector. The effect of private-sector R&D expenditure proves to be statistically significantly negative. This might be due to the fact that R&D in the private sector is typically profit-driven and may prioritize scalable, proprietary technologies that do not necessarily align with community-led energy models.

3.2.3 Model H2a – Availability / Access to energy infrastructure results

A **strong positive relationship is observed between the number of energy facilities per capita and energy community presence.** When specifying among renewable and non-renewable we found that only renewable-related energy facilities hold the significant and positive relationship. This suggests that the density of renewable energy facilities plays a significant role in enabling energy communities. First, it indicates the presence of a relatively mature renewable energy market, including a concentration of companies offering specialised services and technical expertise. Second, it reflects the decentralised nature of renewable energy systems, which

[15] Spasova, D., & Braungardt, S. (2021). Building a common support framework in differing realities—conditions for renewable energy communities in Germany and Bulgaria. *Energies*, *14*(15), 4693.

[16] Due to the unexpected negative sign of the ERDF funding coefficient, we also performed a Two-Stage Least Squares (2SLS) regression using historical ERDF payments (2013–2017) as an instrument. However, results remained consistent, confirming the negative association.

align well with the small-to-medium scale installations typically associated with energy communities, such as rooftop solar panels, wind farms, and biomass plants. Additionally, regions with a high concentration of renewable installations might reflect a context characterised by a favourable policy and regulatory frameworks, further facilitating energy community development (Gjorgievski et al., 2021).

The lack of significance of non-renewable energy facilities in energy community formation suggests that traditional energy infrastructure, with higher magnitude of installed capacity, does not align well with community-led initiatives.

Similar findings are obtained when focusing on installed capacity of renewable and non-renewable energy (model 2.3a and 2.4a). While **renewable installed capacity is significantly and positively associated with the number of energy communities, non-renewable installed capacity shows a significant negative correlation,** suggesting that regions more dependent on centralized fossil-based energy infrastructure may be less conducive to energy community development.

When considering both, installed capacity and number of installations, the results remain consistent: the number of renewable energy installations and installed renewable capacity are positively associated with the presence of energy communities, while **installed non-renewable capacity appears to act as a bottleneck, negatively correlating with energy community development**.

3.2.4 Model H2b – Availability / Access to ITC infrastructure

Findings from this model should be interpreted with caution because the inclusion of ICT variables significantly reduced the size of our sample. While previous models relied on around 230 observations, this specification is limited to roughly 160. This smaller sample is primarily due to inconsistencies in the availability and granularity of ICT data across countries. For instance, data for countries like Germany and Greece are only available at the NUTS 1 level, while for others, such as Poland, the data follow an older NUTS 2 classification (i.e., 2016) that does not align with the 2021 taxonomy used in this research. As a result, these countries were omitted from this model. This limited sample size may affect the robustness and representativeness of our findings and highlights the need for further research to address this aspect.

Overall, **none of the ICT-related variables show a statistically significant relationship with the presence of energy communities**. This suggests that neither basic access to internet at home nor indicators of digital engagement, such as the percentage of individuals ordering goods or services online, can be considered reliable predictors of EC formation in this model specification. These findings point to the limitations of using general ICT indicators as proxies for the digital readiness needed to support energy community development. While digital tools and platforms are often cited as enablers of decentralized energy models, the presence or use of ICT in a broad sense does not necessarily translate into meaningful engagement with community energy initiatives.

3.2.5 Model H3 – Political and institutional context

On average, **social trust is found to have a positive and statistically significant effect** (Annex II), suggesting that higher levels of interpersonal trust are associated with a greater number of energy communities. **Political trust, in contrast, displays a negative and significant relationship,** indicating that in the average case, higher political trust is linked to fewer energy communities. Finally, institutional strength is not statistically significant when considering the average effect across all regions.

To better understand whether these relationships differ across European territory, we explored three extended models that interact each of these institutional variables with regional dummies for Western, Eastern, Northern, and Southern Europe. These interactions allow us to assess not just whether trust or institutional quality exists, but whether and where these factors actually enable energy communities formation. The interaction models (Models 3.2–3.4) address this by allowing the slope of each variable to vary by regional area, providing more context-sensitive insights.

When interacted with regional dummies, institutional strength becomes statistically significant across all regions but in different directions. It shows a positive and significant effect in Western, Eastern, and Northern Europe, suggesting that higher institutional strength facilitates the emergence of energy communities, likely through better governance, reduced red tape, and more effective support frameworks. The strongest positive effect is found in Western Europe, where institutions are typically more robust (see Annex II) and aligned with community-led energy policy.

In contrast, **Southern Europe exhibits a significant negative relationship between institutional strength and EC formation**. This counterintuitive result might reflect deeper structural or governance challenges in these regions, where higher formal institutional scores may not translate into practical support for bottom-up energy initiatives or may even be associated with bureaucratic inefficiencies that deter community action.

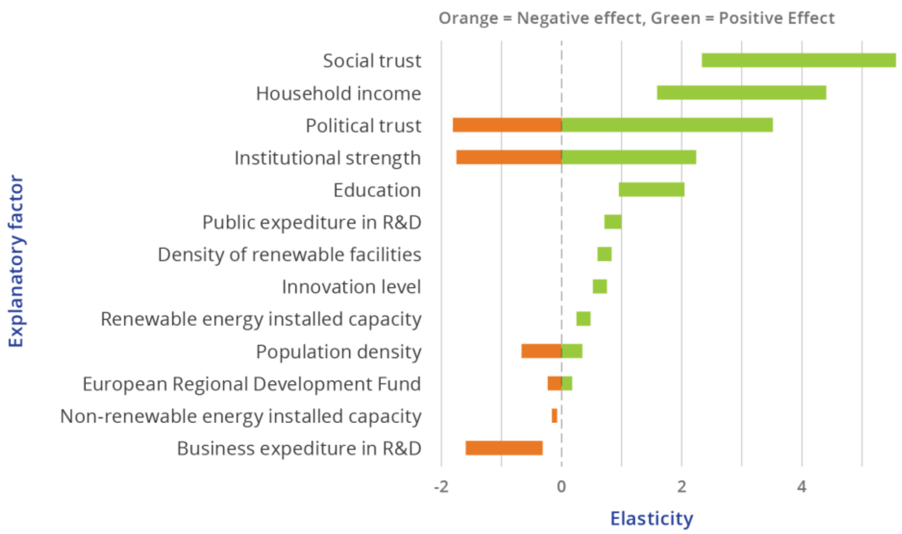
Political trust shows striking regional divergence. In **Western Europe, it is positive and significant**, suggesting that greater trust in political institutions can support community-led initiatives when aligned with policy goals and democratic governance. However, in Southern Europe, the relationship is negative and significant, consistent with the idea that citizens in low-trust environments may mobilize around energy communities as alternatives to centralised systems. **In Eastern and Northern Europe, the coefficient for political trust is not statistically significant**, indicating no clear directional effect. This reinforces the idea that the effect of political trust depends not only on its level, but also on how trust is contextualised. Whether as enabling collaboration with institutions and community led initiatives (Western) or as fostering alternative models that are scarcely aligned with community-led initiatives (Southern).

Social trust remains a robust positive predictor of energy community formation in Western, Eastern, and Northern Europe, with the strongest effect again in Western Europe. This suggests that interpersonal trust (an indicator of social capital and cooperative norms) is a key driver of collective action in energy communities, particularly in contexts where it is reinforced by strong institutions and civic engagement. In Southern Europe, however, the coefficient is not significant, indicating that social trust may play a lesser role, possibly due to cultural, institutional, or economic constraints.

3.3 Discussion

Figure 3.2 summarises the key factors having a statistically significant relationship with the presence of energy communities across European regions. Each factor is represented by the range of estimated coefficients observed across the different model specifications, capturing both its direction and intensity of association. While most of the variables show consistent effects, others (such as political trust or institutional strength) exhibit variation depending on the regional context, highlighting the complex interplay between enabling conditions and territorial specificities.

Figure 3.2
Drivers of energy communities



Socioeconomic factors (particularly household income, education, and social trust) emerge as key enablers of energy community development across European regions. Among all variables, **social trust displays the highest observed positive effect**, remaining a robust and consistent predictor of energy community formation across Western, Eastern, and Northern Europe; with the strongest effects seen in Western regions. As an indicator of social capital and cooperative norms, social trust plays a fundamental role in enabling collective action, which lies at the core of EC success.

The **second most influential factor** overall is **household income**: wealthier regions, where households enjoy higher disposable income, tend to show a stronger presence of energy communities. This likely reflects the financial capacity of residents to make the high upfront investments typically required for community energy projects, such as solar PV systems, storage, or grid interconnection. However, this raises equity concerns—if participation in energy communities is implicitly limited to those who can afford such investments, lower-income households may be excluded, thereby reinforcing existing inequalities in the energy transition.

Political trust reveals a context-sensitive relationship with the development of energy communities, primarily reflecting the degree of alignment between institutional agendas and community needs. In Western Europe, higher political trust is positively associated with EC formation, suggesting that trust in institutions can reinforce collective energy initiatives when political priorities are perceived as supportive of bottom-up, participatory approaches. In contrast, in Southern Europe, political trust is negatively associated with EC presence, implying that energy communities may arise *despite* political institutions, rather than *because* of them. This is the case where official agendas might be misaligned with local priorities or fail to support community-led models. In such contexts, lower political trust may not signal disengagement, but rather motivate grassroots mobilisation as an alternative to top-down governance. These findings suggest that **political trust alone is not inherently enabling or limiting; rather, its effect depends on whether institutional objectives are in tune with the motivations and expectations of community actors**.

Institutional strength also emerges as a significant predictor across all macro-regions, but its effects vary. In Western, Eastern, and Northern Europe, higher institutional quality correlates with greater energy community uptake, likely reflecting more transparent governance, effective policy implementation, and tailored support mechanisms. Western Europe again shows the strongest positive relationship, consistent with its mature regulatory and institutional landscape. However, in Southern Europe, institutional strength is negatively associated with energy community presence. This is possibly due to bureaucratic rigidities, implementation gaps, or a disconnect between institutional capacity and the actual facilitation of bottom-up energy initiatives.

The role of **European funding**, particularly ERDF payments, is also nuanced. While these funds are often directed towards less developed regions, they do not necessarily translate into energy communities support, possibly due to infrastructural and/or institutional limitations in these areas. However, in regions with high-quality governance, ERDF funding is found to effectively support energy community initiatives.

Factors linked to **education, innovation and public-sector R&D also emerge as positive drivers** of energy community development. These variables reflect the importance of a knowledge-based, innovation-oriented ecosystem in supporting energy communities. In contrast, private-sector R&D shows a significant negative association. This may be explained by the profit-driven nature of private innovation activities, which often favour scalable, proprietary technologies that are less compatible with the decentralised and participatory principles of energy communities.

Population density shows a nuanced relationship with energy communities presence. In general, higher density is associated with fewer energy communities, possibly due to spatial and regulatory constraints. Yet, when accounting for the availability of renewable energy infrastructure, the relationship reverses: denser areas appear to favour energy community development, likely because they facilitate social interaction and community engagement, which are key ingredients for collective action.

The **density of renewable energy infrastructure** also plays a key enabling role in the development of energy communities. Our findings show that the density of renewable energy installations is significantly associated with energy community presence, while non-renewable infrastructure does not exhibit a significant relationship. This suggests that decentralised, renewable-based systems are more compatible with community-led energy models, both in terms of technical fit and supportive ecosystem. In addition, a high density of renewable installations may reflect the presence of a mature market with specialised service providers and a regulatory environment conducive to energy community development. In contrast, centralised, fossil-fuel-based systems are less aligned with the distributed, participatory nature of energy communities. ICT infrastructure does not appear to be a decisive factor.

A key limitation of this study is the reliance on the number of energy communities as the unit of analysis. While the TANDEM database represents a milestone by providing the first consolidated dataset on ECs at the European level, it currently offers limited information beyond community counts. Key complementary data, such as the year of establishment, number of participants, installed capacity, etc, remain scattered and inconsistently reported across countries and individual ECs. This lack of detailed and harmonized information may obscure important differences in scale, maturity, and societal impact. For instance, a region with numerous small ECs might serve a smaller share of the population than a single large-scale initiative. Therefore, future research should aim to enhance data completeness and explore alternative or supplementary indicators to better capture the breadth and depth of energy community adoption across Europe.

Additionally, the analysis is based on a cross-sectional dataset, which constrains the ability to draw causal inferences about the observed relationships. While the current database represents a valuable starting point that has enabled the first quantitative exploration of patterns previously understood primarily through qualitative or contextual studies, its continued development is essential. Updating the database over time would allow for longitudinal analyses and stronger empirical grounding for policy evaluation and causal interpretation.

Lastly, future research could build on the findings of the TANDEM project and examine the potential growth of energy communities by 2030, 2040 and 2050. This research could examine several quantitative elements, such as the total installed capacity of community-owned projects, total number of citizens involved, total potential for job creation, total mobilisation of capital, as well as potential displacement of fossil fuel imports. Such a research could form the basis for future EU and Member State-level strategies to boost energy communities.

4

Analysis of Local Practices

4 Analysis of Local Practices

The purpose of the comparative analysis in Task 3 is to understand and analyse how energy communities apply 13 local practices across various national and regional contexts. By examining a diverse range of 20 case studies located across Europe, this analysis seeks to uncover the key factors that influence the success, inclusiveness, and sustainability of energy communities. Therein, the particular focus is placed on how these local practices – each characterising a specific approach or condition – impact the establishment and growth of these communities as well as the specific objectives they can help the energy community to achieve.

4.1 Methodology

To analyse the impact of local practices on the emergence and impact of energy communities, we identified and studies 20 case studies applying one or more of 13 local practices. Below, we outline the 13 local practices in section 4.2 and the selection of the 20 case studies in section 4.2.1 Following that the methodology for data collection and comparative analysis of the case studies is described. 4.2.2 details a two-step data collection process involving desk research and stakeholder consultations to complete case study fiches. Then, section 4.2.3 presents the methodology for the comparative analysis which consists of two steps: analysing each local practice individually and then synthesising overall findings to identify key factors influencing the success and inclusiveness of energy communities.

4.2 Overview of local practices

The case studies analysed the application of 13 local practices identified by the study team in conjunction with ESPON EGTC and the Steering Committee as regularly applied by energy communities and potentially beneficial for their emergence and/or successful operations (see table below). A local practice is defined as a practice that acts as a driver for energy communities and/or aids them in overcoming obstacles to their establishment and development, which is shaped at the local and regional level as opposed to national or EU level. The cases studies analyse the application of these local practice in energy communities or energy community alike initiatives. With the objective of broadening learnings about decentralised energy, this includes initiatives that are not strictly aligning with the EU or national definitions on energy communities but that follow similar practices and face similar obstacles (e.g. municipal-led energy sharing).

Figure 4.1
List of Local Practices

4.2.1 Selection of Case Studies

The selection of 20 case studies was based on a structured and multi-step approach aimed at ensuring a representative and high-quality sample of energy communities across Europe. The process began with the development of a longlist of potential case studies, drawing on three key data sources: responses to the TANDEM survey (primary source), suggestions from the project's Steering Committee, and the research team's prior experience and expert knowledge from prior EU funded projects. To combine these three sources, the survey responses were carefully analysed to identify communities demonstrating one or more of the target local practices. This was complemented by Steering Committee inputs and the research team's insights, especially in identifying cases that reflect less commonly observed practices. The longlist was then assessed against a set of selection criteria, including effectiveness and impact, innovativeness, inclusiveness, replicability, and transferability. High-ranking cases were shortlisted, while also ensuring a balanced representation in terms of geography, community size, and technological focus. Following a literal replication approach, in which the case studies evidence well-functioning local practices, three case studies per local practice (two primary and one reserve) were identified.

Map 4.1 illustrates our list of local practices and case studies across Europe.

Map 4.1
Overview of local Practices

Map 4.2
Overview of local practices

List of practices

1. Municipal-led energy sharing
2. Energy sharing carried out by private enterprises
3. Cross-border energy community
4. Leadership from local political representatives
5. Provision of municipal buildings for renewable energy activities at low or no cost
6. Organising community discussion groups and extensive coordination
7. Fostering territorial development via an integrated approach
8. Social inclusion fostered through education and/or youth engagement
9. Focus on engendering environmental benefits
10. Energy-as-a-Service (EaaS)
11. E-Mobility
12. Community distribution
13. Measures to include vulnerable groups

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*This map is a realaboration made by Ecorys, July 2025.

