GENTE Future Energy Community Scenarios

Deliverable 3.1

SUMMARY

This report presents the results from an investigation into the principal drivers for the growth and decline of community-focused energy initiatives in Europe. A set of future energy community scenarios based on the factors that enable energy community success is developed. In doing so, this report explains the context of the GENTE toolkit, and helps inform the development of technology, modes of community engagement, and recommendations for exploitation that form important parts of the GENTE project.

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Abstract

The ERA-Net GENTE project aims to develop a distributed governance toolkit for local energy communities (LECs) and, more generally, energy communities (ECs). This toolkit will include advanced digital technologies such as internet of things (IoT), distributed ledger technology (DLT), edge processing, and artificial intelligence (AI) for autonomous energy resource management within and across LECs and for flexibility provisions to energy networks. The toolkit will also consider social processes and include a set of guidelines and methods for developing new LECs with potential end-users and further stakeholders.

Energy communities are poised to play a significant role in Europe's energy transition, with projections indicating that collective initiatives such as ECs could contribute up to 37% of renewable energy by 2050 [1]. However, the history and evolution of this type of community, along with the factors influencing their success, remain complex and diverse. This report, based on research conducted as part of Work Package 3 (WP3) of the GENTE project, investigates the dynamics of ECs, encompassing their definitions, historical trends, regional variations, and future prospects.

The research examines the historical growth and decline of ECs, revealing the interplay between economic, legal, and regulatory factors. Regional disparities in EC adoption are linked to differences in regional policies, financial support, and cultural attitudes. Key factors are identified shaping the enabling environment for the growth of new and existing ECs, including government incentives; stable, long-term supportive policies; and suitable financial support. It also highlights the importance of collaboration, professionalisation, and commercialisation of ECs for their sustainable development.

The report concludes by presenting eight Future Energy Community Scenarios (FECS) predicting outcomes based on various contextual factors from the enabling environment and future evolution insights. These scenarios aim to inform the development of the GENTE energy community toolkit, guiding technology development, community engagement strategies, and recommendations for effective exploitation. Overall, this report provides valuable insights for the GENTE consortium into the past, present, and future of energy communities, offering a roadmap for their continued growth and relevance in Europe's energy transition.

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List of Abbreviations

CAI	Community Action Initiative
CEC	Citizen Energy Community
CEP	Clean Energy Package, EU
COMETS	**CO**llective action **M**odels for **E**nergy **T**ransition and **S**ocial Innovation
Co-ops	Cooperatives
CREPs	Community Renewable Energy Projects
DSO	Distribution System Operator
EC	Energy Community
ED 2019	Energy Market Directive, EU
EEG	Renewable Energy Sources Act, Germany
EU	European Union
FECS	Future Energy Community Scenarios
FiTs	Feed-in tariffs
FiPs	Feed-in premiums
GENTE	Distributed **G**overnance for Green **En**ergy Communi**T**i**E**s
IT	Information Technology
JAAC	Jointly Acting Active Customer
JARSC	Jointly Acting Renewables Self-Consumer
KEV	Kostendeckende Einspeisevergütung (compensatory feed-in remuneration scheme), Switzerland
KPI	Key Performance Indicator
kW	Kilowatt
kWp	Kilowatt peak
LCOE	Levelised Cost of Energy
LE	Local energy
LEC	Local Energy Community
MW	Megawatt
P2G	Power to Gas
PV	Photovoltaic
RE	Renewable energy
REC	Renewable Energy Community
RED II	Renewable Energy Directive, EU
RES	Renewable energy sources
ROI	Return on investment
TRL	Technology Readiness Level
UK	United Kingdom
V2G	Vehicle to Grid
ZEV	Zusammenschluss zum Eigenverbrauch (self-consumption association), Switzerland

1 Introduction

1.1 Context of the report

Collective, community-focused initiatives relating to energy generation and consumption are well established across Europe. The exact numbers vary, but recent reports have found that greater than 2 million European citizens collectively engage in more than 8,400 community energy initiatives, comprising more than 13,000 projects [2], contributing more than 6.3 GW of renewable energy capacity to the energy mix, mainly in the form of solar PV generation [3]. Energy communities are one realisation of such initiatives. To date, over 1,900 community energy projects have been reported, involving more than 1.25 million European citizens [4]. The introduction of two legal definitions relating to energy communities – Citizen Energy Communities (CECs) and Renewable Energy Communities (RECs) – in EU law in 2018 is evidence of the relevance of the concept and the phenomenon beyond the research context [1].

The energy community concept has been the topic of numerous journal articles and research projects in recent years. While the term has appeared in articles since the 1980s, the number of articles discussing energy communities has increased manifold since the beginning of the 2000s [5]. Defining the archetypal energy community is not trivial: they come in many forms, may carry out multiple activities, have diverse objectives and interests, have a wide geographical footprint, and may use different technologies. They may also have different legal forms and diverse forms of governance [6].

In the recent research literature, there is a consensus that the term is used in many different ways, with no broadly accepted definition of what comprises an energy community [5]. Consensus appears in the consideration that the members of an energy community are both the recipients of potential benefits, and, importantly, are also co-owners of the project, meaning they can - and do - participate in decision-making processes with the community [6].

It is anticipated that over 264 million citizens in the European Union (that is more than half of the population) will be prosumers by 2050, contributing up to 45% of the renewable energy (RE) that is connected to the electricity network [4]. Energy communities are anticipated to play a central role in the decarbonisation of the European energy system, with about 37% of renewable energy being produced by collective projects such as citizen cooperatives [1]. Figure 1 gives a breakdown of the investor types that are expected to contribute to the renewable energy transition by 2050. ECs contribute by financing renewable energy production, supporting the acceptance of new local infrastructure, promoting energy literacy, and by enabling access to additional private capital that will be used to foster local investments [7].

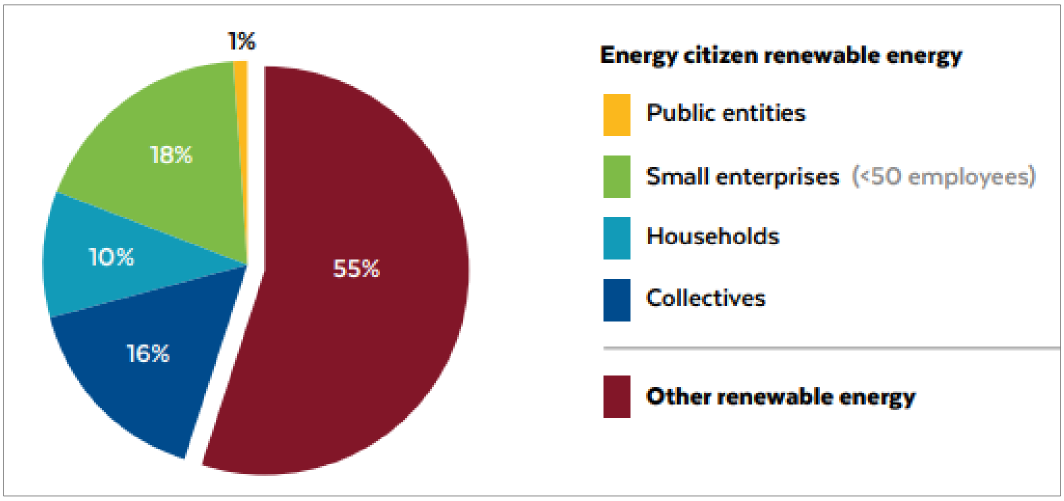

Figure 1 - Predicted share of electricity production by investor type in EU-28 in 2050
Image source: [8]

However, growth has not been uniform: the geographical spread of community initiatives is not homogeneous across Europe, and there has not been a consistent year-on-year increase in the number of new projects. Community energy initiatives are most prevalent in Germany and the Netherlands, with recent estimates being at more than 1,000 community energy actions in these two countries alone. Austria, Switzerland, Denmark, France, Great Britain, Poland, Spain, Greece, and Sweden have also experienced a rise in projects and community groups focused on energy, with each counting more than 100 initiatives, according to recent research. The remaining countries in Europe count fewer than 100 initiatives in total [2].

GENTE develops solutions for energy communities within an encompassing framework of an 'energy community toolkit'. To identify which elements of the toolkit will be most valuable and have the greatest chance of commercial success, an understanding of the factors that influence the success of energy communities and the extent to which communities are likely to grow in future needs to be developed. To date, no comprehensive study has been completed to analyse the reasons for the geographical and temporal discrepancy in the growth of energy communities. This report investigates the principal drivers for the growth and decline of community-focused energy initiatives in Europe, considering, in particular, energy communities. A set of future energy community scenarios based on the factors that enable energy community success are developed. In doing so, this report explains the context of the GENTE toolkit, and helps inform the development of technology, modes of community engagement, and recommendations for exploitation that form important parts of the GENTE project.

1.2 Scope of the report

The report *Future Energy Community Scenarios* describes the outcome of Deliverable 3.1 - *Future Scenarios for Local Energy Systems with Increased Renewable Share* (D3.1). The deliverable encompasses a qualitative literature-based review of the historical development of energy communities and available projections for energy community growth in Europe. The historical context of energy communities was identified, along with financial support mechanisms and relevant legislation. This information was used to understand the role various factors have played in the historical development of ECs and how those factors might impact development in the future. Analysis of data presented in the literature was used, along with quantitative data collected by the COMETS project (see Section 1.3.2) about Europe's current environment of ECs, to anticipate future trends in energy community development in Europe through the creation of future energy community scenarios. The potential relevance of the findings and future projections to the GENTE partners is considered, with the goal of informing the content of the GENTE toolkit.

1.3 Methodology

The methodology adopted for this research comprised a directed discovery literature review coupled with an initial, high-level analysis of the COMETS project public dataset of community energy initiatives in Europe.

1.3.1 Literature review

An approach called *directed discovery* was used to perform the research for D3.1. This involved the following high-level steps:

1. Define and validate the methodology for dataset discovery.
2. Perform literature search to create the dataset, including filtering duplicates and dataset selection.
3. Perform full text review and data extraction of created dataset.
4. Perform data analysis of extracted data.
5. Communication of analysis and findings in report form.

As part of the first step, a set of search terms was defined to ensure a broad enough, but not never-ending, dataset of academic and non-academic (grey) literature was included in the analysis. These can be seen in Appendix 10.1 along with the inclusion criteria for the database search results in Appendix 10.2.

To expedite the processes in the second step, a set of Python scripts were created to automate the execution of search functions on the Clarivate Web of Science platform [9] using the generated search phrases and inclusion criteria. It is intended to open source these scripts in the future. Manual comparison of the returned papers to the defined inclusion criteria was performed to whittle the dataset down to a manageable level, while still maintaining the relevance of the chosen papers to the research topics. Performed twice, this generated a final shortlist of papers for full text review.

As part of the third step, a set of questions was created, based on the data required to answer the research topics, to put structure to the data and information extracted from the literature. 20 papers were reviewed in this fashion. The questions can be seen in Appendix 10.3. More papers were sought out and reviewed during the analysis phase to enhance understanding of the topics extracted from the initial literature dataset.

1.3.2 COMETS database usage

Comprehensive analysis that provides an accurate number of ECs in Europe is limited. COMETS, a Horizon 2020 project[1], has recently published the most complete summary available, providing an overview of community energy initiatives in Europe. The COMETS dataset is provided in a database, described in [2] and available at [10].

The COMETS scope covers Community Action Initiatives (CAIs) whose activities are related to energy production, consumption, distribution, provision of energy services, energy production for use in agriculture, and/or research and development. The comprehensive inventory was created through detailed analysis of databases, interviews, and websites.

There were challenges in aggregating and comparing numbers and values across countries due to inconsistent definitions between jurisdictions, incomplete database fields, and the unavailability of comparable data from one country to the next. For example, a 'technology' field was populated for some but not all initiatives, making reliable comparison of technology types within or across countries difficult.

In GENTE, high level analysis of the COMETS data was conducted, mostly looking at the general transformation of all CAIs over time. Relating that analysis to academic papers that have carried out more detailed in-country investigation was attempted. Analysis was limited to GENTE countries - Switzerland, Sweden, Spain, Türkiye - and countries where there has been significant growth in energy communities, or policy targeting them - Great Britain, Denmark, the Netherlands, and Germany.

GENTE has barely scratched the surface of what could be learned from the COMTES dataset. A more in-depth dive into the data is recommended, especially to explore details of the varying dimensions of ECs with a goal of exposing connections and interactions that could be used to enhance the environment for ECs in Europe.

1.4 Terminology

When analysing the historical and future development of local energy communities, it is important to clarify the terminology used. A significant body of literature exists that discusses energy communities in their various forms. However, the terminology used is often applied inconsistently, meaning it is difficult to determine the boundaries associated with papers describing numerical growth of energy communities. Table 1 lists the common terms used in literature to describe an energy community. In

[1] http://www.comets-project.eu/

this report, the term 'energy community' is generically adopted as an umbrella term to encompass the diverse set of names.

The definitions and characteristics of ECs are considered in detail in Deliverable 4.1 - *Characteristics of energy communities and motivations, engagement, and socio-economic profiles of end users* (D4.1). There is no broadly accepted definition of what comprises an energy community. Two legal definitions have been proposed by EU law - Citizen Energy Communities (CECs) and Renewable Energy Communities (RECs). However, even these do not fully address the diversity of community energy initiatives that have been observed in countries across Europe, and hence cannot be used as a definition for the analysis required for this research.