4.2.2 Data collection and analysis for individual case studies

The data collection for each case study was conducted in two steps, aimed at completing the same case study fiches. The two activities are mutually reinforcing, with the desk research aiding in identifying the most appropriate stakeholders to consult, while the consultations may point to additional valuable sources of information.

- **Step 1 – Literature review**: An in-depth literature review and investigation into online material, taking into account the legislative considerations, key stakeholders, and literature resources that can be consulted.
- **Step 2 – Targeted consultations**: Following the initial effort of desk research, targeted consultations were conducted with identified stakeholders of the case studies to extract further information and validate the findings of the desk research. In most cases, this involved a member of the management team of the respective energy community. These consultations followed a coherent approach with a semi-structured interviews on the basis of a standard interview guide. On top of a standardised interview guide applicable across all case studies, additional questions were formulated for each local practice.

The results were collected in standardised case study fiches, which clearly present the key information, including principal activities, attributes, and impacts. For each of the case studies, the focus within the fiches is laid on the application of the local practice, with a specific section on impacts and takeaways for the respective section. They also extract key lessons on how these may be transferred to different contexts and settings.

4.2.3 Methodology for comparative analysis

The comparative analysis of the case studies was conducted in a two-step approach, first analysing each local practice in itself, followed by an overall comparison of overarching findings, including answers to the key research questions of the TANDEM study and complementing the findings of Tasks 1 and 2.

- **Step 1 – Analysis per local practice**: This step consists of a separate analysis of each of the local practices. It encompasses the collection of the takeaways and findings from all case studies dedicated to a particular local practice as well as a comparative analysis of the commonalities and differences between the local practices. This is followed by a brief summary of key aspects identified as relevant for a successful replication and the local practice's potential for transfer.
- **Step 2 – Overall findings**: This step synthesises the collective findings and of all local practices to identify the impact of different factors on the successful establishment and the inclusiveness of energy communities. The analysis also compiles the impact of other notable observations not covered by the local practices, following an inductive approach based on the case studies' analysis.

4.3 Results

The comparative analysis of the case studies provides critical insights into the diverse yet interconnected factors influencing the formation and success of energy communities across Europe. As such, this section highlights the results from the case studies' analysis, starting with overarching patterns and shared characteristics observed across the case studies, followed by the respective results per applied local practices. This is followed by results of the comparative analysis, which reveals how the emergence and success of energy communities across Europe are shaped by a multifaceted combination of financial support mechanisms, social inclusion strategies, and alignment with broader sustainability goals.

4.3.1 Main findings

The analysis of the case studies revealed several overarching observations relevant to the development and success of energy communities as well as the achievement of specific objectives. First, the **importance of partnerships emerged as a key factor**, particularly when pursuing specific objectives such as the inclusion of vulnerable groups, environmental objectives or social acceptability. Partners can provide the energy community with specific expertise and support the trust-building process, whereas energy communities can bring in their experience as well as committed volunteers. Additionally, the activities of energy communities are often tailored to fit within the constraints and opportunities of their respective national regulatory frameworks, **highlighting the need for context-sensitive approaches**. However, despite these national differences, many of the practices observed are transferable and can be adapted to different settings offering valuable insights for replication elsewhere. Finally, across all contexts, energy communities were consistently identified as social organisations driven by community objectives, emphasising the centrality of community engagement, inclusivity, and collective benefit in their missions.

4.3.2 Findings per local practice

Table 4.1
Overview of findings per local practice

Local practice	Case study	Key findings	Replicability / Transferability conditions
Municipal-led energy sharing	• Otterbeek (BE) • Skawina Energy Cooperative (SES) (PL)	• Municipal-led energy sharing can lead to lower energy costs for vulnerable groups if that is a priority. • Based on the local context, municipalities can take different roles in each case.	• Maturity of energy communities: where energy communities are well-established, municipalities can have a more facilitative role. • Conversely, where energy communities are still emerging, municipalities can follow a more hands-on approach and lead the overall process.
Energy sharing carried out by private enterprises	• CeBASE (IT) • ENERKOM Opavsko (CZ)	• Offering innovative products and high-quality energy-sharing services can broaden an energy community's membership base. • When connecting members with each other to achieve more favourable rates, the energy community is able to maximise interest and awareness of the local community. • Public-Private Partnerships and their participation in energy community activities can also benefit the private sector.	• Reliance on national legislation: Energy sharing agreements can be implemented only if national legislation allows for it. • Private sector willingness: The inclusion of private entities in energy community activities depends on the private sector's willingness to compromise some of its commercial interests.

Local practice	Case study	Key findings	Replicability / Transferability conditions
Cross-border energy community	• Grenzstrom Vindtved (DE-DK) • EGTC Duero-Douro (ES-PT	• Cross-border collaboration encourages the involvement of citizens on both sides of the border and can serve as a stand-out feature of an energy community. • Cross-border ownership with installations (initially) in only one country facilitates regulatory compliance. • The involvement of local authorities and the existence of dedicated funding instruments both support the creation and development of cross-border initiatives.	• Support from local public authorities: The existence of dedicated cross-border legal entities can support in overcoming regulatory challenges and facilitating cross-border energy cooperation. • More integrated and harmonised policies: Such policies would aid for easier establishment and further development of energy-sharing projects across borders.
Leadership from local political representatives	• Green Hrastnik (SI) • ZEZ Sun (HR)	• Local leadership can be key for building trust particularly during the early stages of development of initiatives. • Local political leaders' strategic outreach potential can significantly raise a project's visibility.	• Size of municipality: The role of a local political leader is more effective in smaller communities where relations with relevant stakeholders are closer. • Level of awareness: Local leadership is most impactful in countries where scepticism is high due to limited knowledge about energy communities.
Provision of municipal buildings for renewable energy activities at low or no cost	• Green Hrastnik (SI) • ZEZ Sun (HR) • Balenyà Sostenible (ES) • Volterra (BE)	• Public-private agreements can reduce some of the risks borne by energy communities. • Public authorities can play an active role in engaging social actors in developing solar installations on publicly-owned buildings. • The type of public-private agreement is influenced by the local context.	Dependence on public procurement regulation: If national regulation allows it, public procurement procedures could be standardised to allow for easier collaboration between public authorities and social actors (such as energy communities).

Local practice	Case study	Key findings	Replicability / Transferability conditions
Organising community discussion groups and extensive coordination	• Ecovision (IE) • CER Telheiras/Lumiar (PT) • Coöperatie doarpsmûne Reduzum (NL)	• Open participation mechanisms are most effective at the beginning in order to align the energy community with local needs, raise awareness of the energy community, and to diversify its membership base. • Local discussion groups enable the exchange of knowledge and foster a sense of ownership, hence, encouraging members to more actively engage in decision-making. • Offering commitment flexibility encourages continued engagement among members.	• Strong involvement of residents: Early involvement of residents allows them to collectively shape the energy community and tailor it to the needs of the local community, enhancing both the sense of ownership and the community's visibility to prospective members. However, it depends on the level of people's interest and willingness to actively contribute to the energy community. • Democratic governance: Enabling participation from non-elected (i.e. non-board) members enhances inclusivity, but it may also lead to tensions if decisions are not reached by consensus. • Flexible participation: This approach carries the risk of fluctuating engagement levels, potentially leaving the community short of active volunteers.
Fostering territorial development via an integrated approach	• Opavsko (CZ) • Coöperatie doarpsmûne Reduzum (NL)	• European support schemes, such as LEADER, can act as catalysts for the development of energy communities. • Local context (e.g., institutional frameworks) and the stage of development of energy communities highly affect the approach and structure of the local practice.	• Existing strategies: The presence of a local territorial development strategy captures the objective of deploying energy communities as a key driver in replicability. • Collaboration with EU-level networks: Local Action Groups (LAGs) are more easily enabled when EU-level actors are involved. • Community type: The use of LAGs and the integration of various local actors in energy communities are particularly replicable in rural or semi-rural communities given that there are fewer actors that can be more meaningfully engaged.

Local practice	Case study	Key findings	Replicability / Transferability conditions
Social inclusion fostered through education and/or youth engagement	• Wattnu (NL) • Grenzstrom Vindtved (DE-DK)	• Educational activities are key in fostering community engagement and participation in the energy transition through increasing residents' understanding of the energy transition and addressing initial scepticism. • Education and engagement may cover a variety of activities, but they need to be tailored to the local concerns to meet people's needs, leading to increased involvement.	• Learning opportunities: Tangible, first-hand learning opportunities can stimulate further replication as they raise awareness and demystify the technology in question, helping to decrease or counter opposition. • Local context adaptability: When the approach of providing one-on-one tailored solutions is adapted to the local context, the model can be adapted to empower residents and build social cohesion.
Focus on engendering environmental benefits	• REC pilot project Culatra (PT) • Grenzstrom Vindtved (DE-DK)	• Collaboration with local environmental protection agencies or similar organisations ensures that energy community operations are in line with environmental regulations and that environmental harm is minimised. • It is important that communities' environmental activities are chosen in line with the local setting. • Additional environmental activities can support energy communities in increasing local acceptance and preventing scepticism, especially if the local population is not yet used to renewable energy generation.	• Assessment of the energy community's environmental impact: Energy communities can be established in environmental protection areas if there is a clear assessment and a suitable adaptation of the project to minimise harm is identified. • Environmental education: Educational activities that raise awareness of environmental challenges and highlight the interplay between environmental protection and renewable energy may foster replication. • Collaboration with nature protection authorities: Energy communities can gain expertise on environmental impacts, thereby ensuring that the activities are designed in line with this principle, a practice that may be replicated in other regions where the environmental impact is a particular concern.

Local practice	Case study	Key findings	Replicability / Transferability conditions
Energy-as-a-Service (EaaS)	• CeBASE (IT) • ENERCOOP cooperative (ES)	• Energy-as-a-Service (EaaS) can support the decentralised energy production by collecting and disseminating knowledge, and providing the additional (necessary) capacity services for local actors to start and implement citizen energy initiatives. • Energy communities can empower individual actions, as well as encourage community building and collective action by offering EaaS.	• Barriers faced by decentralised energy initiatives: Depending on the barriers, the fundamental principles of providing specific support services to facilitate community ownership, decentralised renewable energy generation, and social inclusivity are adaptable to diverse setting • Smart grid existence: The models applied in the two case studies are particularly enabled by the existence of smart grids (to manage energy sharing).
E-Mobility	• energie malters (CH) • Ecotxe (ES) • Balenyà Sostenible (ES)	• E-mobility contributes to a multi-faceted sustainability vision for the future. • The high operating costs that come with e-mobility may hinder energy communities from expanding this service.	• Local context: The type of activity, (e.g., charging or renting of electricity cars or bikes), may be adapted to the specific local context and the needs present in the community. • Educational initiatives: Training users on how to use electric vehicles can facilitate their introduction by addressing concerns and building capacity. • Collaboration with local authorities: It is necessary to integrate e-mobility into urban planning, securing dedicated spaces for parking, charging, and overall coordination with wider mobility strategies.

Local practice	Case study	Key findings	Replicability / Transferability conditions
Community Distribution	DuCoop (BE)	• Provides a low-barrier entry point to energy communities, also to people less interested or aware about the topic • Energy communities can expand their membership by offering low-cost entry points, with a minimal upfront cost, both in financial terms and in time commitments.	• Neighbourhood level of establishment: Community distribution can be promising in newly established neighbourhoods where the infrastructure for renewable energy systems can be integrated from the outset and organised through an energy community system, ensuring bottom-up ownership and identification with the project. • Legislation: Legal flexibility can smoothen the process and foster energy community operations.
Measures to include vulnerable groups	• CER Lumiar/Telheiras (PT) • Solarity REC (GR)	• Inclusion tends to be most effective when it is established as a core objective of energy communities from the outset. • Partnerships with local stakeholders, particularly local authorities, have significant added value. • Energy communities vary in how they define and identify vulnerable groups, and there is no 'one-size-fits-all' model. • Alignment with existing support schemes, such as social energy tariffs and social benefits, differs significantly depending on the local regulatory framework and institutional setup.	• National framework: The inclusion of vulnerable groups depends on the specific national context and can benefit if it is tailored in a way to complement the national framework. • Inclusion of local authorities in implementation: Local authorities can base their support for energy communities on inclusivity requirements, and support such practices by providing a framework for it (e.g. qualification criteria), and/or direct financial support for the participation of vulnerable groups.

4.3.3 Relevance of Subsidies and Financial Instruments

The comparative analysis of the case studies show that subsidies and financial instruments **are essential enablers at different stages of an energy community's development**. Subsidies -particularly in the form of grants and feed-in tariffs - are commonly used during the establishment phase to reduce upfront costs and financial risks. For example, in energie malters (CH) and Balenyà Sostenible (ES), grants helped cover installation and start-up costs, thereby improving financial viability. Feed-in tariffs and long-term PPAs provided price stability and investment security in cases like Grenzstrom Vindtved (DE-DK) and Doarpsmûne Reduzum (NL). In contrast, financial instruments such as soft loans and rolling funds played a larger role in scaling up activities, especially in contexts where traditional bank loans are less accessible to non-profit entities. Funds tailored for energy communities (such as those used by Wattnu (NL)) often include advisory support and risk-mitigation features, enhancing access to capital. The analysis confirms that a combination of both mechanisms, strategically matched to the development stage and context, significantly improves the financial resilience and scalability of energy communities.

4.3.4 Social Inclusiveness Through Local Practices

The case studies demonstrate that energy communities can foster social inclusiveness through both formal and informal strategies, though implementation varies based on context and capacity. Formal inclusion - where disadvantaged households are made full members - was seen in Balenyà Sostenible (ES) and CER Telheiras/Lumiar (PT), where local authorities covered initial investments and fees for vulnerable households, allowing equal participation and decision-making rights. Informal inclusion, observed in cases like Otterbeek (BE), energie malters (CH), Wattnu (NL), and Ecovision (IE), focused on outreach, education, and facilitation of access to energy efficiency grants, often through partnerships with public entities and NGOs. These activities benefited vulnerable groups without granting formal membership or decision-making power. The analysis highlights several key factors for success: embedding social objectives early, forming strategic partnerships with trusted local actors, and aligning with existing public policy instruments. However, trade-offs remain, especially when inclusiveness challenges financial sustainability or conflicts with other community priorities. Overall, local practices, when carefully designed and supported, play a crucial role in making energy communities more inclusive and socially impactful.

4.3.5 Reconciling Non-Profit and Market Logics

The comparative analysis of the case studies reveals that energy communities consistently seek to balance their non-profit objectives with the demands of operating in competitive energy markets. As recipients of services, energy communities tend to prioritise collaboration with public authorities, social economy actors, and ethical financial institutions, aligning support with their values while accessing necessary expertise. Where technical needs arise, they often partner with local businesses, aiming to support the local economy. When providing services themselves, energy communities face the challenge of generating sufficient revenue while keeping services affordable. This tension is typically managed through internal deliberation. Communities focused on sharing energy with members prioritise low energy costs, while those with broader social aims may focus on generating higher income to fund wider objectives. In more complex cases, such as supplying vulnerable groups, pricing is often tied to external market benchmarks to balance fairness and sustainability. Overall, the reconciliation is possible through value-aligned partnerships, participatory governance, and transparent pricing strategies.

4.3.6 Energy Communities and Integrated Territorial Development

The case studies showed that energy communities can act as important actors in integrated territorial development when embedded within broader governance structures such as Local Action Groups (LAGs) and Integrated Territorial Investments (ITIs). This connection enhances their access to funding, legitimacy, and alignment with local development goals. In several cases, energy communities were launched or supported by local governments or existing rural development initiatives, which facilitated community buy-in and created synergies with other sustainability efforts. The analysis shows that energy communities embedded in territorial governance structures often benefit from stronger public support and greater resilience. However, fostering inclusiveness through territorial approaches does not appear to be a consistently observed feature in the examined cases. While inclusivity may still be possible and an implicit value or potential outcome of such models, it was not prioritised or explicitly targeted in the integrated approach of the projects reviewed. Nonetheless, some structural elements – particularly the use of public-private partnership models and efforts to balance stakeholder interests – do provide a solid foundation for inclusive community engagement. These governance approaches have the potential to enable broader participation and more equitable representation in energy communities that form part of an integrated territorial approach, even if inclusiveness was not a core focus in the studied examples.