In this report, we adopt the general definition provided in D4.1, namely: "Energy communities involve groups of citizens, social entrepreneurs, public authorities and community organizations who participate directly in the energy transition by jointly investing in, producing, selling and distributing renewable energy" [11].

Table 1 - List of common terms used to describe energy communities in literature

How energy communities are referred to in literature	
Energy community (EC)	Community renewable energy (CRE)
Citizen energy	Community renewable energy projects (CREPs)
Citizen Energy Community (CEC) [2]	Collective Action Initiatives (CAI)
Energy cooperatives	Collective for Citizen Energy
Renewable energy cooperatives	Community integrated energy systems (CIESs)
Renewable Energy Community (REC) [2]	Local energy communities (LEC)
Sustainable energy community	Grassroots initiatives
Community energy	Community power

1.5 Structure of the report

Chapter 1 introduces the report context, scope, and structure; the methodology followed during the deliverable research; and key terminology for the topic area.

Chapter 2 describes the historical growth of energy communities observed in various countries in Europe. Numbers of communities by country are summarised, considering data from academic papers

[2] Legally defined term in the EU

and the COMETS database. Growth drivers and influences are identified and discussed considering: the historical context of various countries and the impact of grassroots support for cooperative initiatives; the resource types and technology mix historically used by ECs; the historical role of financial support mechanisms and legislation; and energy prices and technology costs.

Chapter 3 describes a decline phase seen in the progress of EC development; discusses the specific challenges faced by various key countries in Europe that lead to the decline; and concludes by bringing the factors affecting the EC growth decline together.

Chapter 4 investigates the aspects that enable the next EC growth phase considering the factors that affected EC decline discussed in Chapter 3. Three main areas are investigated: financial and business aspects, regulatory and policy aspects, and the overall environment that enables growth.

Chapter 5 looks at how ECs are expected to evolve in the future through a review of the available literature and taking into consideration the growth environment discussed in Chapter 4. Three main future topics are explored: collaboration between ECs, the professionalisation of ECs, and a continued heterogeneity development versus a move towards homogeneity of ECs.

Chapter 6 combines the enabling environment for EC growth with the future evolution factors to create future energy community scenarios. The chapter briefly mentions scenarios developed in two other papers and then examines the enabling factors scenarios developed for GENTE as the culmination of this research.

Chapter 7 summarises the overall findings from this research, while Chapter 8 makes suggestions for further areas of exploration that are either not entirely covered by this research or would add value as additional topics.

2 Growth of energy communities in Europe

This chapter describes the historical evolution of local energy communities in Europe and factors that have influenced their development, using previous studies and available literature. First, a summary of the scale of energy community growth across the entirety of Europe is provided, broken down according to countries. A commentary then follows on factors that have affected the growth. Various examples are provided from countries that have been particularly affected by the factors that are discussed.

Previous work has identified 'governance systems' variables, such as financial support mechanisms for renewables and government policies, and 'actors' variables, such as attitudes towards cooperative models and existing cultures of local energy activism, to be relevant to the growth of energy communities [12]. These variables and other factors are explored in this chapter. First, attitudes to community initiatives are considered in terms of the historical context in various countries. Next, a discussion of the types of generating technology used to date in ECs is provided. The impact of financial support mechanisms and reducing costs of renewables on EC creation and growth are described, followed by an analysis of the possible role of legislation. Finally, the impact of energy prices is considered.

Research identified two main historical phases of growth for ECs: a rapid growth phase, where ECs proliferated due to the growth in feed-in tariffs (FiTs) and favourable regulations; and a period of stagnation, where ECs were negatively affected by FiTs digression. This chapter deals with the period of rapid growth; the decline in growth is discussed in Chapter 3.

2.1 Number of energy communities by country

Various studies have been conducted into the historical growth of energy communities in Europe. This section provides an overview of EC numbers based on numbers provided in prior studies. As discussed in Section 1.4, a wide range of terminology is used to define the boundaries of such studies: where numbers or graphs are provided, boundary conditions have also been explained to allow comparisons to be made across different studies.

An approximate number of renewable energy cooperatives was provided by [12] for seventeen European countries in 2014 (see Figure 2). The scope of this study was 'renewable energy cooperatives', focusing on initiatives where citizens were able to collectively own and manage renewable energy projects at the local level. The significant majority of the approximately 2,400 cooperatives identified were located in Germany, Denmark and Austria, with the greatest prevalence being in Germany.

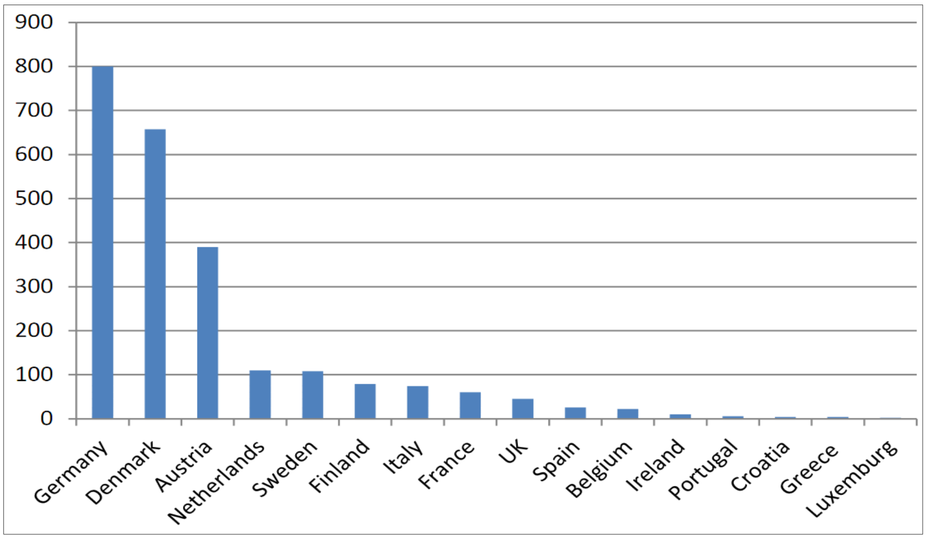

Figure 2 - Approximate number of renewable energy cooperatives in selected European countries
Image source: rescoop.eu, cited in [12]

An updated study was conducted in 2020 by [1]. 24 case studies were presented from nine countries, focusing on energy communities in a more general sense, considering community energy initiatives that included cooperatives, eco-villages, small-scale heating organisations, and other energy projects led by citizen groups. In its preliminary analysis, the study noted the existence of a total of 3,500 renewable energy cooperatives and provided a summary of the number of initiatives in existence in the case study countries, in accordance with its broader definition (see Figure 3). Germany and Denmark were again dominant, although a relative growth in the Netherlands and United Kingdom was also observed. Austria did not form part of the study, preventing a comparison with Figure 2 for that country.

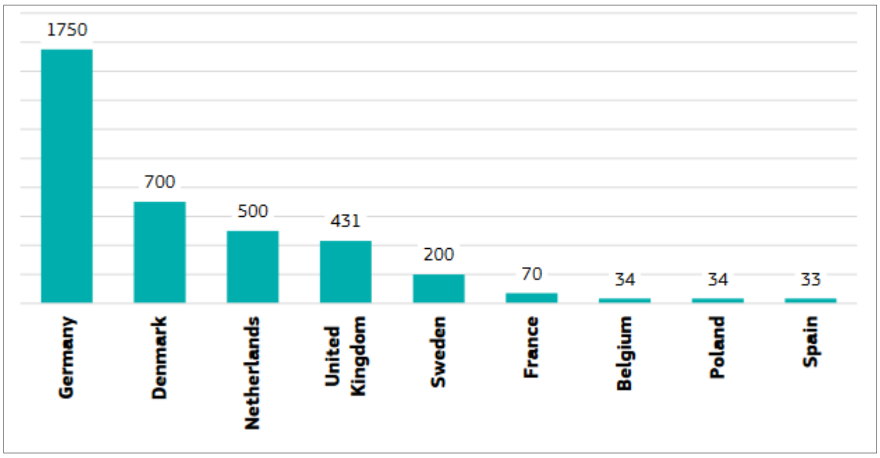

Figure 3 - Approximate number of community energy initiatives from countries considered in case studies analysed in [1]
Image source: [1]

Most recently, COMETS (see Section 1.3.2) completed an inventory of Collective Action Initiatives (CAIs) focused on energy in Europe, considering those that included production, distribution, and consumption of electricity, provision of energy services, community energy initiatives relating to agriculture, initiatives focused on research and development, and those providing advisory services. A preliminary breakdown of the number of ECs per country is shown in Figure 4. Figure 5 shows the number of initiatives across Germany, the Netherlands, France, Denmark, Great Britain, Switzerland, Sweden, and Spain. The analysis conducted in COMETS identified over 13,000 projects that were initiated since 2000, involving more than 8,400 energy communities. Again, with this broader definition, Germany can be seen to dominate the numbers, with other significant countries being the Netherlands, France, and Denmark.[3]

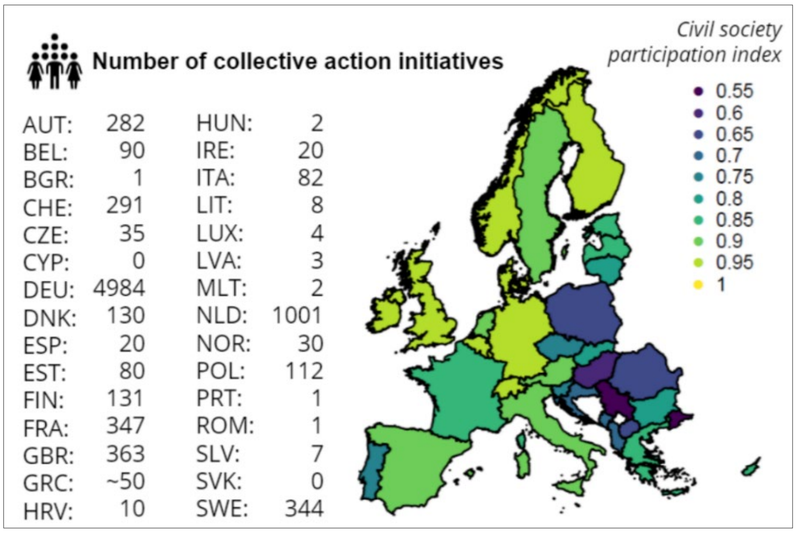

Figure 4 - Number of collective action initiatives in Europe in 2020 based on preliminary estimates from the COMETS database

Note: The colour code for the countries shows the civil society participation index of the Varieties of Democracies Project VDEM (Coppedge et al. 2021)

Image source: [3]

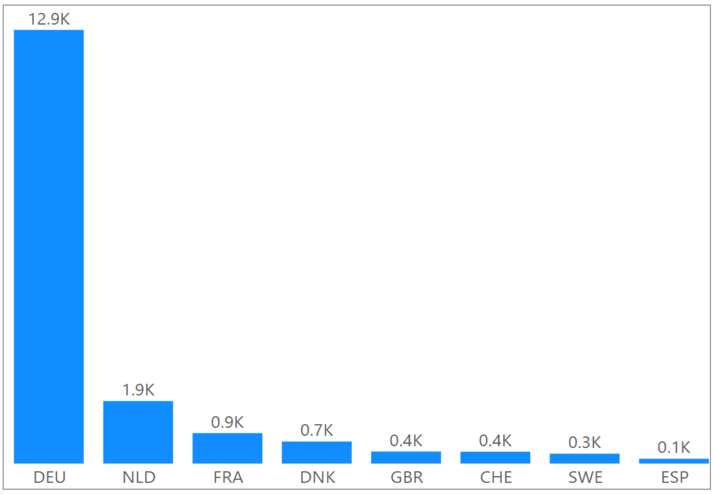

Figure 5 - Number of community action initiatives for selected countries in Europe, based on the COMETS dataset

Image source: HSLU/GENTE. Data source: [2]

[3] There are two reasons the numbers in Figure 4 and Figure 5 are different. Firstly, Figure 4 includes initiatives whose primary purpose is the energy transition, while Figure 5 also includes initiatives whose secondary purpose is the energy transition, but whose primary purpose is something else. Secondly, Figure 4 is based on preliminary data from 2020, while Figure 5 is based on data from the finalised dataset released in 2022.

Figure 6 and Figure 7 show historical development for multiple countries in a single plot, also based on the COMETS dataset. Progression over time is shown from 1990, with Figure 6 showing the historical growth with Germany included in the data and Figure 7 showing historical growth without Germany. The plot without Germany allows a more detailed appraisal of the other countries. Further detailed analysis per country is described later in this report.

In this and other plots based on the COMETS data, a decline can be observed in 2020. The numbers for 2020 may not reflect the actual number of communities established that year due to a delay between establishment and reporting of new initiatives to the data repositories used by COMETS.