4.3.7 Environmental Contributions of Energy Communities

The analysis of the case studies highlighted the wide variety of how **energy communities are supporting and creating environmental benefits**. Across the case studies, they are found to make tangible contributions to environmental sustainability. Environmental benefits by energy communities include, most notably, the production of renewable energy by energy communities themselves as well as additional self-consumption of renewable energy stimulated by energy communities, and the resulting reduction in CO_2 emissions. The case studies also highlight how energy communities are active in the support of energy efficiency through advice, funding, and stimulating behavioural change, where, several cases show them influencing local behaviour and consumption patterns, such as through awareness campaigns, energy coaching, or incentives for sustainable transport. In some instances, energy communities go beyond core energy functions to include environmental protection measures like biodiversity conservation, land stewardship, or the development of infrastructure for electric vehicles. These additional activities help energy communities act as catalysts for broader ecological change, particularly where they align with local environmental strategies and benefit from cross-sectoral partnerships.

4.4 Discussion

The comparative analysis of the case studies demonstrates the growing potential of energy communities to act as enablers of just and sustainable energy transitions across Europe. While each case operates within its own unique local context, several cross-cutting insights emerge that reveal both structural enablers and persistent tensions. In particular, this section discusses the implications of the findings in relation to governance and inclusivity, market engagement, financial frameworks, and environmental impacts.

One of the most prominent findings concerns the **critical role of partnerships in enabling energy communities** to develop capacity, extend reach, and build legitimacy. In particular public authorities and NGOs, but also academic institutions and private partners, consistently play important roles across the life cycle of energy communities, from initial trust-building to long-term service delivery. In municipal-led practices, these public-private partnerships allowed for the explicit inclusion of vulnerable groups through energy sharing schemes. Meanwhile, cross-border cases illustrate how dedicated cross-border legal entities as well as alignment with strategic regional objectives for cross-border collaboration can help to overcome challenges stemming from the regulatory and infrastructural fragmentation, further underscoring the strategic value of inter-organisational alliances. However, the case studies also highlight a key caveat. While partnerships expand the energy community's capacity, they can also introduce trade-offs, particularly when private partners pursue other interests or when public institutions retain control over governance, potentially diluting grassroots influence.

Closely tied to partnership strategies is the question of governance and social inclusivity. The findings underscore that energy communities are fundamentally social organisations, shaped by democratic principles and community benefit goals. Formal inclusion mechanisms where vulnerable groups get equal access as members in an energy community, demonstrate that structural integration of vulnerable groups can be effectively achieved when inclusivity is prioritised from inception and supported from its members and, ideally, from (public) partners. In contrast, informal strategies. such as targeted outreach, education, low-barrier services or reduced energy rates, serve as important, though less robust, tools for widening access. However, inclusivity often remains under-addressed in communities with limited financial resources or weaker institutional support. The analysis reveals that social objectives are most successfully achieved when embedded early, backed by dedicated funding, and supported through active collaboration with local authorities and social service organisations. Nonetheless, some tension persists between inclusivity goals and financial sustainability, especially in communities that rely heavily on volunteer labour or face high capital costs.

This tension is further complicated by the **ongoing challenge of reconciling non-profit principles with market engagement**. Energy communities must navigate competitive energy systems while maintaining affordability, accessibility, and democratic control. The case studies illustrate different responses to this tension. For example, some communities prioritise internal energy sharing and cost savings, while others generate surplus income through external sales to fund broader social missions. Where market logic exerts pressure, particularly in cases with vulnerable group inclusion. transparent pricing strategies, participatory decision-making, and alignment with value-based partners emerge as critical balancing tools. Ultimately, while the reconciliation of market and community logics is possible, it requires intentional design and robust internal dialogue, especially as energy communities scale or diversify their activities.

Unsurprisingly, financial sustainability remains a cornerstone of success and scale-up potential. The study clearly identifies the importance of strategically applied subsidies and tailored financial instruments. Grants and feed-in tariffs help mitigate early-stage risk and enable community buy-in. Meanwhile, flexible instruments such as soft loans, rolling funds, and blended finance models provide critical pathways to scale, particularly in countries where nonprofit energy actors lack access to mainstream credit. What emerges is a clear policy lesson. EC-friendly financial architecture must be adapted to the development stage of the initiative and include both capital and advisory support. Moreover, long-term price stability and revenue predictability (e.g. through mechanisms like PPAs or guaranteed tariffs) are key to reducing financial precarity and enabling broader participation.

Another significant insight is **the territorial embeddedness of energy communities**, especially in rural or semi-rural contexts. The use of tools such as LEADER programmes, Local Action Groups (LAGs), and Integrated Territorial Investments (ITIs) allows energy communities to position themselves not only as energy producers but also as actors in broader regional development strategies. In such cases, territorial integration has enabled access to European funding, cross-sector partnerships, and long-term political support. That said, inclusiveness was not always a central feature of these territorial approaches. While the structural potential exists, the effectiveness of such models in enhancing social equity depends on whether inclusivity is an explicit design goal or merely an assumed byproduct of participatory governance.

Finally, the **environmental dimension of energy community activities emerges as both a core mission and an evolving practice.** The case studies affirm that energy communities are important contributors to climate action through renewable energy production, energy efficiency, and behavioural change. In some cases, energy communities also engage in biodiversity protection, land stewardship, and the development of electric mobility infrastructure, acting as holistic agents of ecological transformation. Where environmental strategies align with local values and involve partnerships with environmental agencies, acceptance and impact are notably higher. This reinforces the potential of energy communities to be not just energy providers but stewards of sustainable local development, especially when supported by local policies and cross-sector knowledge-sharing.

In summary, the discussion of the **case studies results reveals a diverse and dynamic energy community landscape across Europe**. Key success factors include early investment in partnerships, intentional strategies for inclusivity, thoughtful navigation of market dynamics, and strong integration into local development frameworks. However, persistent tensions between social and financial goals, between decentralisation and regulatory complexity, and between ambition and capacity, must be managed through adaptive governance, supportive policy environments, and flexible financial instruments. As the European energy transition deepens, energy communities are well-positioned to contribute not only to decarbonisation but also to more inclusive, resilient, and locally grounded models of energy democracy, when applying local practices and approaches suitable to the respective aims and local objectives.

These findings, however, should be interpreted with **several limitations** in mind. First, the sample of case studies, although selected for representativeness and diversity, is not exhaustive. It primarily reflects examples with at least some demonstrable success – a result of the selection from cases where representatives have filled out the TANDEM survey and were willing to participate in this research – potentially biasing the findings toward better-practice cases rather than highlighting systemic barriers or failed attempts. Second, while the two-step methodology of desk research and stakeholder consultation enriched the analysis, the reliance on a limited number of interviews per case may have constrained the triangulation of perspectives, particularly from marginalised or less-involved community members. Third, the evolving policy and market landscapes mean that the replicability and scalability conditions identified may shift rapidly, particularly in response to legislative changes or technological developments. These limitations underscore the need for continuous, context-sensitive research that captures the dynamic realities of energy community development.

Building on the findings and limitations of this study, **future research** should pursue a more granular understanding of the interplay between national policy frameworks and local practices. In particular, comparative studies that systematically analyse how different regulatory, financial, and institutional environments shape the viability and design of energy communities would provide deeper insight into enabling conditions and barriers. Studies tracking the development of energy communities over time could also help illuminate the evolving dynamics of governance, participation, and market engagement, especially in growing energy communities or as a response to shifts in policy or funding availability. Another critical area for further exploration is the lived experience and agency of community members, particularly those from vulnerable or traditionally underrepresented groups. Ethnographic or participatory research methods could complement the current case study approach by capturing informal dynamics, internal power relations, and the impact of inclusion strategies at the individual level.

5

Conclusions from the analysis

5 Conclusions from the analysis

This research offers a comprehensive view of the development and inclusiveness of energy communities across Europe. While energy communities hold significant promise for contributing to a just and sustainable energy transition, findings from our quantitative analysis (Chapter 2 and 3) and the case studies (Chapter 4) reveal that inclusiveness is often limited and highly dependent on context, support mechanisms, and governance structures.

The main conclusions regarding social inclusiveness of energy communities include:

- Social inclusiveness is driven primarily by **financial support** (e.g. subsidies, loans), regional income levels, and dedicated energy poverty policies.
- **Non-financial support**, while present, does not show a positive impact, possibly due to implementation gaps rather than inherent ineffectiveness.
- **Formal inclusion mechanisms and strong public partnerships** seem to enable deeper integration of vulnerable groups, while informal outreach strategies remain helpful but insufficient on their own.

Taken together, these insights show that energy communities are not inherently inclusive, but with the right financial incentives, multilevel governance approaches, and contextual alignment, they can be shaped into powerful instruments of social equity and territorial resilience.

The main factors which enable energy communities emergence included:

- **Social trust** is the strongest predictor of energy community formation.
- **Household income** is a major driver of energy community presence, as wealthier regions are better positioned to support the upfront investments required for participation.
- **Institutional strength** and political trust shape energy community emergence. However, these factors vary across regions, underscoring the need for place-based policy approaches rather than one-size-fits-all solutions.
- **Territorial embeddedness and infrastructure** further enable energy community growth. Regions with a high density of renewable infrastructure and integration into local development frameworks (e.g., LEADER, LAGs) show greater energy community success. However, territorial strategies must prioritise inclusion explicitly to avoid reinforcing inequalities.
- **Financial viability** remains a core challenge for the emergence and development of energy communities. They require tailored, context-specific funding instruments, ranging from early-stage grants to stable long-term revenue models. Where market pressures grow, transparent governance and alignment with value-based partners help balance their financial and social goals.

The research also showed that energy communities face inherent tensions between their non-profit, socially driven missions and the commercial realities of operating in energy markets. Energy communities often rely on partnerships with public authorities, NGOs, and ethical financial institutions to align market engagement with social values. Trade-offs emerge when inclusiveness challenges financial sustainability, especially in communities serving vulnerable groups. Participatory governance and transparent decision-making are key tools for managing these tensions.

This research shows that energy communities have the potential to drive a just and sustainable energy transition, but their emergence and inclusiveness are not automatic. Their success depends on a combination of enabling conditions (such as financial support, institutional strength, social trust, and renewable infrastructure) as well as deliberate efforts to align governance and funding with social objectives. With the right support, energy communities can become resilient, community-driven models that balance equity, participation, and market realities.

This study's findings should be interpreted with several limitations in mind. The definition of social inclusiveness used was primarily socio-economic, excluding other dimensions like demographic or democratic inclusion. The survey sample was geographically imbalanced, with limited representation from Eastern Europe, potentially affecting insights into regional variations. Additionally, reliance on the number of energy communities as the main unit of analysis, due to limited and inconsistent data on aspects like scale or impact, restricts the depth of interpretation. The cross-sectional nature of the dataset also limits causal analysis, emphasising the need for longitudinal research. Moreover, the case studies, while diverse, are not exhaustive and may overrepresent successful initiatives due to self-selection bias. Finally, limited interviews per case and shifting policy and market conditions further constrain generalisability, highlighting the need for ongoing, context-aware research.

As a result, TANDEM paves the way for future research. Future research could deepen understanding of key dynamics in energy community development, including the unexpected negative effects of non-pecuniary support and EU low-carbon funding on social inclusiveness, which call for causal investigation through longitudinal analysis. Repeating and expanding the TANDEM survey every one to two years would enable time-series data collection, supporting more robust policy evaluation and tracking the evolving nature of energy communities. Additional areas for exploration include the growth potential of energy communities by 2030–2050, focusing on metrics like installed capacity, citizen involvement, job creation, capital mobilisation, and fossil fuel displacement. Comparative studies of national policy frameworks and local practices would clarify regulatory and institutional influences, while ethnographic and participatory methods could illuminate the lived experiences and agency of community members, particularly for marginalised groups, offering a richer understanding of inclusion, governance, and internal dynamics.

Nevertheless, the research provides a solid basis for the policy recommendations presented in the next chapter.

6

Policy Recommendations

6 Policy Recommendations

From the analysis undertaken in TANDEM, and the conclusions reached above, a number of recommendations were derived, including around how to promote inclusiveness in energy communities, encouraging their uptake, improving spatial settings and integrated territorial development approaches for promoting the growth of energy communities, and evolve national data collection efforts on energy communities to further uncover their evolution and the benefits they deliver for Europe's energy transition.

The original set of recommendations were then tested and reviewed thanks to the involvement of external experts and stakeholders working on community energy topics at different governance levels, via two workshops. With this participatory approach, involving around 30 external community energy practitioners, we aimed at ensuring the policies suggested were not only relevant to address the challenges highlighted by TANDEM's research, but also inclusive of the perspective of actors from the field, to avoid posing unnecessary burden to community energy projects around Europe.

These recommendations will be useful for future initiatives to collect data on energy communities, both on regulatory purposes but also research on energy communities including their activities, social benefits, growth overtime, and the actors engaging in them.

6.1 Facilitate social inclusiveness in energy communities

The TANDEM study highlights both the emerging commitment of energy communities to social objectives and the persistent challenges in translating such ambitions into inclusive practices. Given the conceptual overlaps between disadvantaged households, vulnerable groups, and energy poverty, which are often difficult to disentangle, the following measures may address them in combination.

- **Informational support could be provided to local actors relevant to the development of energy communities.** Within the enabling framework that every Member State is supposed to set up according to the Renewable Energy Directive, informational tools such as One Stop Shops, guidance documentation, and capacity-building initiatives could be established and implemented primarily at the local level to ensure accessibility and relevance, and tailored to different actors that work on energy poverty and/or energy communities, with a particular focus on vulnerable households, SMEs, social economy actors, and civil society organisations. This could include organising local-level training and outreach activities specifically designed to inform and empower vulnerable groups to participate meaningfully in energy communities.
- **Policy incentives could be developed to encourage and support the delivery of social objectives of energy communities, such as social inclusiveness**. Generally, targeted incentives could be developed and delivered via stronger collaboration with regional authorities, to encourage energy communities to integrate social inclusion into their objectives. Such incentives could take the form of financial, technical, administrative and legal support tied to measurable criteria around social inclusiveness, such as the number of disadvantaged households, vulnerable households or efforts targeting energy poverty. It is important to note, however, that introducing additional criteria and earmarking mechanisms may increase the administrative burden on energy communities, particularly those with limited resources. Therefore, it is essential to strike a balance between ensuring targeted support and maintaining accessibility and feasibility for community-led initiatives.

6.2 Favourable actions and spatial settings that enable deployment of energy communities

The findings from TANDEM highlight the complex interplay between socioeconomic, geographic, infrastructural, and institutional factors in shaping the emergence of energy communities across regions. Subsidies, financial instruments, and a supportive framework for renewable energy production and related infrastructure, both in urban and rural areas, can support the emergence and development of energy communities.

Nevertheless, there are also particular socio-political, economic and/or institutional obstacles that energy communities face in establishing themselves in different territorial settings, such as Eastern EU regions, or tailoring their activities to promote social inclusiveness (e.g. lack of access to finance, supportive institutional/legal framework for energy communities, access to expertise or tools). To address these obstacles and increase the presence of energy communities in regions where they are least present, TANDEM recommends focusing the below proposed actions:

- **Knowledge-sharing and promotional activities could be launched in less developed regions** to inform the general public and the local governments on the benefit of community-owned renewables projects. This could for example involve the upscale of available tools at regional level to facilitate information-sharing and matchmaking between communities and other local stakeholders, such as companies and local governments, with space available to installations.
- **Co-ownership/co-development models between commercial RES developers and energy communities/citizens could be promoted for larger projects**. This can be done via targets set at regional/local level, as well as the development of targeted incentives.
- **A "Tech-Support Program" to boost the digital and technological capacity of less developed regions** for energy community formation could be launched in combination with the development of step-by-step guides and trainings with expert facilitators to ensure the available tools and knowledge can be used by citizens and municipalities independently.
- **Expand and simplify access to subsidies and financial instruments for energy communities**, while ensuring they are tailored to the unique needs of community-driven, socially-inclusive energy projects. The Commission could acknowledge Community Energy Financing Schemes ("CEFS") created through the LIFE ACCE project, as revolving funds that can crowd significant amounts of private capital.