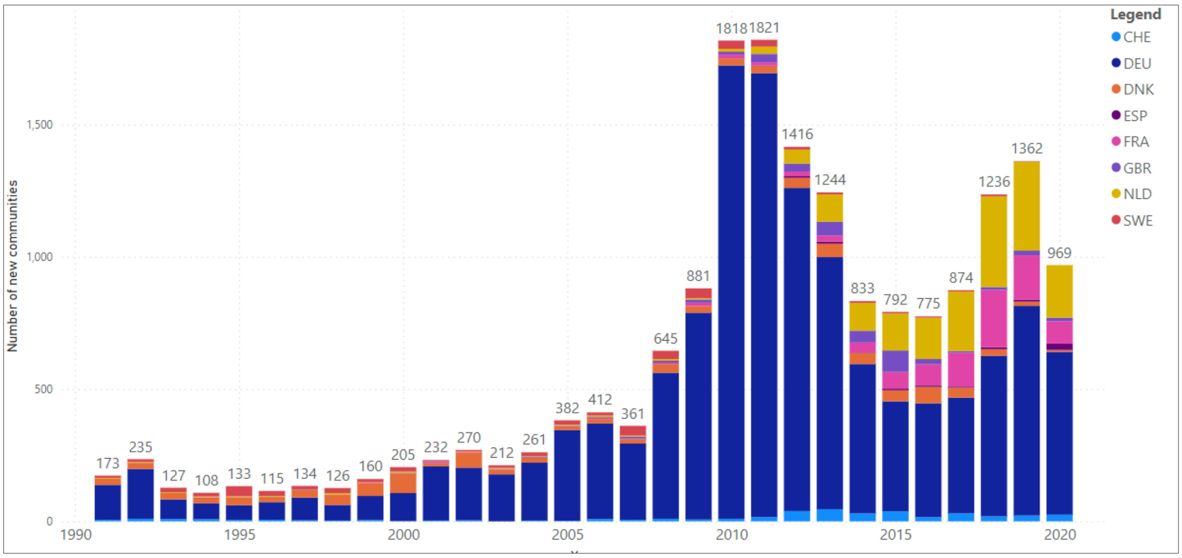

Figure 6 - Historical EC development since 1990 for selected countries, based on the COMETS inventory
Image source: HSLU/GENTE. Data source: [2]

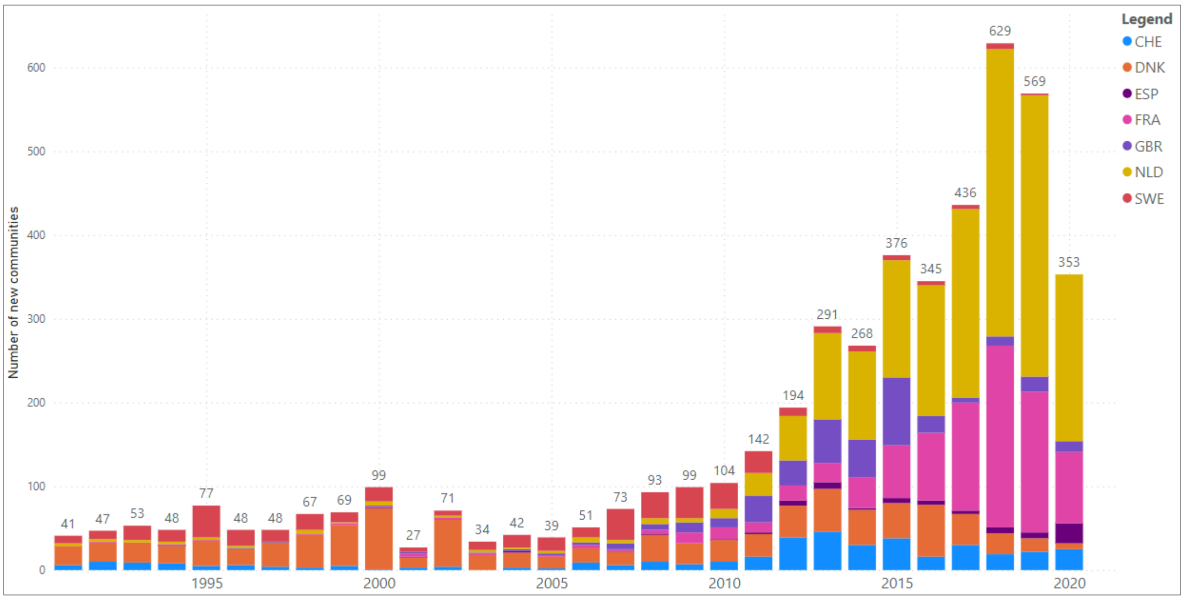

Figure 7 - Historical EC development since 1990 for selected countries, based on the COMETS inventory, excluding Germany data
Image source: HSLU/GENTE. Data source: [2]

2.2 Historical context for EC uptake

Section 2.1 identified a clear disparity from country to country regarding absolute numbers of energy communities, highlighting that the rate of establishment of new communities was not consistent from one country to the next. This and the following sections provide explanations for these disparities.

One explanation for the differences between countries described in literature is the historical context in relation to establishing community initiatives in each country. Where there is a strong tradition of local citizen ownership or of creating cooperatives, renewable energy schemes have been observed to be effective in mobilising citizens to form energy communities. Examples include Denmark and Germany, with their strong tradition of social enterprise and community ownership [1].

Denmark has a long tradition of forming cooperative enterprises. The first cooperatives were focused on the agricultural sector: these became widespread in the first half of the 19th century, with the approach ultimately extending to multiple industries, including food, retail, and public services such as energy utilities. The emergence of wind power technology in the 1970s was seen as a suitable fit for the cooperative model and was adopted accordingly [12].

The oil crisis of the 1970s led to attempts to commercialise wind energy in Denmark. At first, civil society entrepreneurship made a significant contribution, supporting significant growth in energy communities in the form of wind energy cooperatives. The cooperatives were typically organised as general partnerships, where individual citizens jointly invested in the procurement of wind turbines, operating them to sell the electricity output. Towards the end of the 1990s, over 2,000 turbines were owned by such cooperatives [6]. By 2010, it was estimated that 15% of all wind turbines in use in Denmark were owned by cooperatives [12].

Germany also has a history of establishing cooperatives. Citizens have had the right to form cooperatives to generate energy for some time, based on civil law provisions such as the Cooperative Societies Act (1889), thus supporting their ability to form energy communities [13]. The cooperative legal form declined in use towards the end of the 20th century, then subsequent marketing campaigns led by cooperative associations, connected with the 2006 amendment of the Cooperative Societies Act, led to a resurgence in their application. In particular, a ‘new energy cooperative model’ emerged that coincided with the 2007 financial crisis, resulting from a search for new economic models that could replace common financial practice that was evident at that time [12].

In Switzerland, where cooperative business models form a core part of the economic and political structure [14], cooperatives played an important role at the end of the 19th century in the construction of distribution grids in rural areas [15]. Switzerland’s system of direct democracy has been identified as a positive factor in establishing citizen-led energy initiatives [16]. Recent energy-focused cooperatives have been primarily concerned with the production of renewable energy to address environmental objectives [15].

In contrast to cases such as Denmark, Germany, and Switzerland, research has shown that communities are less likely to form where there are negative preconceptions about cooperatives. This is the case in Türkiye, where historical issues with cooperatives, notably the failure of housing cooperatives in the 1990s, have hindered the uptake of energy initiatives focused around community cooperation [17]. A similar view has been observed in certain Eastern European countries, where there are negative perceptions of centrally planned economies or cooperatives. It has been observed that distrust may not be related to social activity *per se*, but rather in national or local political institutions [1]. Energy cooperatives are less developed in what was formerly East Germany (see Figure 8), attributable to the socialist era's negative legacy [12]. In Sweden, a third factor is considered relevant. A history of passive citizenship and a reliance on the welfare state reduces the perceived necessity for grassroots actions such as cooperatives, hindering the active mobilisation of citizens in energy cooperatives [18].

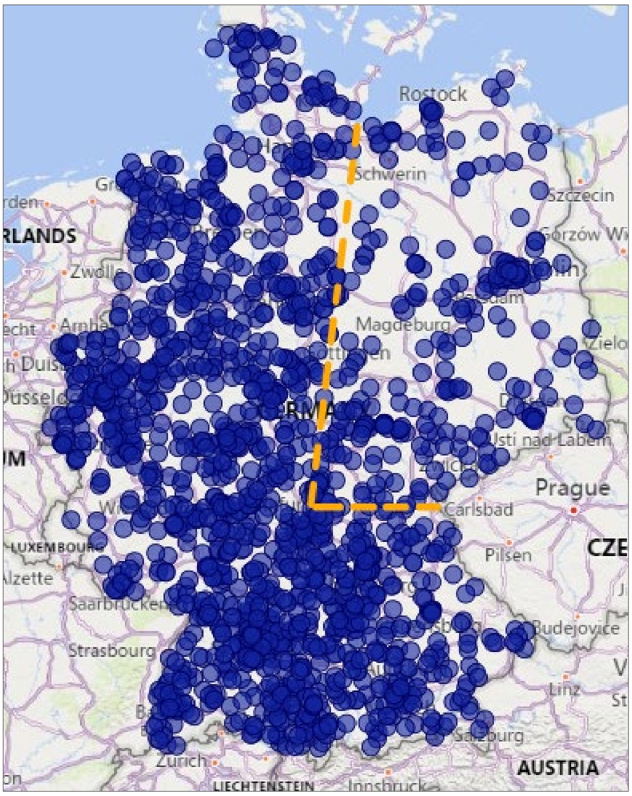

Figure 8 - New energy communities by founding date, since 2000, with approximate location of border between East and West Germany, based on COMETS inventory
Image source: HSLU/GENTE. Data source: [2]

2.3 Resource types & Technology mix

Solar PV and wind generation are the most common technologies employed in energy communities in Europe. This was illustrated by [1] (see Figure 9), when it analysed 24 case studies from across Europe, and is further supported by detailed country-specific analysis, as described below.

In Germany, analysis conducted in 2020 found that while wind generation represents a significant proportion of the installed base of renewable generation overall, energy communities have historically mostly been active in solar generation, as these have traditionally yielded higher returns than wind [16]. In Switzerland, solar generation is also found to dominate as the primary energy source in energy communities. A survey in Switzerland, conducted in 2018, analysed energy cooperatives that were listed in the commercial register, and identified that the most widespread technology for power generation among the survey group was solar PV. 93% of those who took part in the survey had PV-based systems, and 66% planned to expand these systems in five years following the survey [15]. In a comparative analysis between German and Swiss energy cooperatives, it was observed that German cooperatives tended to be much larger. The median PV capacity in Germany was observed to be twice as high and the number of members three times as high as in Switzerland [16].

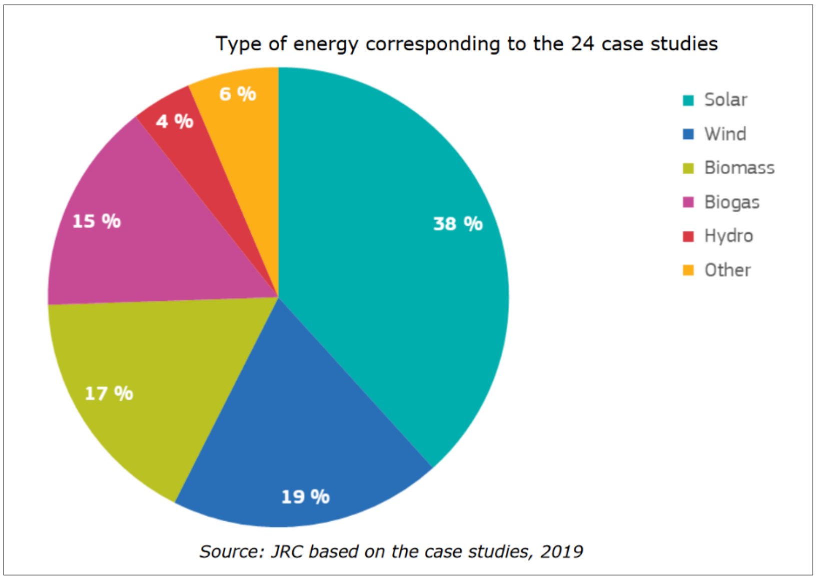

Figure 9 - Energy generation source in Europe in 2019
Image source: [1]

In France, a study in 2020 showed that wind plants represented a majority of the installed capacity (64%) in renewable energy communities, followed by solar, which accounted for 22% (see Figure 10). However, in terms of number of communities, a significant majority (76%) involved solar power plants, in particular rooftop PV (see Figure 10). Wind generation was the next most common energy source (16%), with the remaining being split across small-scale hydro, biogas, and biomass projects [7]. In Türkiye, research was conducted in 2020 on the development of renewable energy communities. 46 communities were identified, with all being based on PV generation [17].

In contrast to Germany and Switzerland, the energy community landscape is dominated by wind generation in Denmark. In 2002, cooperatives owned slightly less than 40% of the total number of turbines installed in the country. This proportion has declined in recent years as new projects have been developed more by professional developers and utilities [19]. In 2017, 20% (1,082 MW) were estimated to be locally owned by citizen cooperatives (549 MW), and farmers and local landowners (484 MW) [18]. Wind energy also dominates as a generation source within energy communities in Sweden. In 2019, [20] identified around 140 active community energy initiatives in Sweden: most generation was from wind cooperatives (around 78 active communities). The second largest group was identified as being eco-villages (32 communities). Small-scale heating organisations and solar PV communities were also identified, and a small number of rural communities used other forms of production (hydropower, heat or energy-saving plans).