6.3 Role of integrated approaches in territorial development

There are factors that support the potential to develop energy communities both in more urbanised (population dense) and rural areas. On the one hand, while spatial and regulatory constraints (e.g. building codes and zoning laws) may hinder energy communities in urban areas with higher population density, they can also facilitate social interaction and community engagement. On the other hand, regions with less population density, which face less spatial and regulatory constraints, could support further growth of energy communities. regional funds, such as the ERDF, the Community Led Local Development/LEADER approach, and others, along with provision of professional support from regional and local governments, can support the development of energy communities. However, territorial strategies must prioritise inclusion explicitly to avoid reinforcing inequalities.

To support territorial inclusive approaches that allow all EU citizens to participate in an energy community:

- **Ensure that policies and incentives around the development of energy communities allows for initiatives that can cover a regional approach**. This includes definitions around energy communities at the national level that allow for a territorial approach to renewable energy development and participation of citizens, local authorities and SMEs as well as a flexible and context-specific approach to the requirement of geographical proximity of energy communities that retain local ownership. Member States can also better support energy communities in their European funding programmes for regional development such as the ERDF, Cohesion and Regional Development Funds, and the Community Led Local Development/LEADER approach. Such tools could be adapted according to a multi-level governance approach, with involvement of regional and local authorities, existing national federations and/or coalitions of energy communities to help design the right calls, and ensure they are disseminated more broadly.
- **Inclusion of energy communities in mapping and planning around the development of renewable energy production technologies (heat, gas and electricity) at the local and regional levels**. Regarding use of the network, operators, both at the distribution and transmission level, could provide transparency (e.g. online access) around available grid hosting capacities, applications procedures including timeline and costs, and maps showing RES potential and available space for installations provided at local and regional level (with the potential to match available space with communities who could use it).

6.4 Registration and monitoring of energy communities at national level

When verifying the research data from national databases, we found that national monitoring systems for energy communities are still emerging and use divergent methodologies for collecting data on energy communities. Furthermore, most national monitoring systems for energy communities do not have quality assurance or concrete criteria to track data on the number of energy communities. There is a need to integrate learnings from existing initiatives to improve the tracking of this information. To aid the further collection and refinement of concrete and accurate data on energy communities, and to track the activities, socio-economic objectives and delivery of member and societal benefits:

- **Responsibility could be assigned at the national level to a body to register, monitor and oversee energy communities**. Otherwise, funds could be provided to a non-governmental organisation to undertake this responsibility. This could be supported by the EU level (e.g. ACER), through the development of a harmonised methodology for national authorities so they can develop their own system to properly oversee energy communities at national level, ensure compliance with the national definition, and collect a minimal amount of information such as number/types of energy communities, their different activities and objectives, individual projects (i.e. distinguish from energy sharing as an activity), investment, installed capacity, number of members, and barriers they experience. Sharing and updating of data (e.g. on an annual basis) can also be linked to receiving public subsidies by energy communities.
- **Ensure registration procedures for energy communities are clear, transparent and simple**, in particular for initiatives that have already been established as a legal form (e.g. association, cooperative, NGO) that would qualify as an energy community. The Registering authority can also provide guidance to energy communities on how to register an energy community. Legal forms can also be promoted that are likely to have socio-economic objectives rather than a primary objective to pass on profits to shareholders.

7

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7 References

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8

Annexes

8 Annexes

Annex I: Chapter 2 Additional figures, modelling results)

Figure 8.1
Breakdown of survey responses by country

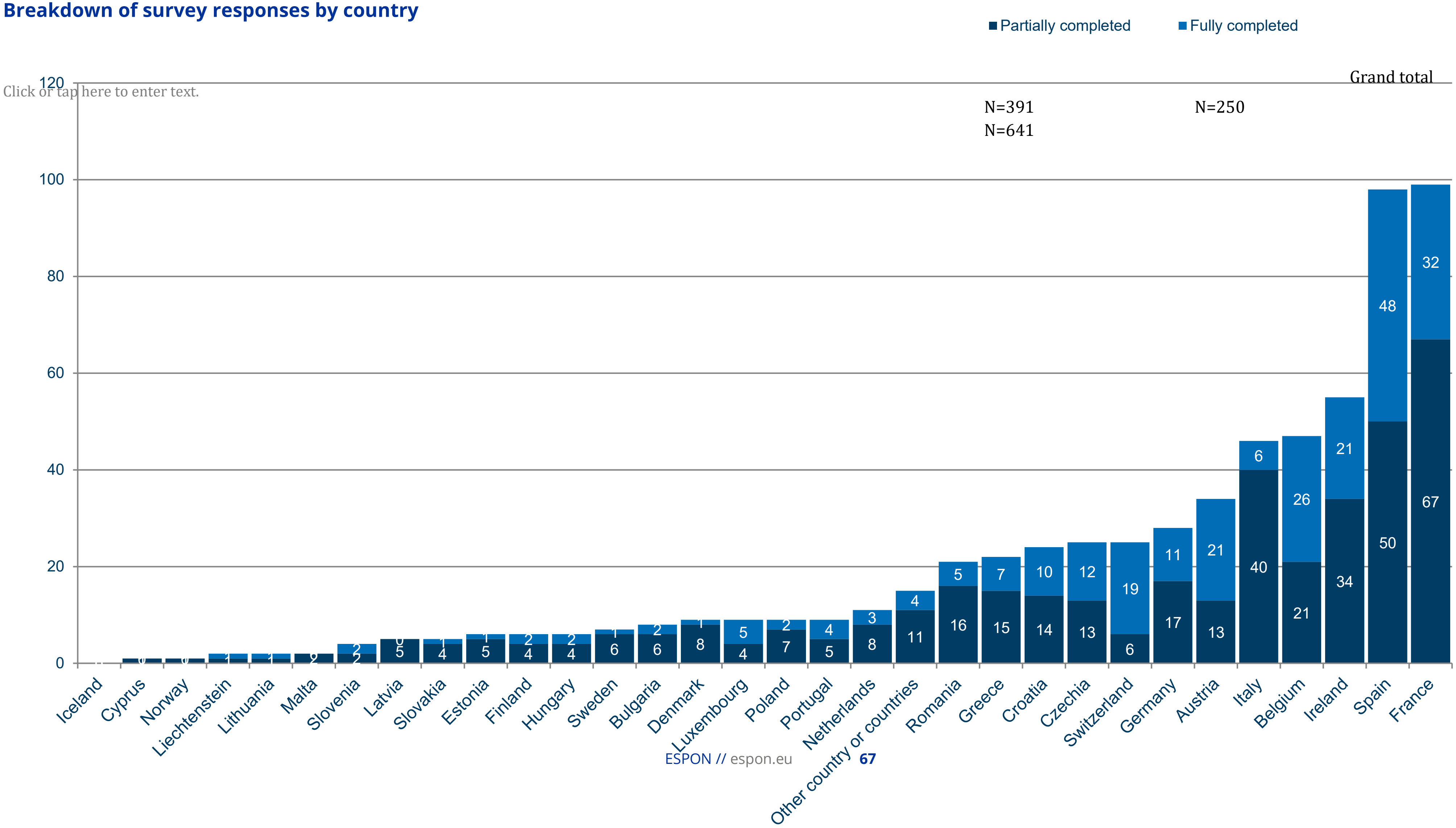


Figure 8.2
Number of goals pursued per energy community (N=347)

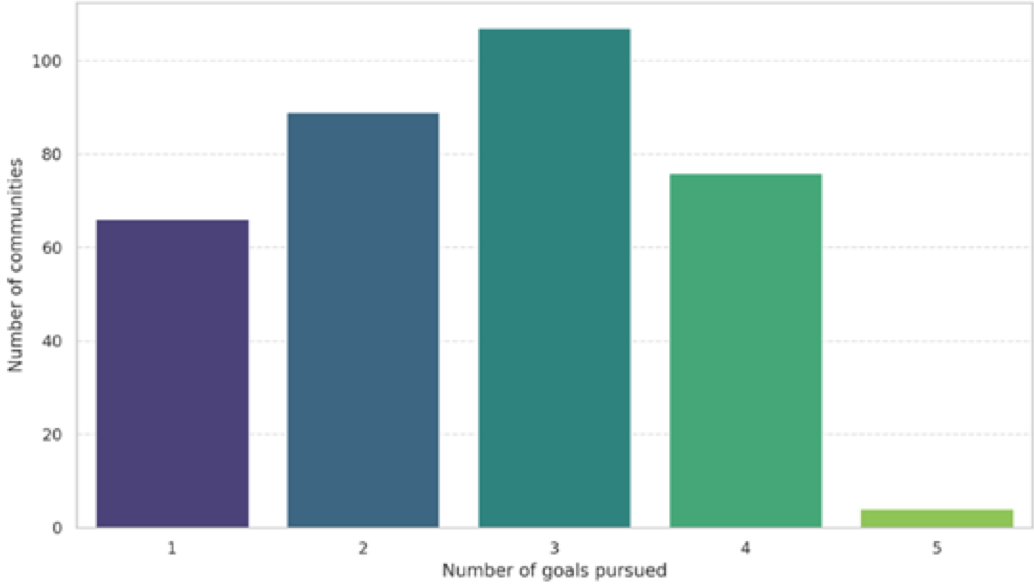


Figure 8.3
Goals of energy communities (N=347)

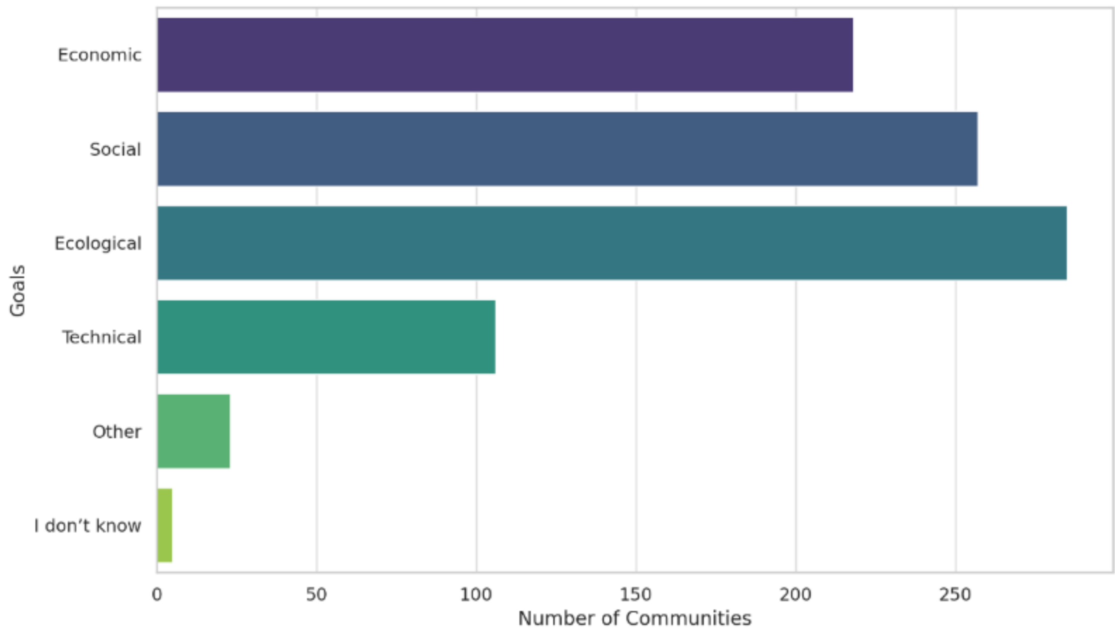


Figure 8.4
Number of services offered per community (N=347)

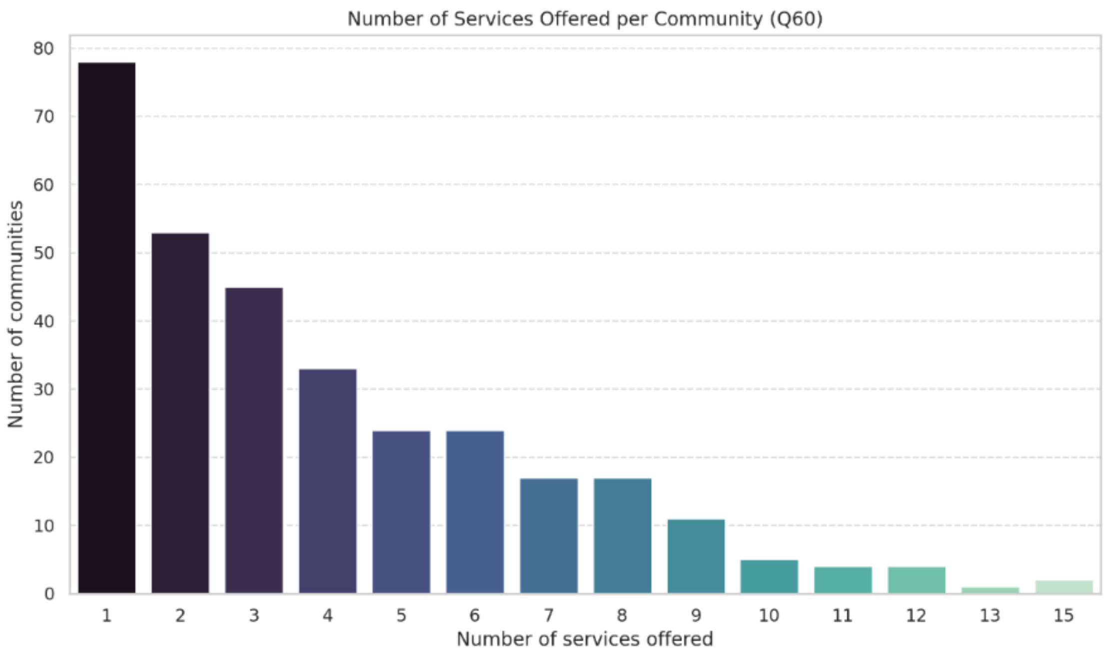


Figure 8.5
Number of services offered per community (N=347)

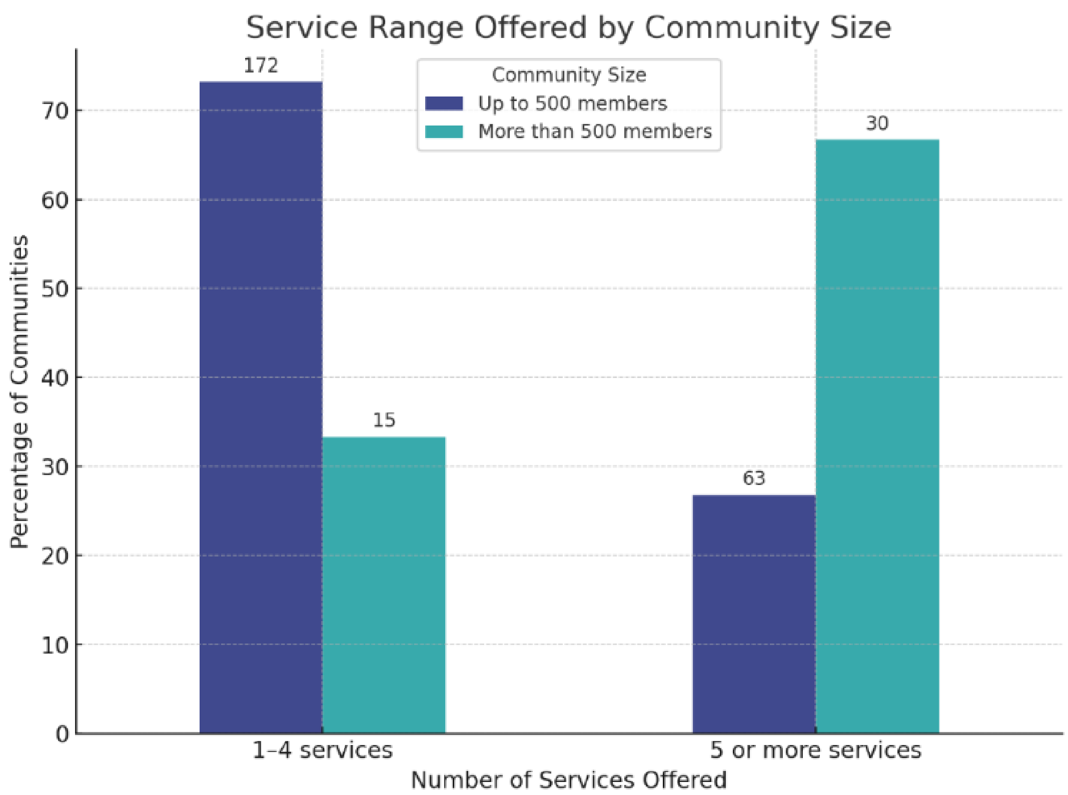


Figure 8.6
Policy on reduced energy tariffs compared to average consumer and small business contracts (N=322)