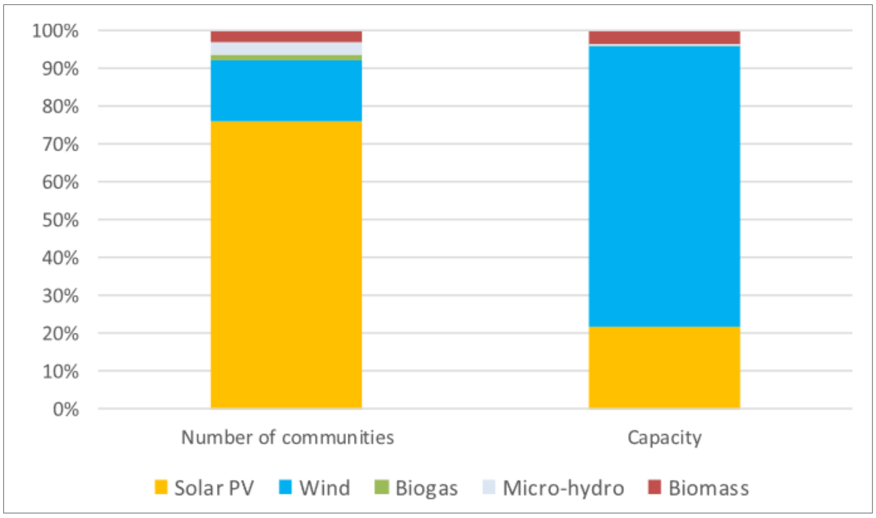

Figure 10 - Percentage of communities per generation source and capacity in France in 2020
Image source: [7]

The situation in the United Kingdom (UK) varies according to country. A study in 2018 found that groups in England, Wales and Northern Ireland were primarily based on solar PV. In contrast, in Scotland, most generation was from wind. Very little activity was identified in relation to sustainable heat generation [21]. Energy efficiency and demand-side measures were found to be a secondary activity in the UK. Where community groups engaged in demand-side optimisation, they were found to produce low carbon plans, or facilitate energy saving measures (such as installation of insulation).

2.4 Financial support mechanisms

The implementation of financial support schemes has been consistently cited as a critical contributing factor to the establishment and ongoing success of community energy initiatives. Guaranteed feed-in tariffs, in particular, have frequently been proven the most effective form of support in stimulating the growth of the energy community model [1], [4].

The analysis presented in Section 2.1 illustrated a rapid growth in energy communities in multiple countries in the period between 2005 and 2015. At the start of this period, renewable energy technologies were not cost-competitive when compared to conventional power generation. Support mechanisms were therefore developed to encourage the market penetration of renewable energy, stimulating their use by making projects that included them economically feasible. Feed-in tariffs (FiTs), feed-in premiums (FiPs), and quota obligations were widely used mechanisms intended to promote renewable energy technology uptake in Europe [12]. It has been observed that the introduction of such support mechanisms coincided with a surge in citizen and community energy initiatives in countries with stable policies supporting renewable energy, for example in Germany, Denmark, and the UK [1].

The German support system played an essential role in developing a diverse ecosystem of power generators [12]. In 2000, the Renewable Energy Sources Act (EEG) was implemented following the liberalisation of the energy market that took place in 1998, leading to the introduction of FiTs. In combination, these measures facilitated a rapid development of renewable energies, and it has been proposed that FiTs led to considerable community ownership investments in wind energy in particular (see Figure 11). Hundreds of local businesses and citizens bought shares to finance wind power projects as part of community schemes [1].

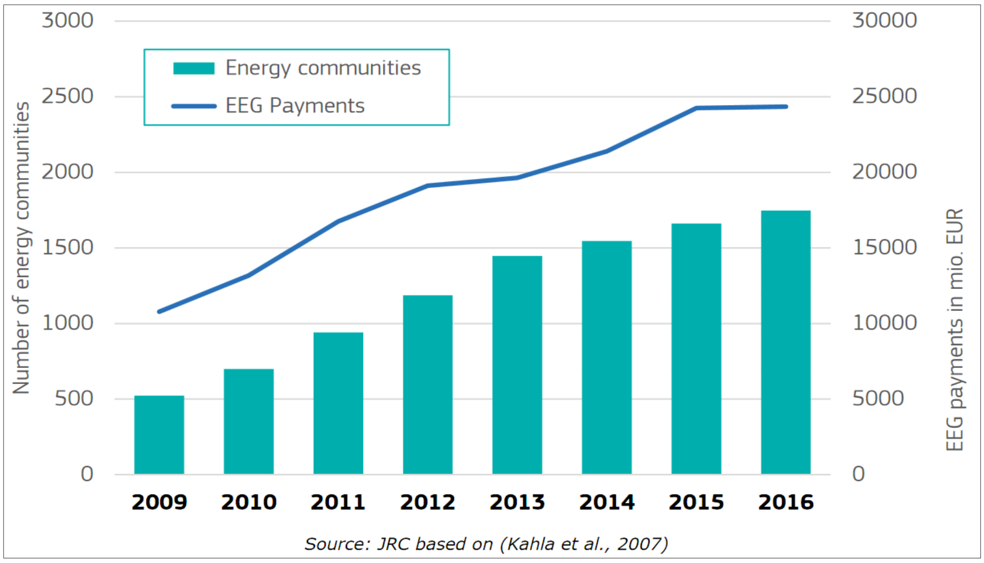

Figure 11 - Growth of payments under Renewable Energy Sources Act (EEG) and citizen-led energy initiatives in Germany from 2009 - 2016
Image source: [1]

Solar cooperatives in Germany also grew very rapidly in the same period. Only four were in existence in 2007; this grew to 200 by 2010. A steep increase in solar cooperatives was observed between 2008 and 2014 during the period when FiTs were available. This continued until the EEG replaced the FiT scheme with a market premium scheme. The market premium scheme had the effect of penalising small-sized generation plants by rendering them less competitive [6].

Similar analysis can be conducted for other countries that have experienced strong growth in ECs. Figure 12 shows community development over time for Germany, Great Britain, the Netherlands, and Switzerland (using the COMETS data), and plot dates of implementation of support mechanisms. Great Britain, the Netherlands, and Switzerland are considered in more detail in the text that follows. The same graphs are presented next to commentary on the regulations from the literature in the Appendix – Case studies.

Community energy emerged in Great Britain in the late 1990s; however, the launch of the government's Feed-in Tariff Scheme in 2010 led to rapid growth in the sector, especially in relation to solar electricity generation in England, and wind generation in Scotland, targeting small scale generation for the first time. The Feed-in Tariff Scheme reduced investment risk for new projects, supporting access to new forms of capital for new projects. A mix of grants and tax advantages were also introduced to complement the feed-in tariff [21].

Community revenue in the UK has primarily come from supply-side (i.e. energy generation) income, rather than demand-side (i.e. energy efficiency) initiatives, although grant funding has been identified as important for energy efficiency components and to cover project start-up costs in general. The importance of supply-side income was particularly pronounced in the early development of the sector [21]. Community energy initiatives also benefited from government-led financial support such as the Enterprise Investment Scheme and the Seed Enterprise Investment Scheme, which offer tax relief to investors in early-stage companies [22].

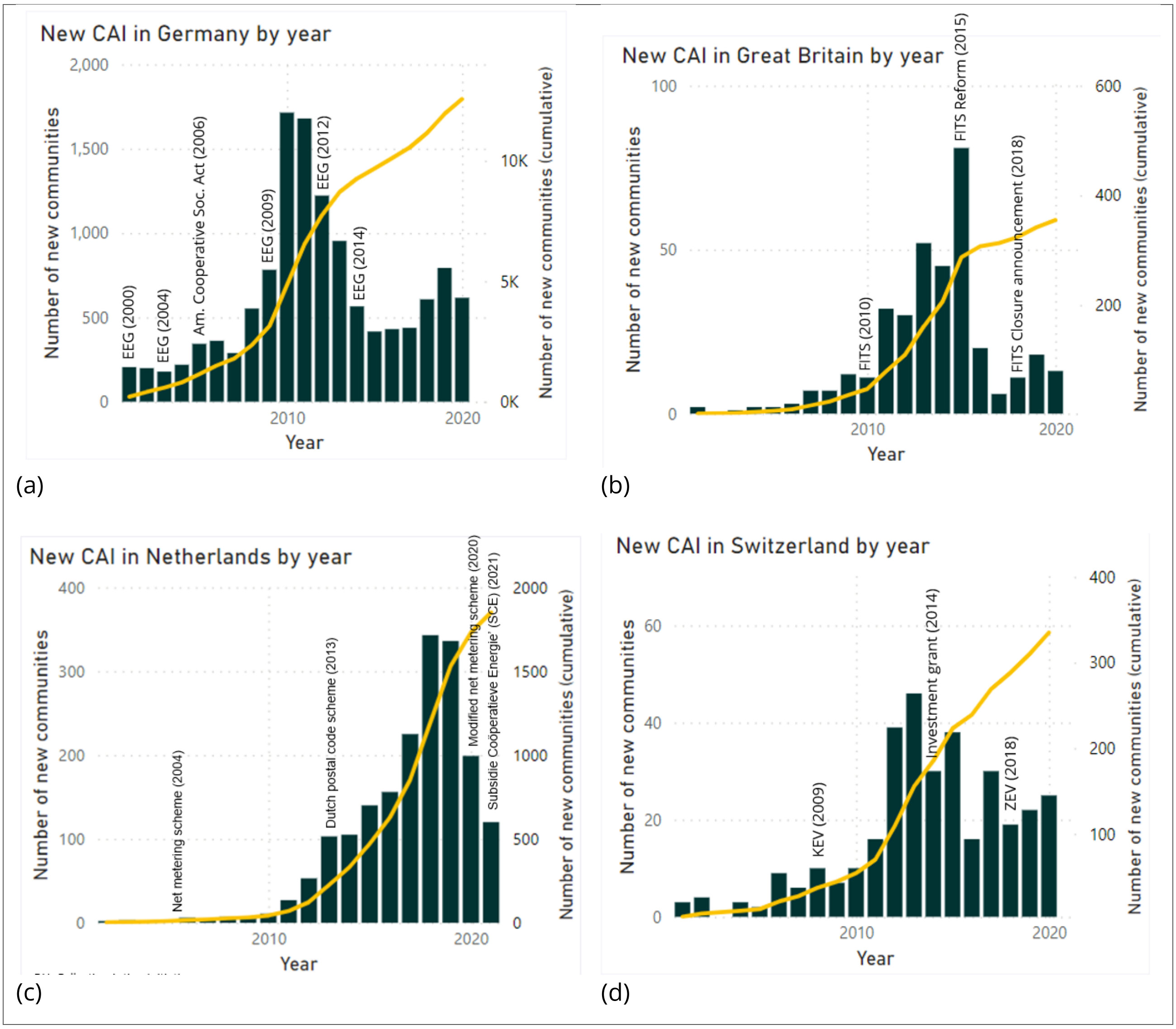

Figure 12 - Development of new communities in relation to support mechanisms implemented, considering (a) Germany (b) Great Britain (c) the Netherlands (d) Switzerland
Images source: HSLU/GENTE. Data source: [2]

The implementation of the 'Kostendeckende Einspeisevergütung' (KEV) ('compensatory feed-in remuneration scheme' in English) in Switzerland in 2009, designed to promote electricity generation by renewable sources, led to a subsequent growth in energy communities [16]. A new scheme was introduced in 2018 that shifted the focus of energy communities from feed-in to self-consumption [23]. Called the 'Zusammenschluss zum Eigenverbrauch' (ZEV) ('self-consumption association' in English), this legislation made a self-consumed kWh more profitable than a feed-in kWh, and a subsequent growth in ECs occurred.

In the Netherlands, research has also indicated that financial incentive schemes have been critical in supporting the growth of energy communities. First, the introduction of net metering allowed produced renewable energy to be offset against consumed energy, eliminating the tax component in energy tariffs. Second, a 'Dutch postal code scheme' and its successor 'Subsidy Cooperative Energy production' provided a financial incentive for the creation of an energy community that collectively invests in production in a linked geographical area (defined by the post code), without the necessity to have photovoltaic panels on a community member's roof [4].

Other countries also provide an insight into the importance of financial support mechanisms. In Denmark, the main support mechanisms historically – targeting wind turbines in particular - were investment grants from the Danish state, tax exemptions for income resulting from wind turbines, and, from the mid-1980s, fixed feed-in tariffs, which included a guaranteed grid connection, offtake obligations, and priority terms for network use. In combination, tax exemptions and FiTs created an asset with high investment security, providing guaranteed, stable incomes. This in turn supported low-cost financing from banks, supporting the growth of energy cooperatives [12].

France was the first country in the EU to introduce dedicated financial mechanisms to enable and encourage the participation of local actors in renewable energy projects. These mechanisms, called 'participatory bonuses', came into force in 2015 through the lobbying of the Collective for Citizen Energy (le Collectif pour l'énergie citoyenne in French) and simplified the legal framework for setting up citizen renewable energy projects (CREPs) by allowing cooperatives to operate projects financed by local citizens and local government. [7] A direct correlation between participatory bonuses being introduced and a growth in new CREPs is visible in Figure 13.