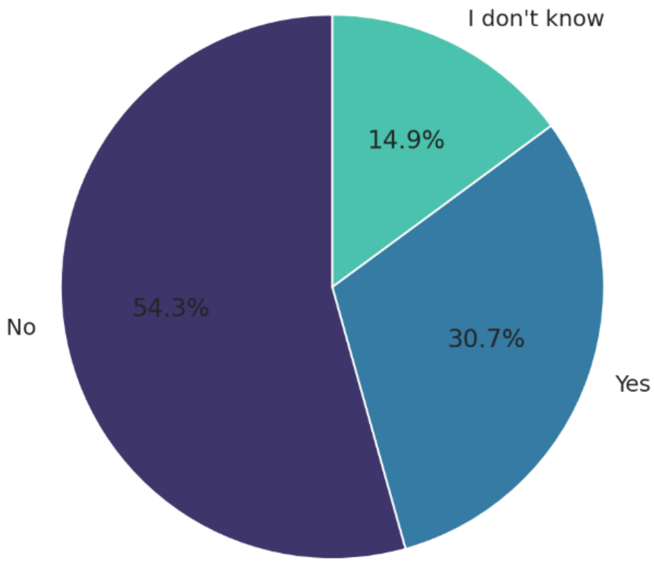


Figure 8.7
Sources of capital used by energy communities (N=105)

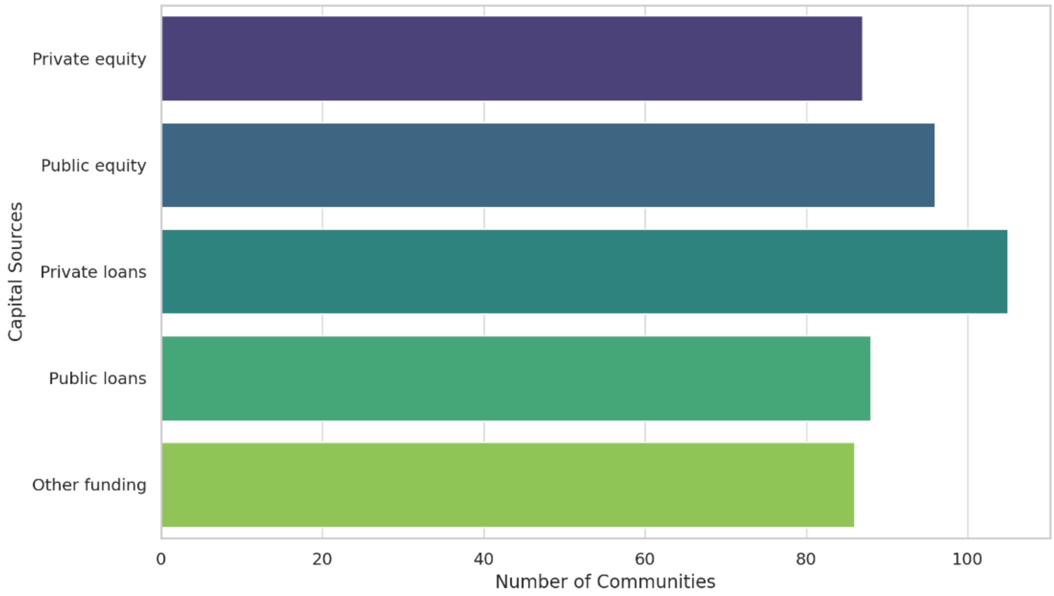


Figure 8.8
Types of financial support received by energy communities (N=264)

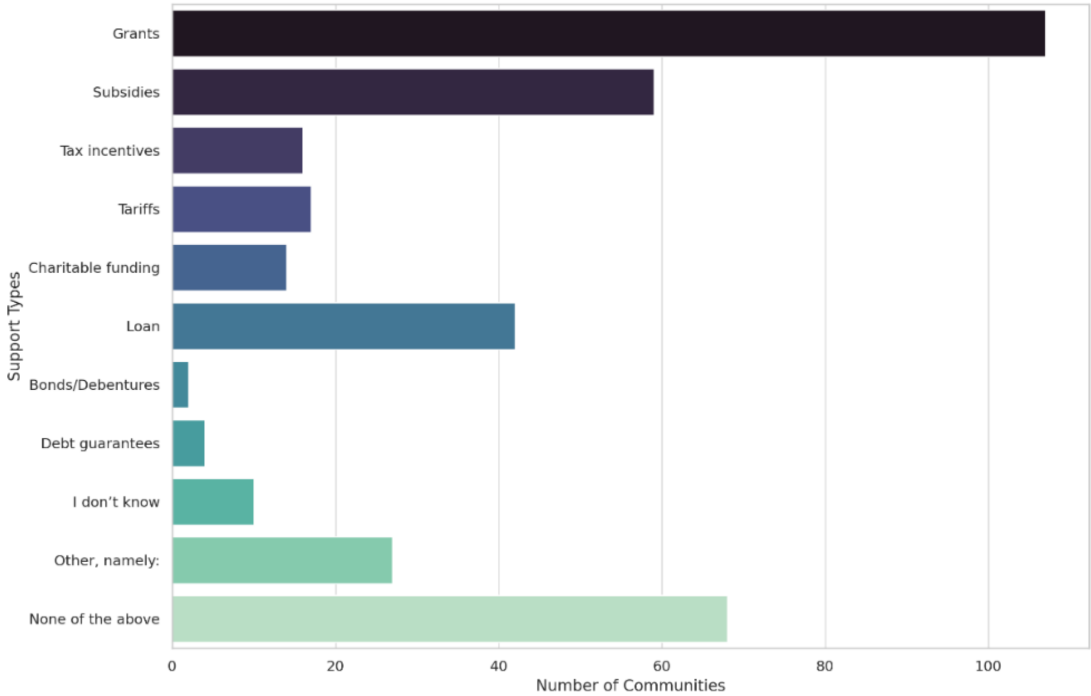


Table 8.1
Matrix of correlations of the sample of regression #8.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
Social Status household within the community compared to the wider region	1																					
Years since founding	0.053	1																				
Community is a cooperative	-0.066	0.164	1																			
Generates energy	0.031	0.141	0.242	1																		
Active within a city	-0.057	0.051	0.026	-0.075	1																	
Community has social goals	0.067	-0.18	0.003	-0.047	0.016	1																
Financial support received	0.241	-0.028	-0.043	0.11	-0.094	0.217	1															
Community engages in outreach	0.028	-0.107	-0.01	0.037	-0.018	0.288	0.2	1														
Offers financial & technical support	0.041	0.014	0.023	-0.034	-0.043	0.311	0.187	0.215	1													
Paid dividends in 2023	-0.079	0.155	0.377	0.324	-0.044	-0.103	0.05	0.048	0.069	1												
Offers lowered energy costs	0.15	-0.054	0.004	-0.039	-0.027	0.156	0.189	0.034	0.108	-0.028	1											
Energy community size > 500	0.148	0.005	0.063	-0.054	-0.115	0.309	0.267	0.252	0.37	0.009	0.309	1										
Non -financial support received	-0.122	0.169	0.358	0.114	0.246	0.122	0	0.148	0.106	0.431	-0.032	0.109	1									
Local or regional energy-poverty policy in place	-0.086	-0.114	0.008	0.152	-0.237	-0.054	0.057	0.172	-0.056	0.003	-0.008	0.029	-0.12	1								
Social Status household within the community compared to the wider region	0.129	-0.058	-0.027	0.112	0.093	0.158	0.199	0.1	0.067	-0.012	0.186	0.225	0.06	0.069	1							

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
log regional GDP per capita by NUTS2	-0.119	0.003	0.08	0.047	0.012	-0.113	-0.024	0.001	-0.176	0.179	-0.069	-0.285	0.132	0.007	-0.042	1						
(17) log_poverty_r~2	0.187	-0.079	-0.091	-0.073	0.068	0.225	0.092	0.102	0.121	-0.2	0.138	0.358	-0.095	-0.053	0.162	-0.511	1					
log EU of low-carbon projects per 100,000 citizens by NUTS2	-0.053	-0.101	-0.208	-0.269	0.042	0.189	-0.04	0.05	0.101	-0.314	0.022	0.135	-0.223	-0.01	0.028	-0.594	0.316	1				
log EU social-inclusion projects per 100,000 citizens by NUTS2	0.018	-0.102	-0.067	-0.019	0.261	0.182	-0.042	0.029	-0.004	-0.093	-0.03	0.107	0.049	-0.106	-0.004	-0.458	0.291	0.579	1			
Log of ESF and ERDF expenditure per capi-tal by NUTS2d	-0.001	-0.047	-0.058	-0.167	-0.029	0.226	-0.045	0.005	0.151	-0.102	0.142	0.179	0.015	-0.075	-0.037	-0.374	0.208	0.644	0.43	1		
Country in Western Europe	0.044	0.103	0.064	0.039	-0.113	-0.117	0.033	0.045	-0.034	0.116	0.116	0.115	0.119	0.155	0.058	0.233	0.133	-0.367	-0.454	-0.219	1	
Log of poverty rate at NUTS2 level	-0.007	-0.069	-0.191	-0.293	-0.008	0.252	0.008	0.097	0.168	-0.172	0.088	0.2	0.023	0.042	0.067	-0.283	0.279	0.667	0.392	0.782	-0.088	1

Table 8.2
Regression results of robustness checks

	(1) EU only	(2) Only EC serving households	(3) Alternative regional specification
Years since founding	.021	.021	.012
	(.022)	(.017)	(.022)
Community is a cooperative	.184	.241	.45
	(.622)	(.641)	(.614)
Generates energy	.19	.644	.042
	(.586)	(.708)	(.641)
Active within a city	-.369	.118	-.269
	(.653)	(.642)	(.652)
Community has social goals	.345	.233	-.088
Financial support received	2.978***	2.647***	2.887***
	(.834)	(.778)	(.884)
Community engages in outreach	.074	.291	.158

	(1)	(2)	(3)
	(.606)	(.699)	(.614)
Offers financial & technical support	-.046	.353	-.405
	(.639)	(.64)	(.577)
Paid dividends in 2023	-.242	-.484	-.336
	(.922)	(.782)	(.852)
Reduced energy prices for vulnerable groups	.959	.746	.852
	(.701)	(.677)	(.651)
Has a policy for vulnerable groups	.08	.314	.354
	(.525)	(.55)	(.528)
Energy community size > 500	-2.357*	-2.289*	-2.263*
	(1.384)	(1.368)	(1.267)
Non-financial support received	-1.722**	-1.45**	-1.428**
	(.687)	(.708)	(.656)
Local/regional energy-poverty policy	.175	.271	.554
	(.683)	(.662)	(.639)
Log GDP at NUTS2	-1.929*	-1.6*	-2.315**
	(.991)	(.969)	(1.011)
Log poverty rate at NUTS2	.449	1.014	.198
	(1.145)	(1.105)	(1.08)
Log EU low-carbon projects per capita	-.463*	-.359	-.25
	(.242)	(.234)	(.237)
Log EU social inclusion projects per capita	.127	.058	.216
	(.201)	(.209)	(.203)
Log of Cohesion expenditure per capita at NUTS2	-.081	-.21	.072
	(.192)	(.213)	(.192)
Country in Western Europe	.26	-.268	
	(1.041)	(1.137)	
Log of number national energy-poverty policies IEA	.308	.605	.353
	(.809)	(.827)	(.698)
EAST Europe			-1.17
			(1.322)
NORTHERN Europe			1.911*
			(1.015)
SOUTH Europe			-.969
			(.899)
WEST Europe			

	(1)	(2)	(3)
_cons	13.623	8.224	18.762
	(11.935)	(11.47)	(11.882)
Observations	174	169	191
Pseudo R^2	.268	.263	.274
	(.809)	(.827)	(.698)
Standard errors are in parentheses			
*** p<.01, ** p<.05, * p<.1			

Annex II: Chapter 3 Additional maps, figures, modelling results

- Variable description:
- **Population density** (persons per square kilometre)**:** Ratio between the annual average population and the land area. The annual average of the last five years available was considered for the modelling task (2019-2023).
- **Households net disposable income per capita**: Net disposable income is the amount of money that an individual or household has to spend or save after taxes and other mandatory charges are deducted. It includes all income from work (employee wages and earnings from self-employment), private income from investment and property, transfers between households and all social transfers received in cash including old-age pensions. Figures are expressed in million PPS, which represents a common currency that eliminates the differences in price levels between countries to allow meaningful volume comparisons of household income. The annual average of the last five years available was considered for the modelling task (2018-2022).
- **PCT patent applications per billion GDP:** Number of patents applied for at the European Patent Office (EPO), by year of filing. The regional distribution of the patent applications is assigned according to the address of the inventor. GDP is expressed in PPS. Patent data were retrieved from the Regional Innovation Scoreboard dataset (RIS). Original patent data in the RIS database have been extracted from the OECD's REGPAT database. Note that due to the degree of skewness >1, patent data were transformed using a square root transformation and then normalised using the min-max procedure (cfr. RIS 2023, pag 21-22[17]).
- **Percentage of population with tertiary education:** the data are calculated as annual averages of quarterly EU Labour Force Survey data (EU-LFS) and provide figures on the share of population from 25 to 64 years having tertiary education (levels 5-8) according to the International Standard Classification of Education (ISCED 2011).
- **Partnership total budget per capita (EUR per capita):** the data provide the total budget that regions receive as beneficiaries of European Union cross-border, transnational and interregional cooperation programmes for the programming period 2016 to 2020. Data are extracted from Keep.eu, total budget for each year is the sum of all budgets of the partnerships started or ongoing in that year. Original data were extracted in EUR per capita, we adjusted data by Purchasing Power Parity and expressed them in PPS per capita.
- **Heating & Cooling degree days:** Heating degree days (HDD) and cooling degree days (CDD) are weather-based technical indexes designed to describe the energy requirements of buildings in terms of heating (HDD) or cooling (CDD). These indexes contribute to the correct interpretation of energy consumption for cooling and heating buildings[18]. To smoothen variations among years and ensure a more stable estimate, we took the annual average of the last five years available (2019-2023) for both HDD and CDD indexes.
- **Accumulated ERDF Payment per capita (2018-2022):** The data were extracted from cohesiondata.ec.europa.eu/. The database provides regionalised (NUTS-2) annual EU expenditure data for specific EU funds - ERDF, Cohesion Fund, EAFRD/EAGGF and ESF. For this analysis we prioritised the European Regional Development Fund (ERDF) as it is designed to strengthen economic, social and territorial cohesion in the European Union. Therefore, ERDF is more likely to be related to renewable energy projects and/or energy efficiency improvements, including energy infrastructure development.
- The cohesion dataset covers the regionalisation of payments under the following programme periods:
  - 1989-1993

[17] https://research-and-innovation.ec.europa.eu/system/files/2023-07/ec_rtd_ris-2023-methodology-report.pdf

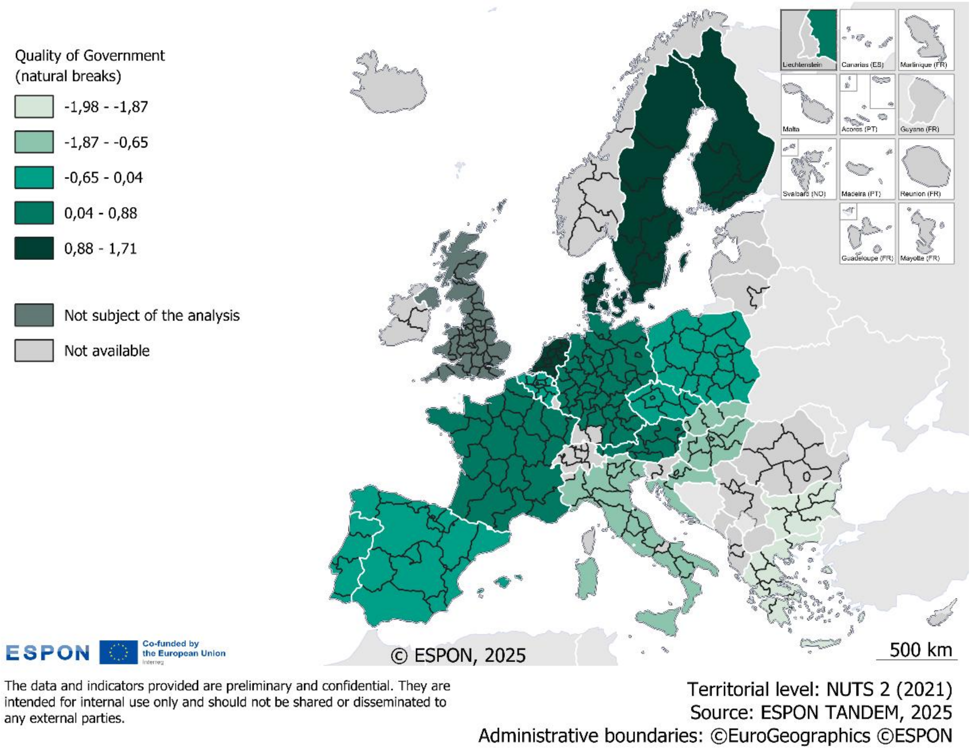
[18] https://ec.europa.eu/eurostat/statistics-explained/SEPDF/cache/92378.pdf

  - 1994-1999
  - 2000-2006
  - 2007-2013
  - 2014-2020

- Considering our dependent variable refers to the year 2024, we need to select an ERDF programme period that closely aligns with the emergence of energy community initiatives. Since earlier periods are unlikely to be linked to energy community initiatives, we opted for the 2014-2020 programme period. For consistency, we further filtered the data for annual payments made between 2018 and 2022, ensuring the retained payments are most closely aligned with our reference year of 2024.
- In the absence of a harmonised system or information to classify investments by their thematic nature across funds and programme periods, further filtering of the data by thematic natures of investments was not feasible.
- To calculate the accumulated ERDF payment, we summed up annual payments from 2018 to 2022. The original data, which was in EUR per capita, was adjusted for Purchasing Power Parity and expressed in PPS per capita. Finally, we divided the accumulated payment by the average population to obtain a per capita value.
- **Total R&D expenditure (share of GDP):** The data provides Research and Development (R&D) expenditure figures as a percentage of GDP. R&D expenditure refers to the creative and systematic work undertaken to advance knowledge, including human, cultural, and societal knowledge, and to develop new applications of existing knowledge. The data encompasses R&D expenditure across all relevant sectors, including business enterprise, government, higher education, and private non-profit sectors. To address the issue of missing data across years and regions and smoothen variations among years, we calculated the average R&D expenditure for the most recent 5-year period (2018-2022).
- **R&D expenditure in the business sector:** The indicator captures the formal creation of new knowledge within firms. Data were retrieved from the Regional Innovation Scoreboard dataset (RIS) 2023.
- **Number of energy facilities per capita:** The indicator shows the number of power plants, and is also divided in number of non-renewable (coal, nuclear, oil/gas) and renewable (geothermal, solar, wind, hydropower, bioenergy) power plants. Data were retrieved in January 2025 from Global Energy Monitor (GEM) at single power plant level and aggregated at NUTS 2.
- **Total Installed Capacity (MW per capita):** The indicator aggregates the capacity (MW) of all the power plants within a region. The installed capacity distinguishes also between non-renewable (coal, nuclear, oil/gas) and renewable (geothermal, solar, wind, hydropower, bioenergy) power. Data were retrieved in January 2025 from Global Energy Monitor (GEM) at single power plant level and aggregated at NUTS2.
- **ICT usage in households and by individuals:** Data inform on the use of Information and Communication Technologies (ICT) in households and by individuals. Specifically, the following variables were considered:
  - **Percentage of households with broadband access.** Reference year, i.e., last available year, is 2021. Data gaps for 2021 were imputed utilising data from previous years whenever available.
  - **Percentage of individuals who ordered goods or services over the internet for private use**. Reference year, i.e., last available year, is 2023. Data gaps for 2023 were imputed utilising data from previous years whenever available.
  - **Percentage of households that have internet access at home**. Reference year, i.e., last available year, is 2023. Data gaps for 2023 were imputed utilising data from previous years whenever available.
  - **Percentage of individuals regularly using the internet.** Reference year, i.e., last available year, is 2023. Data gaps for 2023 were imputed utilising data from previous years whenever available.

- **Institutional strength:** This index was extracted from Muringani et al. (2024[19]) and informs on the extent to which governments deliver public goods efficiently, impartially, and free from corruption. Therefore, this index reflects institutional effectiveness, transparency, and rule of law, which are structural factors that facilitate energy community formation by reducing bureaucratic barriers and ensuring fair regulatory frameworks. According to Muringani et al., the index is assessed using a composite index appraising citizens' perceptions of their regional government's performance across four dimensions: (i) control of corruption; (ii) rule of law; (iii) government effectiveness; and (iv) voice and accountability. This index is based on metadata from the European Quality of Government (EQI) surveys conducted in 2010, 2013, and 2017.

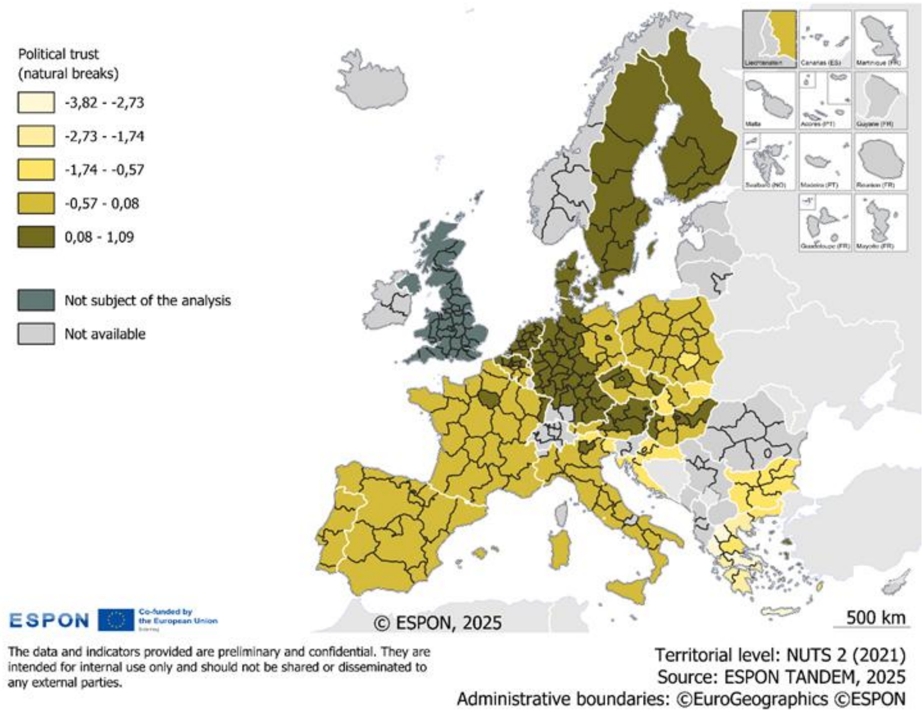
Map 8.1
Institutional strength by NUTS 2 Regions



Political trust: This index was extracted from Muringani et al. (2024) and informs on the regional level of trust in politicians and the political system. On one hand, high political trust legitimises the government and increases acceptance of its actions, leading to greater compliance with the law, improved economic policies, and enhanced third-party enforcement. In addition, political trust promotes conventional political participation, which, in turn, fosters other forms of cooperative behaviour. The index is a composite measure, constructed from individual responses from the eight waves of the European Social Survey covering the period between 2002 and 2016 and regarding trust in various political institutions, such as the United Nations, European Parliament, national parliament, politicians, political parties, the legal system, and the police.

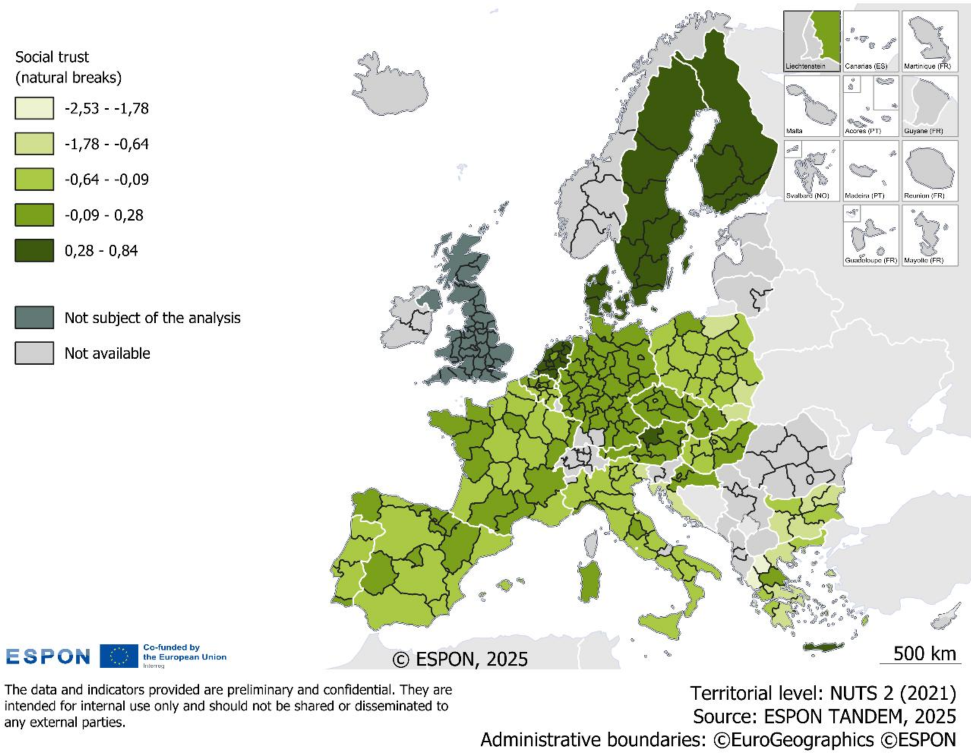
[19] Muringani, J., Fitjar, R. D., & Rodríguez-Pose, A. (2024). Political trust and economic development in European regions. *The Annals of Regional Science*, *73*(4), 2059-2089.

Map 8.2
Political trust by NUTS 2 Regions



Social trust: This index was extracted from Muringani et al. (2024) and refers to the trust individuals have in other people not familiar to them. The index is an aggregate measure constructed from individual responses from the eight waves of the European Social Survey covering the period between 2002 and 2016. In this case, responses to three trust-related questions were considered: (a) "would you say that most people can be trusted, or that you can't be too careful in dealing with people?" (trust in people or generalized trust); (b) "do you think that most people would try to take advantage of you if they got the chance, or would they try to be fair?" (fairness); and (c) "would you say that most of the time people try to be helpful, or that they are mostly looking out for themselves?" (helpfulness). Responses to these questions were rated on a scale from 1 to 10. Finally, a factor analysis was employed to construct the composite index (cfr. Muringani et al. (2024) pag 2067-2068).

Map 8.3
Social trust by NUTS 2 Regions



Numerical results

Table 8.3 shows the results of the baseline model.

Table 8.3
Baseline model results (control variables) *** p<.01, ** p<.05, * p<.1

Dependent variable: number of energy communities per 100.000 persons	(0.1) OLS	(0.2) OLS	(0.3) OLS	(0.4) OLS
intercept	-38.691 (5.918)***	-38.276 (6.702)***	-15.428 (7.463)*	-14.704 (6.685)*
Population density	-0.480 (0.107)***	-0.518 (0.111)***	-0.500 (0.133)***	-0.379 (0.110)***
Household net disposable income	3.551 (0.679)***	3.482 (0.781)***	2.807 (0.710)***	0.673 (0.762)
Percentage of population with tertiary education	1.628 (0.396)***	1.528 (0.409)***	0.993 (0.428)*	1.594 (0.388)***
Number of patents	0.077 (0.177)	0.217 (0.265)	0.734 (0.256)**	0.338 (0.212)

	(0.1)	(0.2)	(0.3)	(0.4)
Partnership total budget (cooperation level)		0.085 (0.094)	0.072 (0.104)	0.210 (0.094)*
Heating degree days (HDD)			-1.998 (0.503)***	
Cooling degree days (CDD)			-0.296 (0.089)**	
Western regions				2.598 (0.406)***
Northern regions				1.697 (0.645)**
Southern regions				2.778 (0.387)***
Observations (EU NUTS-2 regions)	240	235	229	235
Residual sum of Square	830.43	814.93	719.41	622.04
Adjusted R2	0.273	0.270	0.318	0.436
F-stat	23.42	18.33	16.17	23.57
Mean VIF	1.57	1.54	1.89	1.59
Max VIF	2.05	2.26	2.44	3.35

Table 8.4 shows the results obtained from the models integrating the variables for access to public and private finance.

Table 8.4
H1 model results – access to finance *** p<.01, ** p<.05, * p<.1

Dependent variable: number of energy communities per 100.000 persons	(1.1) OLS	(1.2) OLS	(1.3) OLS	(1.4) OLS	(1.5) OLS
Intercept	-14.248 (7.114)*	-8.698 (8.169)	-7.657 (8.161)	-11.721 (7.957)	-18.760 (9.138)*
Population density	-0.427 (0.124)***	-0.595 (0.136)***	-0.637 (0.138)***	-0.679 (0.144)***	-0.496 (0.133)***
Household net disposable in-come	2.838 (0.662)***	2.630 (0.733)***	2.513 (0.726)***	1.419 (0.813).	2.737 (0.965)**
Percentage of population with tertiary education	0.717 (0.427).	0.112 (0.469)	0.089 (0.475)	0.700 (0.494)	0.343 (0.466)
Number of patents	0.553 (0.235)*	0.209 (0.313)	0.381 (0.289)	-0.095 (0.151)	-0.119 (0.534)
Cooling degree days	-1.940 (0.466)***	-1.891 (0.480)***	-1.769 (0.464)***		
Heating degree days	-0.320 (0.081)***	-0.298 (0.090)**	-0.278 (0.090)**		

	(1.1)	(1.2)	(1.3)	(1.4)	(1.5)
ERDF Payment per capita	-0.093 (0.053).	-0.092 (0.050).	-0.095 (0.050).		
R&D expenditure (share of GDP)		0.723 (0.276)**	0.889 (0.271)**	0.825 (0.248)**	0.987 (0.411)*
R&D expenditure in the business sector index			-0.329 (0.169).	-0.349 (0.128)**	-1.615 (0.572)**
ERDF Payment per capita in Eastern regions				-0.253 (0.066)***	
ERDF Payment per capita in Western regions				0.164 (0.059)**	
ERDF Payment per capita in Northern regions				-0.058 (0.145)	
ERDF Payment per capita in Southern regions				-0.070 (0.063)	
ERDF Payment per capita x Institutional strength					0.151 (0.050)**
Observations (EU NUTS-2 regions)	234	222	222	224	194
Residual sum of Square	712.60	646.98	636.36	630.08	485.99
Adjusted R2	0.338	0.362	0.370	0.380	0.364
F-stat	17.98	16.69	15.40	14.68	16.75
Mean VIF	1.90	2.10	2.23	1.85	2.73
Max VIF	2.44	2.96	3.41	4.00	4.87

Table 8.5 shows the results addressing the relationship between energy infrastructures density and the presence of energy communities. In this case the number of installations and the total installed capacity for renewable and non-renewable energy, respectively, were considered as indicators of density of grid infrastructure facilities.