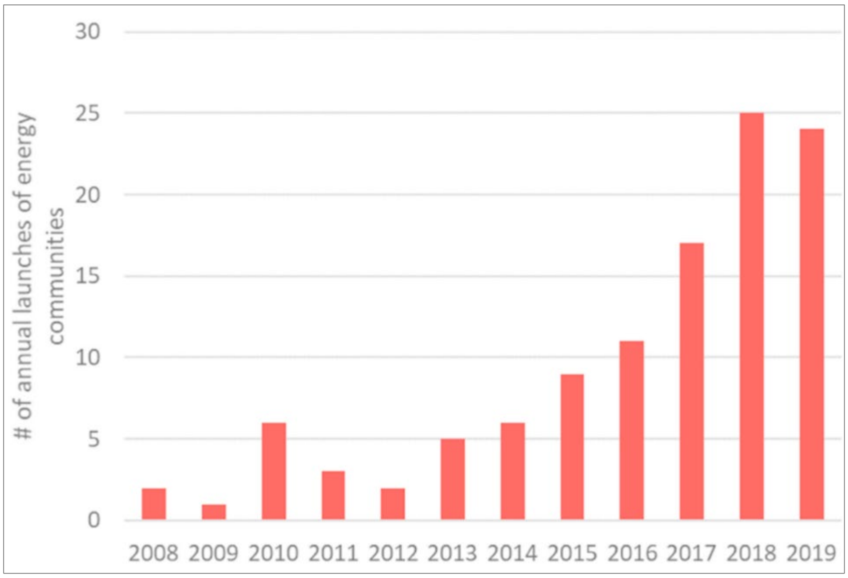

Figure 13 - Number of annual launches of CREPs in France from 2008 – 2019
Image source: [7]

2.5 Supportive legislation and policy

While financial support mechanisms represent one form of supportive legislation that have historically encouraged the growth of energy communities, other regulatory or policy actions can also have an impact. Studies have shown that recent waves of development have a clear correlation to the implementation of policy support schemes [1].

In Germany, for example, the EEG combined financial support through FiTs with a regulatory mechanism that provided priority feed-in for energy from renewable sources, which had the effect of considerably reducing market risks and increasing investment security by guaranteeing offtake conditions. Loans were also provided with preferential conditions to new schemes, and associated refinancing possibilities were supported by Deutsche Ausgleichsbank (now Kreditanstalt für Wiederaufbau (KfW)). In combination, these created additional favourable factors and helped develop a stable and broad base for supporting community-focused initiatives within the banking sector [12]. The amendment of the Cooperatives Act (GenG) in 2006 has also been identified as an important contributing factor [16].

Policy measures that provide preferential treatment for local ownership of renewable energy resources have also been observed to support citizen-led projects. Denmark promoted the ownership of wind power by local citizens, companies, and cooperatives from early on, using planning schemes and specific regulations. For example, in Denmark local residents were given the opportunity to invest in shares in wind farms built in or close to their municipality [1]. Initially, the government restricted ownership of wind turbines to local actors living or being registered in geographical proximity to the turbine they owned, leading to very high levels of local ownership [18]. Additionally, wind projects were eligible for a refund on both the Danish carbon tax and the energy tax, leading to what essentially amounted to a doubling of the payment that was accessible for wind power. Furthermore, legislation which gave consumers the freedom to choose their electricity provider and promoted a certificates-based quota system for renewable energy, drove behaviour that encouraged the creation of community energy initiatives [22].

Similarly, the Netherlands has a well-developed and appropriate policy landscape, including appropriate incentives, but also emphasised efforts to engage citizens. Strategies and tools for communicating with citizens were developed to increase levels of engagement in, and awareness of, EC schemes. Platforms providing guidelines were also developed to inform and support prospective ECs and demonstrate the advantages of establishing initiatives. Research indicates that this supported growth [18].

In the UK, while large companies tend to dominate the generation market, government policies have acted to liberalise and privatise energy infrastructure and supply capabilities and have encouraged the formation of markets. As part of the transition, new laws have been enacted that grant community and local ownership of renewables, for example through community shares [1]. This has created an opportunity for small-scale energy generation companies, among them community energy groups [21]. Measures to improve engagement and communication with prospective communities have also been implemented, for example the publication of a UK government Community Energy Strategy in 2014. The strategy encouraged the development of networks and the transfer of learning within the community energy sector, thus contributing to the growth of the sector [21].

Lessons can also be drawn from legislation that adversely affects community growth. Official registration as a renewable energy cooperative has previously been blocked by the UK Financial Conduct Authority, with the decision being based on an assertion that members would not participate sufficiently in organisations that focused on energy supply [24]. Furthermore, UK regulation prevents energy cooperatives from acting as small-scale energy suppliers, as they are too small to apply for supplier licences. This has been harmful to the sector [12].

In Spain, the right to participate in electricity generation has historically been limited, although this changed at the end of the last decade. Cooperatives had no authority to generate electricity, being only able to distribute and market it. This meant that people could participate only via self-consumption, limiting the ability to take advantage of revenue from generation export [13].

2.6 Energy prices & Renewable energy technology costs

Energy prices and the cost of renewable energy (RE) technologies can also play a role in supporting the growth of energy communities, in addition to governmental support for renewables through financial incentives or favourable legislation.

In Spain, an increase in electricity prices in 2012 was observed to lead to a corresponding increase in the creation of new energy cooperatives as community members sought a way to lower the costs of their energy [1]. The work reported that many cooperatives took on the role of suppliers, providing cheaper electricity to members.

In a set of participatory case studies performed by the COMETS project, the Polish and Spanish groups identified that the increasing prices of energy would stimulate the development of CAIs [25]. In the same report, the scenarios for Estonia, Poland, Spain, and Italy showed that improvements in RE technologies and a reduction of their costs would propel the growth of CAIs.

In a paper from 2018 that reviewed the available data and literature on energy cooperatives in Denmark, Austria, Germany, and Great Britain, a link was made for all four countries between the decreasing costs of solar PV and a higher number of cooperatives utilising PV [22].

In Germany, "[s]ince 2012, RE plant owners have had the possibility to directly market their electricity and receive the difference between fixed tariff and average exchange price – the so-called "market premium" – from grid operators. This FiP [Feed-in Premium] system has been compulsory since the 2014 amendment of the EEG" [12]. The Feed-in Premium system provides some protection for RE generators against fluctuations in energy prices.

ZEV communities in Switzerland (see Section 2.4) do not pay any grid utilisation fees on electricity they produce and consume themselves. The amount a ZEV operator is allowed to charge members for electricity is based on the effective costs of generating the electricity locally and cannot be greater than the local network operator charges for grid energy [23]. These three points mean that the electricity price members of ZEVs pay will always be less than what the network charges non-members. ZEV members are also protected from price fluctuations due to the costs of local generation only going up if new investment is made, not due to energy market price dynamics.

Further research into this area is recommended to explore energy price impacts on EC development in more depth (see Chapter 8).

3 Decline in energy community growth in Europe

Following the growth of energy communities (ECs) as described in Chapter 2, various factors consequently led to a decline in that growth, both in new incorporations and shutdowns of previously active ECs. Various European countries were researched, and a graphical representation of the growth and decline was generated out of the COMETS dataset (see Figure 6 in Section 2.1). While a variety of barriers to EC creation and operation were identified, a small set of specific factors were seen to be the cause of, what the researchers termed, the 'Winter of ECs' in Europe; and those countries that did not experience this phenomenon were seen to have clear reasons why. This chapter discusses the specific challenges faced by various key countries in Europe and concludes by bringing the factors affecting EC decline together.

3.1 Challenges affecting ECs

In Germany, changes to the Renewable Energy Sources Act (EEG) throughout the 2010s led to capped feed-in tariffs (FiTs) and then a complete replacement of FiTs with an auction-based tendering system for renewable energy grid feed-in rights [22]. While small-scale installations were exempt from this auctioning process, no suitable financial incentive was forthcoming to support energy communities. The regulations became geared towards larger, market-level renewable energy production. 2015 saw the number of new cooperatives fall 25% compared to 2014 [1]. This was the start of an ongoing drop in new energy communities [16]. Both Figure 6 and Figure 14 show a strong visualisation of this decline.

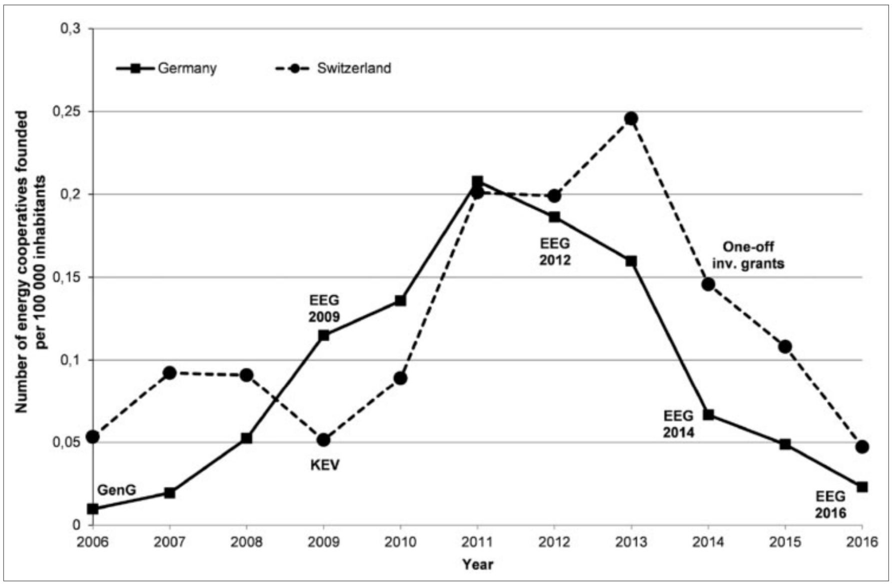

Figure 14 - Number of newly established energy cooperatives per year in Germany and Switzerland from 2006 - 2016
Note: EEG = Renewable Energy Sources Act; GenG = Amendment of the Cooperatives Act; KEV = compensatory feed-in remuneration scheme.
Image source: [16]

Similarly to Germany, changes and uncertainty in Swiss energy policies in the early to mid-2010s led to a dramatic decline in newly incorporated ECs [16] (see Figure 14). A significant waiting list for gaining government financial support via KEVs developed by 2013 [15]. [16] states that “As early as 2012, new applicant projects had little chance of ever being funded.” This, along with “complicated regulations such as tax deductibility (provided for one's own investment, but not for involvement in a cooperative)” [15], the introduction in 2014 of a one-off payment for self-consumption meant to replace the current KEV funding mechanism, and the limits of what volunteers in local ECs could handle being reached [15], meant the environment for EC development soured. Continuing weak and unpredictable government support policies and an only partially liberalised energy market providing limited sales opportunities for energy generated by ECs (smaller consumers (less than 100 MWh) are tied to a single regional supplier) [16] exacerbated the decline in ECs in Switzerland by keeping them isolated and lacking wider support.

In Denmark, a pioneer country for ECs, two factors drastically reduced the occurrence of ECs (an 88% drop since the year 2000 according to [22]): a shift in political discourse against green energy [18] and the liberalisation of the European energy market, both occurring in parallel during the 2000s. This decline is visualised in Figure 15. The FiTs scheme was ended in 2003 by an anti-renewables government. Without this financial incentive, the fruition of new communities was delayed and “many existing ones were dismantled” [1].

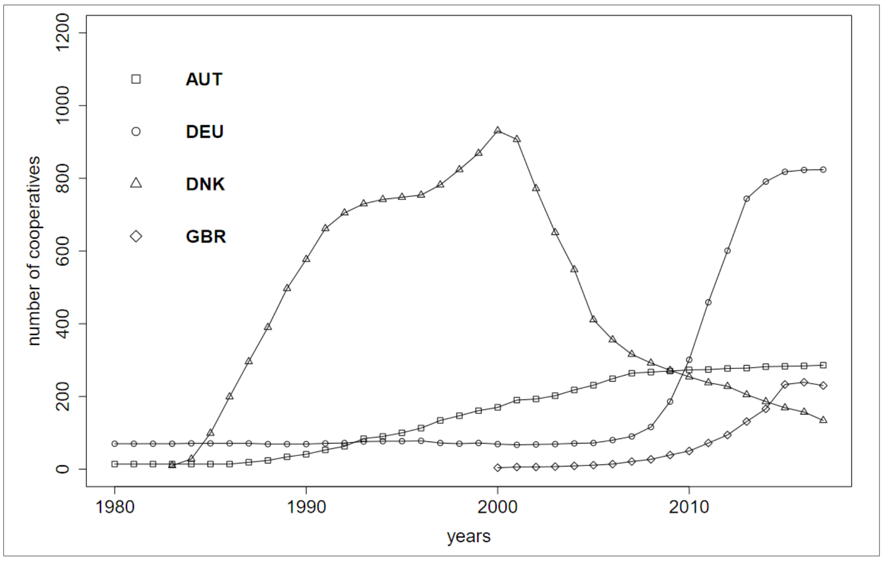

Figure 15 - Number of energy cooperatives in Austria (AUT), Germany (DEU), Denmark (DNK) and Great Britain (GBR) per year from 1980 – 2018
Image source: [22]

With the liberalisation of the energy market, previously favourable conditions for the creation and operation of ECs were demolished in Denmark. “A focus on international competitiveness creates pressure to establish competitive energy prices in order to have the national industry compete internationally” [18]. This led to “low spot prices on the common electricity market” [18] and exposure to the price volatility of the markets [12]. ECs, who now had to operate under these market conditions, could no longer compete and became financially unviable. Another contributing factor to the decline at this time was generous incentives for “decommissioning and repowering old turbines” [12] set up by the same government. This led to the now at-risk cooperatives selling off their assets to commercial developers and shutting down the community ventures [12].

The UK's electricity system has been (and remains) heavily centralised. There was a push towards decentralisation during the Conservative - Liberal Democrat coalition years of 2010 to 2015, realised via generous FiTs payments, no feed-in caps for small-scale producers, and tax reliefs. This led to an increase in EC incorporation. However, the setting of energy policy and regulation remained at the national level, so when government policy shifted away from the localisation movement at the end of the coalition in 2015, a significant drop in new ECs entailed (see Figure 16). A serious reduction in FiTs payment levels, a cap on feed-in allowance, the removal of tax relief and other financial incentives, and an increase in planning complexity for small producers all impacted the ability of ECs to be and remain viable [22]. Policy shifted to encourage large-scale energy infrastructure projects [21]. At the same time, local planning decisions in favour of on-shore wind started to be vetoed by the national government, effectively stalling the ability of small and large renewable wind power producers from creating on-shore wind farms, cutting off another avenue for ECs [21]. Overall, the energy system in the UK has not been that influenced by the EC movement and ECs remain niche [21].

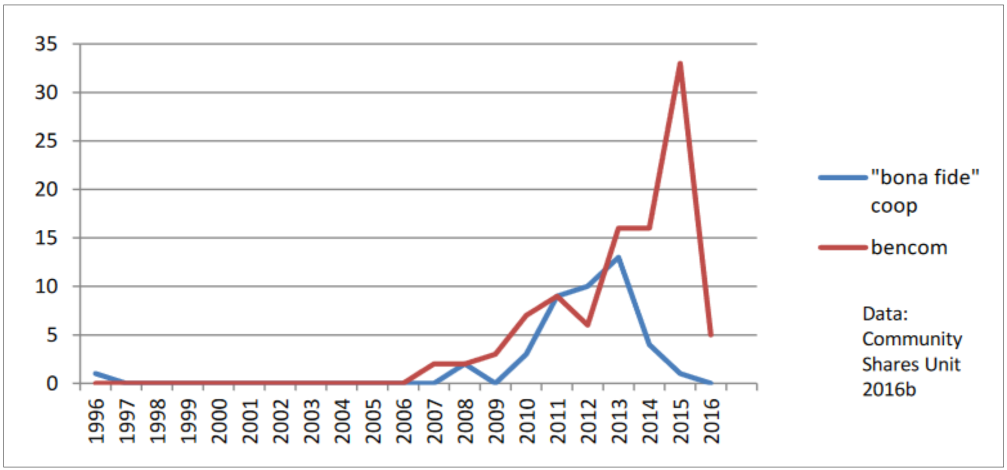

Figure 16 - Registrations of community energy cooperatives per year in the UK from 1996 – 2016
Image source: [21]

In Sweden, a strong welfare state and low carbon energy mix limited the growth of ECs [20]. "[T]he Swedish discourse on passive citizenship and the welfare state leads to little perceived necessity for grassroots actions" [18]. This lack of community focus, in the energy sector specifically, is likely due to state institutions being "very active" [18] in the energy transition, with municipalities taking a leading role as suppliers of all forms of energy [26]. The low carbon energy mix Sweden already benefited from - hydro and nuclear power are the principal sources - also removed a key driver for EC instigation, namely a desire to decarbonise energy production. This approach of large, centrally-controlled power generation, like in the UK and the Netherlands, led to a lack of government or financial incentives for small-scale production [18], [20].

Even with these small numbers of ECs, the influence of changing regulation in Sweden can be seen on the number of new community initiatives set up (see Figure 17). A new tax regulation in 2009 affected the uptake of wind initiatives leading to a decline in their numbers. Electricity prices have also been low since 2012 which has removed even that incentive for community energy [20]. It is not discussed in the paper that Figure 17 is from what might have caused the steep decline between 1999 and 2001. Even though a clear rise and fall of EC incorporation is indicated, a full-blown Winter of ECs in Sweden is not likely to occur due to the small volumes of communities overall.

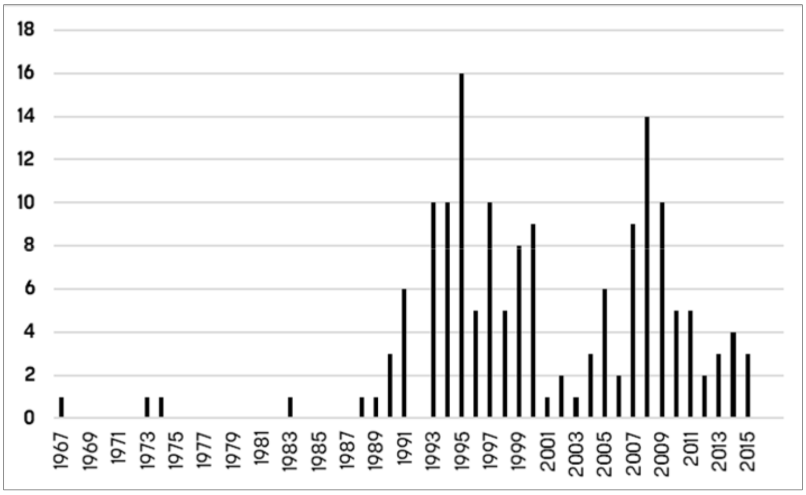

Figure 17 - Number of community energy initiatives starting each year in Sweden from 1967 – 2015
Image source: [20]

3.2 Exceptions to decline trend

In the Netherlands, a historical dominance of centralised fossil-fuel institutions and a focus on being competitive on an international scale [18] meant the EC movement only took hold in the late 2000s and 2010s. No evidence of a Winter of ECs was found for the Netherlands. Barriers to the creation and operation of ECs were identified in the research (see [27]), but they are not unique to the Netherlands so will not be discussed here.

France, Spain, and Türkiye also show little to no evidence of experiencing a Winter of ECs. This could be due to the lower uptake of the EC model in these countries in the first place. France has a dominant energy player in EDF [4] and an already low carbon energy mix with nuclear making up 92% of the electricity generation, taking away two key incentives for EC creation [7]. Spain's EC journey struggled against a cultural scepticism of cooperatives [28] and from delayed regulation that would enable community participation in energy production [29]. In Türkiye, a lack of formal regulations [13], a low trust environment, the energy market's lack of legitimacy, strong risk aversion from the population, and a cultural prejudice against the cooperative model [17] all contributed to the country's limited EC uptake.

[4] https://www.edf.fr/en

The rise and fall trends in number of EC incorporations per country aligned across the reviewed literature and the graphs generated out of the COMETS dataset (see Figure 6 and Figure 7 in Section 2.1). The exact numbers were not compared.

3.3 Factors affecting decline

Overall, the decline in EC growth seen in Germany, Denmark, the UK, and Switzerland was led by a shift in political discourse towards uncertain and unsupportive governments and policies. This manifested itself as:

- the dampening or removal of government financial incentives;
- regulation being amended to favour large scale production;
- complicated tax reliefs and planning regulations;
- the capping of feed-in allowances; and
- shifting and unsettled policies.

For those researched countries that did not experience the decline, namely Sweden, the Netherlands, France, Spain, and Türkiye, the main reason was the limited or delayed uptake of ECs in the first place. This was seen to be due to:

- an existing low carbon energy mix;
- centrally controlled energy players dominating the market;
- cultural scepticism towards cooperative structures generally;
- a lack of formal regulation; and
- either a high trust environment with a strong welfare state (e.g. Sweden) or a low trust environment with high risk aversion (e.g. Türkiye).

The factors identified as causing or exacerbating the decline of new ECs will be compared with factors identified as important for EC growth in the next chapter, with a view to establishing what an enabling environment for ECs looks like and how that evolves into the future.

4 Enabling the next growth phase

Despite the decline in energy community (EC) growth seen in some European countries (see Chapter 3), the EC model is still appealing and continues to be adopted by many communities across Europe despite the difficulties. With the implementation of the Renewable Energy Directive (RED II) and the Energy Market Directive (ED 2019) as part of the Clean Energy Package (CEP) [13], the EU has given a clear indicator of the important role it wants ECs to play in the energy transition and energy future across the continent.

> "Given the novelty of the two directives and the usual long gestation period of any major revision of EU legislation, it is likely that the EU legal framework currently in place will be the one shaping the development of RES [renewable energy sources] communities for most, if not all, of the decade up to 2030…" [6]

It is expected that 264 million European citizens will join the energy market as prosumers by 2050, generating up to 45% of the renewable electricity of the grid [4]. To create a suitable growth environment for the EC movement in countries in all stages of EC development, the factors that caused the decline in new ECs (as described in Chapter 3) and any remaining barriers to EC creation and operation need to be overcome.

This chapter investigates the aspects that enable growth of new and existing ECs, delving into three main areas: financial and business aspects, regulatory and policy aspects, and the overall environment that enables growth.

4.1 Critical aspects to enable growth

The overarching drivers for transformation and growth in the energy sector are well understood, namely: the increasing impacts of climate change and the need to move away from carbon-intensive generation; continued improvements in renewable energy (RE) technologies; increased adoption of RE systems leading to, sometimes significant, price reductions for the technology; changes to legal and regulatory systems to encourage adoption of RE technology; and fluctuations in energy prices due to geopolitical influence [25].

A distinction between these growth *drivers* and the necessary *factors* for enabling ECs is important to make. ECs are a particular form of energy system, combining stakeholders from across a spectrum that traditionally has not included the public or groups of citizens, where the purpose is not necessarily profit-oriented, and deep knowledge of energy physics, technology, or infrastructure might not be present. These necessary factors have been identified by [25] as:

- a commitment to the energy transition at a national level;
- that the relevant regulation is in place;
- the ability for citizens to get involved in the energy transition;

- the need for citizens to be informed and empowered;
- for citizens to actively participate;
- that suitable subsidies and financial support mechanisms exist;
- continuing energy and electricity price increases; and
- innovation and exploration of new energy sources, technologies, and solutions.

What can be seen from this list is that appropriate regulation, financial mechanisms, and knowledge are the key areas that enable ECs to contribute to the wider energy transition.

Countries that have pioneered the implementation of ECs can and should be learnt from. The “crucial steps” [4] that a country can take based on learnings from these leading players are:

- “the improvement of law making and its understandability and readability;
- the proliferation of economic benefits;
- the reduction of the existing limitations on systems & grid;
- the adequate dissemination of the concept of sustainability; [and]
- the development of dedicated awareness campaigns to boost social awareness." [4]

These learnings show that it is not just technical skills that will determine the success of an EC project. Social skills, in particular information dissemination and negotiation, are vital to ensuring a project is accepted by the local and wider communities [7]. It is thought that:

> "...simply addressing technical constraints in legislation, economic incentives, and technical barriers could be less effective than combining these actions with a proper information campaign focusing on EC benefits for the individual and the environment to develop the necessary social engagement crucial to sustainability." [4]

Deliverable 4.1 - *Characteristics of energy communities and motivations, engagement, and socio-economic profiles of end users* (D4.1) discusses the social and societal aspects of ECs in detail.

Many of the key barriers to the growth of new and existing ECs can be overcome by rethinking / reintroducing government-supported financial incentives, rethinking regulation, as well as setting and keeping in place long-term supportive policies. The remainder of this chapter discusses these aspects in more detail.

4.2 Financial support and changing business models

Much of the reviewed literature (including [1], [3], [4], [7], [15], [21], [25], [29], [30]) suggests that supportive financial policies and economic support for ECs, from both the public and private sectors, are necessary for EC growth. These come in the form of feed-in tariffs (FiTs), tax incentives, subsidies, grants, and market-based remuneration methods. The breadth of support mechanisms determines the available business models for ECs. Three of the four lessons to be learned from a pioneering EC country (the Netherlands) for increasing the speed of EC growth in other countries (according to a study comparing a pioneer country to a laggard country [4]) are financial, namely: improve market access, improve flexibility, and have tailored tax policies for ECs. This indicates the importance of financial mechanisms to the usage of ECs as a contributor to the energy transition.

The strength of governmental support and incentive schemes has a direct impact on the success of ECs. “This is seen in their rapid expansion after policy support schemes became more widely available across Europe” [1]. Incentives should have clear definitions, be convenient to make use of, and be consistent and long term to be sustainably effective [4].

Financial support differs per country and down to the municipality level. These differences require that ECs, while fundamentally local organisations, are able to access information about what is available specifically for them. These differences are seen in the reviewed literature. For example, the paper ‘*Community renewable energy in France: The state of development and the way forward*’ [7] describes a national fund called EnRCiT, regional subsidies, local investment grants, bank warranties from local authorities, and "crowd-equity-raising platforms such as Energie Partagée Investissement (EPI)" [7] as options available for ECs to gain funds – a mix of both public and private support; while the working paper ‘*The Evolution of Community Energy in the UK*’ [21] from the UK Energy Research Centre (a country where most government-led financial mechanisms have been removed) describes how community share issues, businesses that provide services to community initiatives such as Energy4All, alternative financial platforms which enable ordinary citizens to provide financial backing, and the usage of revenue from currently running ECs to fund new communities are innovations in the financing of ECs that “aid in replacing [the] loss of other financial avenues.” [21]

The outlook of communities to be viable in the long run is not always positive. A survey of Swiss ECs in 2018 found that approximately 70% of respondents did not think their EC would be regularly distributing a return to members in the next five years, nor would the ECs be supplying a large part of their own community with energy, with approximately 85% responding as such [15]. These worries need to be addressed to enable ECs to become attractive and viable options for citizens and investors.

To ensure energy communities remain viable in the long term, business models that can gather sufficient funding, either externally or through becoming self-sustaining, are needed [1]. Re-assessing and updating business models will also enable ECs to take advantage of different aspects of the energy sector.

Providing a variety of energy services to current energy system participants, such as DSOs, opens up revenue streams to ECs and embeds them directly into the wider energy industry, allowing them to become indispensable assets with a voice in the industry. These services could include flexibility services such as demand side management and time-of-use optimisation (which become increasingly important as more intermittent renewables attach to the grid) and aggregation services. For example, sector coupling (AKA “multisector market coordination” [29]) is an area where local ECs could be the enabler and leader for local industry to connect, focusing on energy efficiency between a variety of local businesses and organisations.