Table 8.5

H2a model results – access to energy infrastructures *** p<.01, ** p<.05, * p<.1

Dependent variable: number of energy communities per 100.000 persons	(2.1a) OLS	(2.2a) OLS	(2.3a) OLS	(2.4a) OLS	(2.5a) OLS
Intercept	-21.726 (6.746)**	-22.103 (6.774)**	-25.274 (7.585)**	-25.540 (7.836)**	-25.041 (7.396)***
Population density	0.134 (0.155)	0.181 (0.160)	-0.079 (0.130)	0.173 (0.157)	0.344 (0.172)*
Household net disposable income	2.416 (0.684)***	2.442 (0.688)***	2.912 (0.658)***	2.707 (0.722)***	2.380 (0.727)**
Percentage of population with tertiary education	1.273 (0.381)***	1.263 (0.370)***	0.955 (0.397)*	0.972 (0.404)*	1.289 (0.399)**

	(2.1a)	(2.2a)	(2.3a)	(2.4a)	(2.5a)
Number of patents	0.357 (0.202).	0.166 (0.247)	0.516 (0.209)*	0.244 (0.323)	0.187 (0.306)
Cooling degree days	-0.302 (0.079)***	-0.275 (0.080)***	-0.199 (0.096)*	-0.126 (0.101)	-0.157 (0.095)
Heating degree days	-1.196 (0.458)**	-1.098 (0.475)*	-1.461 (0.475)**	-1.028 (0.523).	-0.812 (0.489).
Total number of energy facilities (per capita)	0.909 (0.177)***				
Number of non-renewable energy facilities (per capita)		-0.247 (0.161)			0.238 (0.275)
Number of renewable energy facilities (per capita)		0.822 (0.162)***			0.595 (0.170)***
Total Installed Capacity (per capita)			0.589 (0.151)***		
Total non-renewable installed capacity (per capita)				-0.103 (0.041)*	-0.170 (0.072)*
Total renewable installed capacity (per capita)				0.474 (0.114)***	0.248 (0.109)*
Observations (EU NUTS-2 regions)	234	234	234	234	234
Residual sum of Square	617.63	603.20	662.82	615.43	569.19
Adjusted R2	0.426	0.437	0.384	0.426	0.464
F-stat	25.71	23.61	21.76	22.58	21.17
Mean VIF	2.18	2.09	2.11	2.20	2.82
Max VIF	2.67	2.71	2.60	2.80	3.59

Table 8.6 shows the results addressing the influence of ICT infrastructures availability and use on the development of energy communities.

Table 8.6
H2b model results – access to ICT infrastructures *** p<.01, ** p<.05, * p<.1

Dependent variable: number of energy communities per 100.000 persons	(2.1b) OLS	(2.2b) OLS	(2.3b) OLS	(2.4b) OLS
intercept	-47.459 (14.057)***	-30.694 (7.710)***	-44.784 (18.827)*	-44.260 (14.740)**
Population density	-0.274 (0.131)*	-0.213 (0.127).	-0.222 (0.123).	-0.226 (0.126).
Household net disposable income	3.951 (0.728)***	3.968 (0.717)***	3.835 (0.769)***	3.784 (0.739)***
Percentage of population with tertiary education	0.120 (0.477)	0.188 (0.593)	0.224 (0.497)	0.062 (0.547)

	(2.1b)	(2.2b)	(2.3b)	(2.4b)
Number of patents	0.623 (0.247)*	0.589 (0.238)*	0.639 (0.247)*	0.641 (0.241)**
Cooling degree days	-0.460 (0.075)***	-0.431 (0.077)***	-0.453 (0.076)***	-0.420 (0.077)***
Heating degree days	-1.548 (0.424)***	-1.559 (0.444)***	-1.560 (0.435)***	-1.539 (0.433)***
Percentage of households with broadband access	4.520 (3.044)			
Percentage of on individuals who ordered goods or services over the internet for private use		0.707 (1.024)		
Percentage of households that have internet access at home			4.006 (4.627)	
Percentage of individuals regularly using the internet				4.087 (3.315)
Observations (EU NUTS-2 regions)	162	161	161	161
Residual sum of Square	357.55	363.69	363.07	360.89
Adjusted R2	0.535	0.522	0.523	0.526
F-stat	27.46	25.97	26.05	26.34
Mean VIF	1.99	2.28	2.07	2.21
Max VIF	2.61	2.88	2.62	2.59

Table 8.7 presents the results of our analysis on the impact of political and institutional context on energy communities development

Table 8.7
H3 model results – Political and Institutional context *** p<.01, ** p<.05, * p<.1

Dependent variable: number of energy communities per 100.000 persons	(3.1) OLS	(3.2) OLS	(3.3) OLS	(3.4) OLS
intercept	-33.278 (8.197)***	-21.133 (7.320)**	-31.767 (7.335)***	-33.696 (6.951)***
Population density	-0.387 (0.136)**	-0.431 (0.103)***	-0.640 (0.127)***	-0.465 (0.146)**
Household net disposable income	4.426 (0.789)***	1.591 (0.800)*	3.134 (0.860)***	3.217 (0.786)***
Percentage of population with tertiary education	0.807 (0.462).	2.018 (0.339)***	1.378 (0.428)**	1.525 (0.422)***
Number of patents	-0.300 (0.475)	-0.185 (0.296)	-0.290 (0.453)	-0.324 (0.410)
Cooling degree days	-0.221 (0.127).			

	(3.1)	(3.2)	(3.3)	(3.4)
Heating degree days	-1.182 (0.592)*			
Institutional strength	0.420 (0.329)		0.218 (0.281)	0.086 (0.264)
Institutional strength in Eastern regions		1.090 (0.502)*		
Institutional strength in Western regions		2.239 (0.206)***		
Institutional strength in Northern regions		1.003 (0.344)**		
Institutional strength in Southern regions		-1.763 (0.250)***		
Political trust	-1.851 (0.560)**	-0.507 (0.184)**		-1.303 (0.404)**
Political trust in Eastern regions			1.345 (0.989)	
Political trust in Western regions			3.526 (0.984)***	
Political trust in Northern regions			-0.010 (1.251)	
Political trust in Southern regions			-1.826 (0.444)***	
Social trust	1.165 (0.608).	0.323 (0.315)	0.340 (0.422)	
Social trust in Eastern regions				2.848 (0.725)***
Social trust in Western regions				5.578 (1.072)***
Social trust in Northern regions				2.338 (0.964)*
Social trust in Southern regions				-0.523 (0.523)
Observations (EU NUTS-2 regions)	206	206	206	206
Residual sum of Square	485.54	298.31	357.59	361.43
Adjusted R2	0.396	0.627	0.553	0.548
F-stat	15.95	35.49	26.37	25.88
Mean VIF	3.15	2.67	2.32	2.26
Max VIF	5.63	14.00	7.37	6.12

Annex III. Case studies

The table below provides an overview of the 20 energy communities and energy community-alike initiatives with the respective local practices that were studied. The table is followed by a brief description of each community.

Table 8.8
Overview over Case Studies

Name of Community	Country	Local Practices studied	REC/CEC[20] alignment
DuCoop cvba	Belgium	Community Distribution	Yes
CER Telheiras/Lumiar	Portugal	Organising community discussions groups Measures to include vulnerable groups as members	Yes
Ecotxe	Spain	E-Mobility	No
Ecovision	Ireland	Organising community discussion groups and extensive coordination	Yes
Otterbeek	Belgium	Municipal-led energy sharing	Partly[21]
CeBASE	Italy	Energy sharing carried out by private enterprise Energy-as-a-service (EaaS)	Yes
Skawina Energy Cooperative SES	Poland	Municipal-led energy sharing	No
ENERKOM Opavsko	Czechia	Municipal-led energy sharing Fostering territorial development via an integrated approach	Yes
energie malters	Switzerland	E-Mobility	Yes
Grenzstrom Vindtved	Germany & Denmark	Cross-border energy community Social inclusion fostered through youth engagement and education Focus on engendering environmental benefits	Yes
Green Hrastnik	Slovenia	Leadership from local political representatives Provision of municipal buildings for renewable energy activities at low/no cost	Yes
Coöperatie doarpsmûne Reduzum	The Netherlands	Organising community discussion groups and extensive coordination Fostering territorial development via an integrated approach	Yes

[20] Alignment with the definitions of Renewable Energy Community or Citizen Energy Community in EU Directives 2018/2001 (REDII) and 2019/944 (IEMD) or their respective national definitions.

[21] The Otterbeek project is a partnership between the city and Klimaan, an energy community aligning with the REC/CEC definitions.

Name of Community	Country	Local Practices studied	REC/CEC[20] alignment
Volterra	Belgium	Provision of municipal buildings for renewable energy activities at low/no cost	Yes
ENERCOOP cooperative	Spain	Energy-as-a-Service (EaaS)	Partly[22]
EGTC DUERO-DOURO and the EFIDUERO cooperative	Spain & Portugal	Cross-border energy community	No
Solarity REC	Greece	Measures for the inclusion of vulnerable groups	Yes
ZEZ Sun	Croatia	Leadership from local political representatives Provision of municipal buildings for renewable energy activities at low/no cost	Yes
Balenyà Sostenible	Spain	Provision of municipal buildings for renewable energy activities at low/no cost E-Mobility	Yes
REC Pilot Project in Clatra	Portugal	Focus on engendering environmental benefits	Yes
Wattnu	The Netherlands	Social inclusion fostered through education and/or youth engagement	Yes

DuCoop cvba, Ghent (BE)

DuCoop cvba is an energy community located in the North of Ghent (Belgium) and has been supplying district heating and wastewater collection services to the newly developed neighbourhood De Nieuwe Dokken (engl.: The New Docks) since 2020. In this environment, DuCoop is a key player as it is the sole heat supplier for the 400 houses that will form the neighbourhood of De Nieuwe Dokken. This is done through their own community-owned district heating network and with residual heat from a neighbourhood factory.

Setting up an energy community in a newly urbanised area following a tendering procedure by the city of Ghent allowed them to become the sole district heating supplier in the new neighbourhood. Every owner or tenant of one of the houses automatically becomes not only a customer of DuCoop's services but also a member of the cooperative. This approach allowed the energy community to diversify the membership base, also reaching residents with limited initial interest in energy communities. This was also made possible as the community offers energy prices following tariffs set by the city of Ghent. Moreover, DuCoop's low entrance hurdles – both in financial terms and in time commitment – allow individuals to join the energy community with a relatively minimal upfront cost and gave DuCoop a broad and solid membership base from the outset.

CER Telheiras/Lumiar, Lisbon (PT)

The CER Telheiras/Lumiar energy community initiative emerged in 2021 in the Telheiras neighbourhood of Lisbon, Portugal, and installed 13 photovoltaic panels on the roof of a community centre that are providing electricity for the 17 members (households) of the energy community. The energy community is managed by the non-profit association Viver Telheiras. It exemplifies an inclusive and sustainable governance model that integrates energy-poor families into its renewable energy initiatives through the provision of services at reduced fees. The community has actively involved its members in important decisions for the energy community through different means, for example through regular open coordination meetings. This has been essential to create a sense of empowerment within the energy community. The energy community generates solar energy,

[22] ENERCOOP started from the energy community COMPTEM and now supports emerging energy communities aligning with REC/CEC definitions but no longer fulfils the full criteria itself.

distributes it in an equitable manner among members, and employs smart meters for the precise allocation of energy and the reduction of costs. The project also exemplifies innovative strategies, including the utilisation of an NGO framework, volunteer coordination, and inclusive membership criteria, which collectively enhance social, economic, and environmental impacts.

Ecotxe, Mallorca (ES)

ECOTXE is a cooperative of consumers and end-users based in Palma (Mallorca, Spain) that offers hourly rental services of shared electric cars. The carsharing service allows users to book a car for a period of time via internet or mobile phone, using the vehicle at the reserved times and paying only for the time used. Ecotxe does not fully comply with all requirements of an energy community as per both the Spanish legislation and EU Directives. Nonetheless, ECOTXE shares a set of values and characteristics that are typically common in community energy projects and schemes such as citizen participation, community engagement, environmental goals. ECOTXE is also characterised by a solid bottom-up approach in its decision-making system and therefore its governance model resembles the one typical of an energy community: the cooperative structure and principles. Energy communities keen in developing e-mobility services can learn from ECOTXE's path from a community-led initiative operated by volunteers to a mature car-sharing system. Given the absence of a carsharing provider in the territory, the cooperative pioneered the way for this type of services in the area. A key determinant of success was the close collaboration with the local authorities, particularly regarding urban planning.

Ecovision, County Tipperary (IE)

Ecovision is a non-profit organisation based in County Tipperary (Ireland) that emerged as a local economic development initiative and has been providing energy efficiency services to its members for over 10 years. Since 2021, it has expanded its portfolio and now operates a one-stop-shop for the whole residential housing renovation, renovation process, assisting its members with all the necessary steps throughout the process. Ecovision, originally started as a local energy community, has now emerged into an "umbrella energy community" made up of 15 local energy communities and its activities have been consistently supported by national grants such as those from the Sustainable Energy Authority of Ireland (SEAI).

Ecovision is characterised by its openness, democratic participation and inclusiveness. Since its inception, the community has placed a significant emphasis on engaging with its members, with numerous communication and dissemination activities. Key players include the SEAI, local development companies, the Tipperary Energy Agency and financial partners such as Clann Credo, who provide vital bridging finance. Funding remains a critical enabler, with €18 million invested since inception, primarily through SEAI grants. Ecovision's business model includes income from carbon credits and a community fund for energy-related projects. Social benefits include job creation, community empowerment and reduction of energy poverty, while environmental impacts include significant energy savings and carbon reduction. Ecovision exemplifies replicable and innovative practices in citizen-led regeneration, collaborative governance and strategic stakeholder engagement, providing a scalable blueprint for energy communities in Ireland and beyond.

Otterbeek, Mechelen (BE)

The Otterbeek project was launched in 2021 in the Belgian city of Mechelen with the aim of addressing energy poverty, as promoting a just transition has become an increasingly challenging task. Since its inception, over 200 apartments in the neighbourhood have been fully equipped with photovoltaic panels.

The project is the result of a well-established collaboration between three key stakeholders: (1) the City of Mechelen, (2) the energy community KLIMAAN, and (3) the publicly managed social housing organisation Woonland. This case study exemplifies an inclusive and sustainable governance model that places vulnerable groups at its core. The municipality has been instrumental in the project's development, with its design and implementation stemming from a public tender they issued. This process enabled the recruitment of KLIMAAN as the leading entity to execute the project.

The structured collaboration framework, alongside a supportive environment for developing renewable energy-sharing pilot projects like Otterbeek, has been instrumental in its success. Establishing a viable business model remains a complex challenge, but KLIMAAN's adaptability highlights the necessity for resilient approaches in innovative projects such as Otterbeek. In the long term, the project aspires to extend its benefits to households without solar panel installations in a similar manner.

CeBASE, Florence (IT)

CeBASE, an energy community based in Florence, Italy, was established through collaboration between a PhD graduate and the regional multi-utility company Convoi. It builds on years of feasibility studies assessing the possibility of setting up a local service provider supporting citizens and municipalities in energy related matters. Inspired by Solidarity Purchasing Groups, CeBASE promotes energy sustainability, active citizenship, and affordable services. Operating as a non-profit association, CeBASE supports diffused self-consumption schemes through the work of 16 volunteers. Members enjoy benefits such as reduced energy costs, access to feasibility studies for siting renewable installations, and guidance on financial and bureaucratic processes.

The community has achieved notable social, environmental, and economic impacts, fostering cooperation across diverse groups, advancing the energy transition, and addressing energy poverty through innovative and inclusive practices. By negotiating favourable terms with partners and engaging in public education, CeBASE exemplifies a scalable model for community-driven energy solutions. Its most significant achievements, including volunteer dedication, collaborative governance, and partnerships with public authorities, offer a replicable framework that can be adapted to other contexts.

CEBase, in collaboration with private companies, is able to offer its members a variety of services that are ranging from free techno-economic feasibility studies, discounted prices, electricity supply, energy consultancy services, support with bill payment for those affected by energy poverty and discounted services through partner collaborations. All these services fall within the category of Energy-as-a-Service, one of the key local practices showcased in this case study. Furthermore, the majority of these services are carried out in collaboration with private companies, who also organise energy sharing activities, showcasing a novel combination of private companies and energy communities to offer different energy services.

Skawina Energy Cooperative / Spółdzielnia Energetyczna Skawina-SES, Skawina (PL)

The Skawina Energy Cooperative (SES) is a municipally initiated energy community involving three public stakeholders: the Skawina Municipality, the Regional Museum, and the Public Library. Situated in the Małopolskie voivodship near Kraków, the municipality faces significant energy transition challenges, including the planned closure of the local coal-fired CEZ power plant. The cooperative emerged as a strategic response to stabilise energy costs for public buildings and increase the share of renewable energy sources in local energy generation.