Opening access to energy markets enables ECs to get involved in the wider energy system and not just focus on local contribution. The types of markets include wholesale energy markets, peer-to-peer markets, local flexibility markets, ancillary markets, and capacity markets [29]. Access to markets allows for new sales opportunities for the energy an EC generates (whether wholly due to a better return or excess energy that the community itself does not use) meaning ECs can diversify their revenue opportunities.

Currently, some market-based remuneration mechanisms can “pose certain restrictions for energy communities because of their small size and resources” [1]. For example, Italy’s implementation of the RED II directive into national legislation specifies that an REC can have a maximum incentivised power of 200 kWp [4]. This does not leave a lot of scope for scaling a community to the size needed to compete on the open market. When non-market schemes are not available or limited in scope, this can highly limit the likelihood of ECs to even get off the ground because the economics do not make sense. This leads to the need for more innovative financing schemes to “overcome barriers to investments” [1]. The ability for ECs to participate in commercial energy activities is becoming both increasingly possible and vital to their growth, as individual communities and as a conceptual mechanism contributing to the wider energy system transition. Commercial activities do not need to conflict with an EC’s social objectives [1]. In fact, the JRC Science for Policy Report ‘*Energy communities: an overview of energy and social innovation*’ concluded that ECs “are most likely to succeed when delivering value for all types of customers and the wider energy system” [1].

A wider set of business models available for ECs to choose from also enables them to become more adaptable to changing regulations and incentives, boosting their resilience. How ECs make use of these different financial instruments can be determined based on the overarching goals and focus of each EC individually. For example, if the goal of a community is to provide renewable energy to local consumers, they might focus on measures that prioritise self-consumption or local grants; whereas a community whose focus is getting the greatest return on investment might focus on measures that generate the highest price per kWh. However, it needs to be stated that business models and their implementation rely on public support because this, directly and indirectly, “determines the available financial resources" [7]. Financial support for ECs is tied to how the public perceives the EC’s potential and actual impact (both positive and negative).

The decrease in the cost of renewable technologies and increases in energy prices also enable and incentivise people to come together to form ECs [25]. EC business plans and pitches can make use of these factors to encourage investors to invest and citizens to become members, by investing themselves and/or providing space for renewable generation assets.

Enabling the next growth phase of new and existing ECs is heavily dependent on what money is available to them and the diversity of revenue opportunities, allowing for sustainable business and enabling adaptability to changing incentives and regulations.

4.3 Regulation and policy

Regulation has been identified as a key factor in the development and success of energy communities in Europe, specifically in the following reviewed literature [4], [6], [16], [15], [21], [25], [19], [29], [30].

Section 2.5 of this report describes specific areas of legislation and policy relevant to ECs for the countries considered in this research.

> "The activities of energy cooperatives, and community energy more generally, do not take place in an institutional void (Creamer et al., 2018). Rather, interaction with and support by governments are recognized as crucial for thriving community energy organizations (Hoppe, Graf, Warbroek, Lammers, & Lepping, 2015)." [16]

Various specific regulatory aspects are shown to be important to the growth of ECs. These include:

- having a legal definition of EC types;
- having a stable and consistent governmental policy environment;
- that regulations are as simplified as possible with guidance on usage and implementation provided;
- that the timing of regulation implementation is optimised;
- that political resistance is minimised through increased EC representation in policy making;
- that the impact of regulations on financial support is well defined;
- that over-regulation is avoided; and
- that there is an understanding of the relationships between energy and non-energy regulations on EC development.

Legal and regulatory frameworks are important because they define the "rights that an entity is entitled to and the obligations it must abide by" [6]. This is particularly important for actors in the energy sector because it is a highly regulated industry with a wide variety of interacting organisations. Legal recognition also provides validation of the concept of ECs and the contribution they can make to the energy transition [6]. Having a definition of energy community in national law enables growth through certainty and recognition. Countries that do not yet have this or where recognition in law was delayed have been hindered in their EC growth (e.g. Spain [19] and see commentary in Chapter 3).

The way regulations are implemented at supranational, national, regional, and municipal level defines how supportive or unsupportive the environment will be for ECs in each region. In the EU, for example, how the CEP directives are interpreted into national policies is considered indicative of how successful ECs will be [6]. It has been suggested that "local governments are best positioned for collaboration with community energy" [16], but it remains important to highlight that "local energy governance arrangements must be understood in the context of multilevel governance, which includes federalist systems" [16]. The options for implementation of regulations can be stricter versus less prescriptive, with more versus fewer provisions for ECs. Specifics of how these supportive and unsupportive attitudes could play out in the EU are discussed in Section 4.4 as they lead to defining what an enabling environment for ECs could contain.

The timing and order in which measures are implemented by policymakers can affect the growth trajectories of ECs. "...policymakers should be cognizant of the progression of policies in order to elicit the desired outcomes with respect to EC growth specific to their region or country and its goals" [29]. For example, if a region wants to increase the number of ECs with a focus on self-consumption, introducing a policy for ensuring self-consumption-type communities are legally recognised before finalising favourable energy tariffs for such communities would make procedural sense.

Consistency and a long-term view are vital to successful EC growth. As with any infrastructure project, the return on investment (ROI) timescale for energy community investments is in the decades. This means that any fluctuation in the support and regulations that the community has to adapt to could negatively impact this ROI, making initial commitments less attractive to all actors. The Swiss ECs surveyed in [15] emphasised that "…the energy policy environment must be geared to the longer term in order to promote renewable energies and energy cooperatives" [15].

Situations where politicians promise and then renege on EC support need to be avoided as well. This was experienced in Spain and the Netherlands where CAI participants in the COMETS project Participatory Case Studies stated that "politicians keep on saying one thing and doing the opposite" [25]. Public administration, not just politicians, must also avoid acting in an inconsistent manner. A Spanish EC expressed an environment where "the public administration spreads a message in favour of energy communities while the regulation is slow and sometimes deliberately delayed" [25], leading to uncertainty in the future of the EC. The high demand on EC projects due to complex regulations and this "uncertainty in the political environment" [15] were identified in [15] as limiting factors on EC growth, with the impact of these only increasing in the next five years. In Switzerland, surveyors noted that "cooperatives are not very ambitious with regard to their growth. This is probably due, among other things, to the uncertain political environment and the sales difficulties" [15]. However, as part of the RED II EU directive, Member States have to "ensure the removal of unjustified regulatory and administrative barriers" [6] as they implement their EC framework, so there is a process happening to minimise these limiting factors.

Along the same vein, political resistance is also a barrier to supportive regulation and policy making. In Switzerland, this was not considered a big issue with only 11% of survey respondents feeling limited by political resistance. However, this was expected to increase in the coming years [15]. These limiting factors can breed frustration and lead to a tumultuous situation for ECs [15], so the stability of political environments towards the energy sector, and ECs in particular, needs assurance for EC growth. An increase in representation of ECs at all levels of government and politics increases the likelihood of supportive regulation and policy being put forward and ultimately implemented [15]. Representation also helps limit political resistance as awareness grows within governments and political parties.

Policies from other non-energy regulators also have an impact on the growth of the EC concept [21]. In particular, land use planning, environmental regulations, noise pollution regulations, construction and building regulations, financial market regulations, among others, can all impact the ability for an EC to incorporate and operate, even down to the level of controlling the types of technology that can be used by an EC or the business models that can be adopted.

On the flip side, too much regulation can be stifling, putting heavy demands on individuals trying to set up an EC and/or on people trying to operate an EC. One example seen in the research was from the results of a survey of Swiss ECs [15] in which a regulation which allowed for tax deduction for investments in one's own assets but not for involvement in a cooperative conflicted with a self-consumption regulation that encouraged self-consumption as part of a community. It is easy to see how inconsistencies and over-regulation like this would hinder EC adoption.

Regulations also impact on the financial aspects of ECs. For example, in the EU RED II directive, there is an article relating to "cost-effective network charges, and other relevant charges, levies and taxes, which must ensure an adequate, fair and balanced contribution of communities to the overall cost-sharing in the system (art. 22.4, letter d)" [6], ensuring that Member States consider financial aspects in their implementation of the directive into national regulation and policy. Revisit Section 4.2 for further details on how the financial aspects impact EC growth. Have a look at Section 2.5 of the D4.1 report for a summary of how the CEP directives define ECs.

4.4 Enabling environment

Taking the insights from the previous sections in this chapter, the factors that create an enabling environment for the growth of new and existing ECs are summarised in this section, along with a deeper look at the supportive and unsupportive measures that impact EC growth based on the work in the paper '*The future of renewable energy communities in the EU: an investigation at the time of the clean energy package*' [6].

The factors that create an enabling environment for energy communities are laid out in Table 2. The factors are grouped into categories loosely aligned with the focuses of the sections in this chapter. Alongside the expected financial and regulatory factors, societal and behavioural aspects are of equal importance. In particular, gathering, documenting, and sharing knowledge and information about the energy community concept and learnings from existing ECs will both expose more people to the possibilities of ECs and aid new ECs in setup and operation [4], [16], [19], [29].

Table 2 – Enabling environment factors for energy communities

Category	Factor
Governmental	Increase in representation of ECs at supranational, national, regional, and local levels
	Increase in stability of political environment towards the energy sector and the EC concept in particular
	Increase in long-term thinking in EC finance and policy
Energy industry	Increasing importance of flexibility (in operation and as a service) to the distribution and transmission grids
	Sector coupling increases in viability and application, giving ECs more options for revenue generation
Societal & Behavioural	Increasing knowledge base, knowledge access, and knowledge sharing about and between ECs

Category	Factor
Financial	Continuation and increase in financial support for EC types
	Access to energy markets for appropriate EC types
	Energy prices remaining high, leading towards people exploring alternatives such as ECs
	Renewable energy technologies continue to decrease in price, reducing the upfront costs
Policy & Regulation	The implementation of policies that: ● enshrine in law different forms of ECs in more regions ● have clear and progressive goals for encouraging and growing ECs and their contribution to the energy transition [30] ● “preserve space for smaller actors in the energy transition, and avoid the creation of new infrastructure monopolies in the fields of energy data and smart energy systems” [30] ● improve market access for ECs ● tailor tax incentives to enable/encourage/incentivise ECs ● enable peer-to-peer trading for ECs ● allow for ECs to perform aggregation management ● prioritise self-consumption ● support “community and shared ownership targets for energy generation projects” [30] ● “take a ‘whole society value’ approach and recognise the benefits community energy brings to other policy areas (local economies, health and wellbeing, etc.)” [30] ● promote a strong local community mindset ● work towards the democratisation of community energy [30]

The impact of the factors on the types of ECs is an area that warrants further investigation. [29] found that:

> “…many market-focused measures, including wholesale, local flexibility, capacity, and multisector market measures favor larger, more integrated communities, while regulatory, legal, and organizational measures, including peer-to-peer trading, aggregation, and self-consumption favor smaller, more distributed communities.” [29]

Section 4.3 discussed that the way regulations are implemented can impact how supportive (or unsupportive) an environment for ECs could be. The paper ‘*The future of renewable energy communities in the EU: an investigation at the time of the clean energy package*’ [6] takes a deep dive into how Member States could implement the CEP to be more or less supportive of ECs in national policy. This work is particularly informative in understanding factors that create an enabling environment for ECs. A conceptualisation of renewable energy communities into two motivational categories (Economics-driven and Relation-driven) and two geographical categories (Local and Dispersed) was performed by the paper's authors (see Figure 18). This conceptualisation is reminiscent of the community archetypes developed in D4.1 within GENTE (see Section 6.3 of that report). The paper [6] defines supportive and unsupportive measures for each EC type defined in the EU directive (JAACs, JARSCs, CECs and RECs).

	Prevailing Motivation	
Geographical Scope	Local & Economics-driven	Local & Relation-driven
	Dispersed & Economics-driven	Dispersed & Relation-driven

Figure 18 - Conceptualisation of RES communities from [6]

Table 3 (see pages 45 - 47), created by the authors of this report (D3.1), collates the *measures* with the conceptualised *categories* to more easily show the types of measures that are expected to be effective for different types of EC. This is particularly useful for GENTE as it aims to cover a broad spectrum of energy community types. Having insight into the different needs of each EC category is valuable for the creation of an effective and useful toolkit within GENTE. The information within Table 3 is grouped with the following headings:

- **Potential**: This heading includes information about the potential purpose, goals, and values the category of EC can support.

- **Limit**: This heading includes information about the boundaries and limitations of the category of EC.

- **Relevant EU EC types**: This heading includes a list of the relevant legal EU EC type for the category of EC.
    - JAAC = jointly acting active customer
    - JARSC = jointly acting renewables self-consumer
    - CEC = citizen energy community
    - REC = renewable energy community

- **Supportive**: This heading includes a list of the *measures* that would support each category of EC.

- **Unsupportive**: This heading includes a list of the *measures* that would hinder each category of EC.

GENTE is contributing to the EC enabling environment by:

- facilitating representation of ECs in government through the co-design process for new ECs, involving actors from all stakeholder groups [governmental factors];
- developing technologies that enable greater awareness and control of energy assets within communities, meaning the dimensioning and operation of an EC can be optimised, leading to potentially lower upfront and ongoing costs [financial factors]; and
- the creation of a toolkit for EC adoption and operation [societal factors].

The enabling factors and supportive / unsupportive measures presented in this section directly informed the future energy community scenarios created as part of this research. These scenarios are presented and discussed in Chapter 6. What is clear for a successful EC environment is that “energy regulators need to be allowed to look beyond just reliability and lowest cost” [30] and take into account other governmental, industry-related, societal, and behavioural aspects.