SES is designed to be a financially efficient structure, with low operating costs covered by the municipality and revenues from energy generation. Its longer-term vision includes diversifying renewable energy sources but expansion is constrained by national legal frameworks, including requirements around energy production-consumption balance, and public procurement rules, all of which complicate the inclusion of private or household members. Consequently, the cooperative remains limited to public institutions. Nonetheless, the municipality is considering establishing a separate cooperative for private stakeholders, as proposed by the mayor during local elections. In summary, SES represents a proactive and cost-effective local response to the energy transition, showcasing how a municipality can take a leadership role in establishing a stable, renewable energy system. The cooperative demonstrates that, even within tight financial and regulatory constraints, significant progress can be made through strategic planning, internal resource use, and focused public-sector cooperation.

ENERKOM Opavsko, Opavsko (CZ)

ENERKOM OPAVSKO is an energy community in the Czech Republic (one of the first ones), established to consolidate and advance sustainable energy initiatives in the Opava region, which encompasses nearly 150,000 inhabitants. Emerging from a long-term strategy launched in 2008, the community sought to address energy challenges, including dependence on fossil fuels and energy poverty, while contributing to the global energy transition. The formal establishment of ENERKOM OPAVSKO was motivated by the need to better organise energy-saving and renewable energy activities under a unified concept of community energy. ENERKOM OPAVSKO operates as an association, with a governance model emphasising democratic principles, equal participation, and reinvestment of profits into community development. The creation of the community was initiated by the MAS (LAG) Opava, which was a key success factor (diverse member basis, long-term experience in sustainable development).

energie malters, Malters LU (CH)

energie malters is an energy community operating in Malters, Switzerland, dedicated to advancing local renewable energy and sustainable mobility solutions. Established in 2019, the cooperative was founded in response to a municipal decision against installing solar panels when renovating a local sports hall, leading local residents to take collective action to invest in photovoltaic (PV) projects. Since its inception, energie malters has successfully installed solar panels on the communal sports hall and two cooperative apartment buildings, with plans for future expansions. The cooperative operates under a self-consumption model, selling electricity to tenants and the municipality while feeding surplus energy into the grid. In addition to solar energy, energie malters has expanded into sustainable mobility, offering an electric car and cargo bike-sharing service to reduce reliance on private vehicles. The cooperative is governed democratically, ensuring broad community participation, and it benefits from strategic partnerships with municipal authorities, private investors, and local businesses. Despite legal and financial challenges, the cooperative continues to thrive and aims to make Malters a "plus-energy municipality".

Grenzstrom Vindtved, Ellhöft (DE/DK)

Grenzstrom Vindtved is a cross-border energy community located at the German Danish border in Nordfriesland and stands as a pioneering example of how renewable energy initiatives can foster both local and cross-border social cohesion, environmental sustainability, and economic development. Established in 2005, this community-driven wind energy project is a collaboration between German and Danish residents, who together own and operate a wind farm on the German side of the border. The project's success has been grounded in its innovative governance structure, local partnerships, and dedication to social, environmental, and economic impacts, all of which have contributed to its long-term viability.

The energy community's emphasis on cross-border collaboration with shared ownership and joint investment between neighbouring communities have helped to overcome regulatory challenges and prevent Danish opposition, while fostering ties between the regions on both sides of the border. Moreover, the project's commitment to community engagement that is evidenced by its transparent decision-making processes, regular consultations, and involvement of local residents in the planning stages, has created a sense of trust and inclusion, ensuring that both shareholders and non-shareholders benefit from the wind farm's operations. This was further amplified by the role of energy communities in promoting awareness and understanding of renewable energy and its importance through an accessible wind turbine, which creates a tangible and hand-on experience of renewable energy, as well as the energy community's biodiversity compensation areas that complements its activities with a holistic understanding of sustainability.

Grenzstrom Vindtved has created local job opportunities, boosted regional economic growth, and provided a model for equitable land lease payments, where both landowners and the broader community share in the benefits of the wind farm. This multifaceted approach has not only contributed to the community's energy goals but has also helped improve social cohesion, create jobs, and ensure the region's long-term sustainability.

Green Hrastnik, Hrastnik (SI)

The Green Hrastnik energy community initiative emerged in 2021 in the municipality of Hrastnik, Slovenia. It was established through a collaborative effort between the local government, the environmental NGO 'Focus', and the residents of Hrastnik. The project saw the installation of a 300-kW photovoltaic power plant on the roof of Hrastnik Primary School, providing electricity to 30 members, including households, public institutions, and businesses. The energy community is managed by the cooperative Green Hrastnik, embodying an inclusive and sustainable governance model. By enabling collective self-consumption, it reduces grid congestion and empowers consumers to become prosumers, reducing reliance on fossil fuels. The initiative exemplifies a public-commons partnership, fostering environmental sustainability and community solidarity. It has actively involved its members in key decisions through regular open meetings, creating a sense of empowerment within the community. The innovative approach has set a precedent for similar projects across Slovenia, enhancing social, economic, and environmental impacts.

Coöperatie doarpsmûne Reduzum

Doarpsmûne Reduzum, a pioneering energy community in the Frisian countryside of the Netherlands, stands out for its strong local ownership and deep integration into village life. One of the cornerstones of its success is the community-oriented reinvestment of financial dividends. Instead of distributing profits to individuals, funds are redirected to support local initiatives - ranging from clubs and associations to sustainable transport and shared mobility services. This approach fosters broad community engagement, and has even led to projects like the shared electric vehicle - an idea proposed and supported by residents.

The development of the cooperative was made possible in part by strategic public support, which provided crucial funding to finance the replacement of the original wind turbine. Since then, the community has expanded its activities beyond energy production to support local citizens through partnerships with schools, churches, housing associations, and volunteer networks. These collaborations enable the cooperative to contribute to broader objectives. By embedding energy generation within a wider ecosystem of social value, Doarpsmûne Reduzum builds engagement and supports a shared sense of ownership, reinforcing the social and cultural fabric of the villages.

Volterra, Meetjesland (BE)

The Volterra energy community applies the local practice of utilising municipal buildings in collaboration with the municipality of Eeklo. The arrangements were made possible through Flemish Energy Company (VEB), which offers an enabling framework for third-party financing of solar panels for municipalities by energy communities. Volterra, together with four other cooperatives, was selected to operate in multiple municipalities under this scheme. Municipalities can sign up for participation, and the energy communities take care of delivering the project.

Within the partnership, Volterra specifically targets the smaller municipal projects. By financing solar panels and supplying locally used electricity, Volterra helps reduce costs for municipalities—especially because self-consumption results in lower excise and distribution charges. The cooperative itself incurs no additional costs, and even small projects tend to be profitable. This model allows Volterra to support municipalities while simultaneously offering value to the local members.

When municipalities actively support these initiatives, it enhances visibility and community participation. This effect is two-fold; citizens without suitable rooftops are offered a chance to invest in sustainable energy through the municipality and the cooperation. Secondly, it stimulates interest from real-estate owners who may also want to allow their rooftops to be used for solar panels by the cooperative.

While the implementation has generally gone smoothly, Volterra did face some initial hurdles, particularly in securing the initial approval from VEB. Close collaboration with other cooperatives was essential in navigating this stage. Today, municipalities increasingly reach out to partner with the energy community. One of the key incentives for them is that they do not need to go through a tendering process, and the third-party financing model means the investment does not impact their financial position. Moreover, this approach helps promote citizen participation in the energy transition. Municipalities typically do not hold shares in the cooperative, but their involvement as stakeholder play a vital role in project success.

The availability of municipal roofs positively contributes to the success of these projects, in additional to the specific electricity usage of a specific building. The profitability remains comparable to similar arrangements with companies or individuals, particularly when the energy generated is used for self-consumption.

ENERCOOP Cooperative, Crevillent (ES)

Enercoop, a century-old energy cooperative based in Crevillent, Spain, exemplifies how local, community-led models can drive the energy transition. Through its innovative Energy-as-a-Service (EaaS) model, Enercoop installs and manages solar PV systems—mainly on public buildings—allowing residents to access clean energy without upfront investment. The cooperative shares energy cost savings with users while reinvesting in infrastructure, fostering energy independence and reducing CO_2 emissions. Governed democratically on a "one member, one vote" basis, Enercoop empowers citizens to co-own and co-manage their energy future. Its role in launching Spain's first local energy community and participating in EU-funded innovation projects (like MERLON, STREAM, and COMMUNITAS) highlights its leadership in decentralised, smart grid-based energy systems. The cooperative's model promotes inclusivity, affordability, and resilience, making renewable energy accessible to all, including vulnerable groups. Enercoop's strong ties with municipalities, use of smart grid tech, and involvement in over 30 energy communities across Spain show that its approach is highly replicable and scalable across Europe.

EGTC DUERO-DOURO and the EFIDUERO cooperative, ES-PT border

This case study elaborates on how the local practice of a Cross-border (quasi-) energy community enabled the realisation of a local community energy project in the region of Duero-Douro at the border between Spain and Portugal. The key actor in this case is the European Grouping of Territorial Cooperation of Duero-Douro, an entity that has the mandate of representing the citizens of this area as well as implementing policies and activities with the objectives of helping this cross-border territory. The EGTC was able to realise a European Energy Cooperative named "Efiduero SCEL" with the objective of distributing the electricity amongst the municipalities, citizens, SMEs located in the cross-border territory. The set-up is very peculiar, encompassing PV plants owned by the EGTC, producing the energy then distributed by the cooperative. All in view of contributing to the energy transition of the territory and achieving its energy independence as well as securing its electricity supply. The following pages detail how the EGTC realised the project, set-up the entity and dealt with the specific cross-border barriers faced.

This Case Study yielded a series of key takeaways such as that strengthening EGTCs and municipal cooperation is essential for effective cross-border energy governance, requiring stronger mandates and streamlined regulations. Also, flexible legal frameworks and harmonised permitting procedures will facilitate smoother energy trading between regions. Furthermore, increased financial support through EU programmes, improved grid access, and incentives for decentralised projects will enhance cross-border energy resilience. Encouraging innovation, cooperative-led initiatives, and the expansion of smart grids will drive socioeconomic benefits and long-term energy independence in border regions.

Solarity REC, Nea Ionia (EL)

Solarity K.A.E. (Renewable Energy Community of Limited Liability) is a citizen-led energy cooperative based in Attica, Greece. Founded in 2023 by 30 members, the organisation has rapidly developed into a community with 92 members. Within just 20 months of its establishment, Solarity successfully implemented a 400 kWp photovoltaic park operating under the virtual net metering model, which now serves household electricity connections of its members.

The primary motivation behind Solarity's creation was to provide its members with access to affordable, renewable energy. The community operates within the framework of the social and solidarity economy, with explicit objectives to tackle energy poverty and promote energy sustainability. Solarity strives to set an example of how energy communities can be vehicles for social impact while delivering economic benefits to members through reduced energy costs. What distinguishes Solarity is its commitment to addressing energy poverty and its inclusive approach. The cooperative has incorporated provisions in its statutes to support vulnerable households by allocating a portion of the energy produced to those in need. Additionally, Solarity is exploring ways to expand its activities to include e-mobility and energy storage solutions, with plans to share surplus energy with the broader community.

Solarity faces challenges common to energy communities in Greece, particularly regarding recent legislative changes that have affected the virtual energy metering model and introduced virtual energy billing with several ambiguities. Despite these obstacles, the energy community has demonstrated remarkable effectiveness in its implementation timeline and continues to seek ways to expand its social impact while developing a sustainable business model.

This case study examines Solarity's approach to inclusiveness and its efforts to address energy poverty, providing insights into how energy communities can incorporate social objectives within their operational frameworks.

ZEZ Sun, Križevci (HR)

ZEZ Sun, established in 2024 by the ZEZ cooperative in Križevci, Croatia, has pioneered renewable energy community-led projects in the region. The functioning public-private agreements with the municipality of Križevci, coupled with the fast-track crowdfunding campaigns allowed the installation of a 200kWp solar PV system on the city market's roof. This project, funded by 127 cooperative members who raised €140,000, benefits cooperative members and strengthens community engagement. Despite the existing institutional barriers posed on the establishment of energy-sharing schemes, ZEZ Sun was able to define an operative business model. The proactive support of the municipality and the mayor has been crucial in overcoming financial and administrative barriers, promoting public participation, and sustaining the momentum of energy community initiatives. The city of Križevci fostered the work of the energy community thanks to the inclusion of social components in the evaluation criteria. As ensuring the active engagement of citizens in the PV installation was highly valued in the tender process, ZEZ Sun was able to win the bid at a competitive price. Based on the agreement signed in the tender, the cooperative pays the rent with 7% of its monthly revenue, ensuring a shared risk between the cooperative and the municipality. Moreover, Križevci's Mayor had a pivotal role in the promotion of an enabling framework for energy communities, and he contributed to raise ZEZ Sun's visibility in the international arena, while building trust across national citizens which may otherwise be reluctant to participate in an energy community. Being a pioneer energy community in Croatia is challenging due to the lack of awareness across citizens and the limited enabling framework, so having trusted public player, as well as an experienced cooperative on the lead is key. As of today, ZEZ Sun is expected to be connected to the grid by 2025, utilising a separate connection point to the grid.

Balenyà Sostenible, Barcelona (ES)

Balenyà Sostenible has established itself as a role model for community-driven energy transition, combining environmental sustainability with social responsibility and local economic development. Since 2021, the cooperative Balenyà Sostenible has gathered 170 members who consolidated a mature energy community which offers affordable renewable energy and services of electromobility among other services. The city council of Balenyà had a pivotal role in the establishment of the energy community, as it ceded public-owned buildings for photovoltaic installations in its rooftops to generate electricity for its distribution across the different members of the community. Fighting energy poverty is at the core of the aim and scope of the Energy Community, which is why a unique agreement was made to offer vulnerable family's affordable renewable energy at a lower price. To reach neutrality in the municipality, reducing CO_2 emissions related to transport is crucial, which is what motivated the installation of six electric charging stations distributed around the community to promote the usage of e-vehicles.

REC Pilot Project in Culatra, Culatra Island (PT)

The Culatra pilot project on a Renewable Energy Community was initiated in 2023 under the aegis of the Culatra 2030 initiative, with the objective of enhancing energy resilience and sustainability on Culatra Island, Portugal through solar power, smart grids, and energy efficiency measures. This initiative incorporates advanced new energy management solutions and engages local stakeholders through participatory governance initiatives and workshops.

The REC pilot project has been particularly focused on engendering environmental benefits, and has had a considerable impact on the local community, with benefits including social, economic, and environmental contributions. Significantly, the establishment of the C-COOP cooperative by Culatra residents with the objective of promoting the energy transition on the island has fostered inclusivity, enabled community-driven energy initiatives, and contributed to the alleviation of energy poverty. This cooperative was selected as the management authority of the energy community. In terms of specifics environmental impact, the REC has enhanced energy independence, reduced power outages, and improved sustainability awareness through education and participatory governance. Furthermore, the energy community has been in close collaboration with the natural protection authorities, thereby establishing a positive example of how energy communities can also contribute to nature conservation.

The establishment and development of the Culatra Pilot Project REC has been characterised by a number of key success factors, including the extensive stakeholder engagement and the implementation of a participatory economic model, ensuring that all citizens are cognisant of both their individual contributions to the community and the returns they receive.

Wattnu, Gooise Meren (NL)

Wattnu is an energy community in Gooise Meren that builds on the collective efforts of volunteers, municipal collaboration, and an inclusive community engagement, for a successful and bottom-up energy transition. At its core, Wattnu empowers residents to actively engage in energy-saving initiatives and adopt renewable energy practices. This includes awareness raising, advice on energy efficiency, collective investments in renewable energy, and most recently also district heating. Particularly notable in these efforts are Wattnu's "energy coaches", volunteers who are trained by the energy community and support residents, including energy-poor households, by providing tailored advice and guidance on sustainable investments, energy efficiency, and demand management to reduce energy consumption. Through education, including school programs and one-on-one support, Wattnu promotes energy efficiency, environmental consciousness, and sustainable practices within the community. This approach reduces energy consumption, builds resilience among vulnerable groups, and strengthens local bonds. As such, it both fosters social cohesion and personal empowerment. This practice is enabled in particular by over 120 motivated and trained volunteers, through which the energy community is leveraging local knowledge and expertise as well as a strategic partnership with the Municipality of Gooise Meren, which ensures long-term financial security and broader outreach, making the initiative a model for other municipalities and regions in the Netherlands and Europe.

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