As stated in [24], the effectiveness of any measures aimed at enabling the growth of the “extraordinarily multifaceted phenomenon” [6] that are ECs greatly relies on how those measures are implemented. This is due to the variety of definitions of ECs; their differing goals, financial situations, regulatory environments, technical know-how, community spirit; being “very heterogeneous in terms of organisational models and legal forms” [1]; and the wide breadth of factors that influence their potential for growth.

In the next chapter, a discussion of how ECs are predicted to evolve in the future is undertaken, covering the progression of these growth enablers into future scenarios.

Table 3 - Conceptualisation of energy communities based on geographic scope and prevailing motivation, including supportive and unsupportive aspects. Collated from [6]

Supportive and Unsupportive Aspects		
	Prevailing Motivation	
Geographical Scope	*Economics-driven*	*Relation-driven*
Local	Potential: Align private interests of members and coordinating collective action	Potential: Development of new forms of relation that allow for sharing of fulfilment of specific needs and preferences
	Limit: Restricted size & scope of communities	Limit: Limited size, high costs, possible difficulty in attracting enough engaged members
	Relevant EU EC types: JAAC | CEC | **JARSC** | **REC** (Bold: contain options to “weaken negative effect of limited size and scope” [6])	Relevant EU EC types: JAAC | CEC | JARSC | REC

		Supportive: ● set remuneration level for self-generated electricity sold to the grid as a combination of market energy price and the long-term value to the energy grid, society and environment ● support schemes must provide fair and even access to available subsidies	Supportive: ● enable ECs “to be involved in a broad number of activities: not only the generation, storage, consumption and sale of energy but also its sharing within the community and the possibility of participating in flexibility and energy efficiency schemes” [6] ● possibility for ECs “to own, establish, purchase or lease distribution grids and to autonomously manage them.” ● treatment must be in a “proportionate and non-discriminatory manner” [6] ● ensure cooperation with DSOs ● relieves cost pressure by opening up variety of activities ● encourage & enable the involvement of tenants & building-owners ● tools to access finance and support ● tools that enable safe sharing of data ● regulatory support for public authorities wanting to set up or participate in ECs
		Unsupportive: ● free to limit remuneration for feed-in electricity to the market price ● free to introduce charges for self-generated-self-used electricity (ie self-generated electricity that never goes onto the grid) ● not providing adequate support schemes ● strict application of the proximity condition for RECs	Unsupportive: • less strong implementation of measures to support ECs

Dispersed		Potential: Larger amount of resources, operating a more diverse set of activities	Potential: Aggregation of like-minded people from diverse geographies
		Limit: Expansion & professionalisation of the community may lead to attracting fewer engaged members, losing the participatory governance of ECs	Limit: Potential weakness of bonds that connections members of these types of communities
		Relevant EU EC types: JAACs | CECs (the regulations do not limit geographic scope)	Relevant EU EC types: JAACs | CECs (the regulations do not limit geographic scope)
		Supportive: ● mandated enabling framework can be applied in such a way to require disperse ECs to maintain beneficial characteristics of local ECs, such as voluntary participation, control by members, and non-financial primary purpose	Supportive: ● right to perform several activities ● treatment must be in a "proportionate and non-discriminatory manner" [6] ● promotion of networking between communities and enabling federation of communities
		Unsupportive: ● potential for no specific support to be implemented for dispersed ECs as this is not mandated	Unsupportive: ● potential for no specific support to be implemented for dispersed ECs as this is not mandated

5 Evolution into the future

The energy transition requires a multi-faceted approach with a much wider range of contributors than in more traditional energy setups. The move towards decentralised, intermittent generation with the decreasing costs of renewable technologies has opened up the landscape for the public to become energy citizens, producing their own energy for self-consumption and/or sale. In turn, this, along with supportive regulation and suitable finance options, enables different forms of energy organisations and businesses. Energy communities (ECs) are one of these forms, allowing ordinary citizens to play a role in the energy transition. Chapters 2 and 3 of this report discuss the history and progression of ECs in Europe, with Chapter 4 covering what factors enable ECs to grow both individually and as an applied concept more widely. Now, a look at how ECs are expected to evolve in the future is given, through a review of the available literature. Three core topics became apparent: collaboration between ECs, the professionalisation of ECs, and the continued heterogeneity development versus a move towards homogeneity of ECs.

5.1 Collaboration

Collaboration between ECs is expected to increase in the future. While always of importance, as ECs look to keep abreast of changing policies and take advantage of new opportunities, being in touch with other like-minded individuals and collectives will become a necessity to navigate the energy transition landscape.

The goals of collaboration among ECs can vary and are not necessarily mutually exclusive. Different types of ECs, in different stages of their development, will have different goals for collaboration. The types of goals (compiled from [7], [21], [25], [27]) include:

- to increase of operational efficiency through, for example, sharing administrative tasks, pooling resources, hiring permanent staff, coordinating actions, and implementing lessons learned elsewhere;
- to increase the number of members, investors, and customers;
- to benefit from economies of scale; and
- to increase the clout of ECs and EC representation within industry and government / politics.

Within the EU, the leeway in the way Member States implement the Clean Energy Package (CEP) directives allows them to promote “the emergence of networks of RES communities able to take advantage of their respective strengths and weaknesses and better support each other” [6].

Collaboration can take a multitude of forms including sharing knowledge and resources, offering services between themselves, and creating alliances. ECs can also join forces to create larger communities [27]. These forms take two main types according to [27]:

1. Alliances and partnerships
2. Cooperative development agencies

Type (1) leads to an increase in professionalisation. Type (2) targets commercialisation and scaling up. The difference between professionalisation and commercialisation is that professionalisation is a social process where an activity becomes able to support individuals as a means for livelihood, while commercialisation is a process where a product or service is made saleable and a price put on it. Various specific forms of the two types have been collated from the reviewed literature and are presented in Table 4.

Table 4 - Specific forms energy community collaboration takes

Form	Type	Information about specific form
Regional networks of ECs	1	Facilitate knowledge exchange Share best practices Being part of a network is considered by some to be "a "guaranty [sic] of quality"" [7]
Umbrella organisations	1	Facilitate knowledge sharing between ECs Example: REScoop.EU [5]
Energy associations	1	Provide access to other energy groups, industry knowledge, reputational validation, networking opportunities, amplification of EC voice Example: Verband unabhängiger Energieerzeuger (VESE) (Association of Independent Energy Producers) [15]
Local capacity builders	1	ECs that become catalysts for other ECs to be created in their region [6] [7] Because they have been through the processes of setting up and operating already, they can provide guidance to other groups through project initiation and implementation. Due to their geographic proximity, they can also help with operational issues on the ground.
ECs that fund ECs	1 & 2	Established ECs that fund the establishment of more ECs and sector collaborations [21]

[5] https://www.rescoop.eu/about-us

[6] "...some CREPs become local capacity builders and catalyse the emergence of other CREPs in their vicinities by centralising and mutualising information and by becoming local CREP trustees." [7]

Form	Type	Information about specific form
Specialist EC development companies	2	"These "intermediaries" can be seen as helping new or under-resourced groups engage on better terms with the existing energy regime, through providing technical knowledge, contacts, and labour time (most including producing key documents such as share prospectuses, or undertaking day-to-day administration, among their services)." [21]
Federated ECs	2	Groups of ECs that legally connect their communities, including IT infrastructure Similar to Aggregator ECs, but with a focus on energy generation and sale Goals: • To gain access to commercial level contract and service options • To provide better (more secure, higher price) ROIs to members • To better fulfil goals of communities
Aggregator ECs	2	Groups of ECs that legally connect their communities, including IT infrastructure Similar to the federated ECs form, but with a focus on providing energy services such as flexibility Goals: • To gain access to commercial level contract and service options and new revenue streams • To provide better (more secure, higher price) ROIs to members • To better fulfil goals of communities

The importance of learning from peer groups was highlighted in the literature [7]. Both collaborative forms make use of knowledge sharing as a tool. One of the outcomes of the paper '*Energy Communities Implementation in the European Union: Case Studies from Pioneer and Laggard Countries*' [4] is the lessons to be learned from two differing types of EC, showing how learnings from a well-established EC and its environment can facilitate the growth and improvement of an EC in a less supportive environment (see Chapter 5 of that paper for specifics of the lessons).

The benefits of collaboration do not necessarily translate to implementation in the real world. For example, the results of a survey of Swiss ECs in 2018 [15] show that a majority did not plan to cooperate with other ECs in the future (timeframe next 5 years) when it comes to exercising political influence, and even less expected that local networking would increase between ECs. Most of the expected collaboration was stated to be around joint projects and investments, but not around joint commercial activity such as purchasing or sales. The paper purports this varied reaction to EC collaboration to be due to the spontaneous nature of local networking and therefore its unpredictability.

The willingness of communities to engage internally and externally plays a large role in their success [31]. Sharing knowledge, forming influential groupings, and becoming legally federated are all forms this engagement can take. What is clear from the research is that any form of collaboration between energy communities is increasingly important to their success in contributing to the wider energy industry and transition, whether that be through greater influence or greater generation capacity.

5.2 Professionalisation & Commercialisation

Professionalisation is a social process where an activity becomes able to support individuals as a means for livelihood. The professionalisation of ECs involves the grouping of ECs into larger entities, changing to more market-centric business models, and moving away from work being done on a voluntary basis. Professionalisation is needed to make effective use of changing policy environments and to enable federation and sector coupling. A prerequisite is effective collaboration within and between ECs (see Section 5.1).

There is an expectation seen in the research that communities will professionalise [32]. ECs will transform from single cooperatives focused on hyper local goals run by volunteers to neighbouring cooperatives (co-ops) working together to gain more benefits for their members to co-ops acting as energy companies in their own right with paid employees, fulfilling a broader set of objectives such as providing balance and energy management services (commercialisation). How this professionalisation will affect the makeup of communities in terms of settlement patterns and regional locations is not clear at this point.

What can be distilled from the literature are the goals that community professionalisation is trying to fulfil and the forms this can take. The goals seen in the research are:

- energy community growth, taking various forms including increasing member numbers, boosting generation capacity, or creating the ability to offer energy services, among other growth mechanisms;
- having enough revenue to employ people to manage the EC and hire permanent staff;
- the ability to adapt to changing regulations;
- the ability to assess and take advantage of new business opportunities;
- the ability to increase the reach and impact of the community;
- increasing the return-on-investment (ROI) for members;
- increasing operational efficiency;
- boosting demand for renewable energy sources; and
- mobilising more prosumers.

The forms professionalisation and commercialisation can take include the Type 2 organisations as seen in Table 4 and in particular:

- becoming an energy services provider (e.g. flexibility services, aggregation services) to boost commercial revenue, leading to the ability to pay volunteers or hire staff;
- commercial federation of ECs;
- commercial relationship of an EC with an energy retailer; and
- co-development and co-ownership between EC and energy company of assets and operation.

The federation of ECs relates to communities having both a physical or virtual power connection and a contractual agreement to combine the community assets and services. This aspect of EC professionalisation was not researched as part of D3.1. It is recommended for further exploration as part of an assessment of potential and future business models for energy communities.

The paper '*Cooperatives, incumbency, or market hybridity: New alliances in the Dutch energy provision*' [27] presents findings from an assessment of the cooperative energy space in the Netherlands, focusing on how cooperatives are approaching scaling up their operations by forming alliances with energy companies. The creation of hybrid forms of energy company combining "commercial and cooperative drivers and mechanisms" [27] is observed. These hybrid forms show a shift to cooperatives acting more like utilities and utilities acting more like cooperatives. This is illustrated in Figure 19 taken from the paper. This hybridisation of energy organisations is a clear example of one form of EC professionalisation.

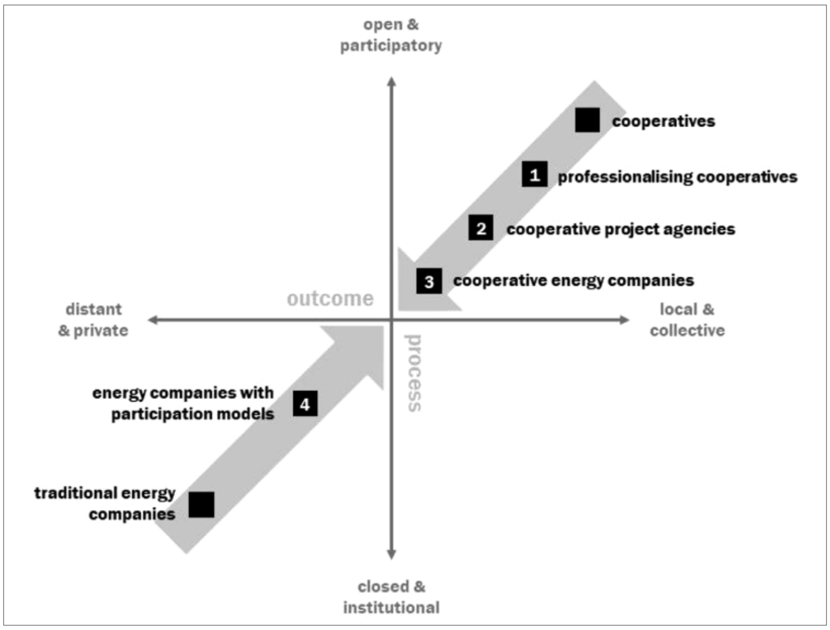

Figure 19 - The professionalisation movement of energy communities [27]

Another factor that influences if ECs commit to professionalisation is whether they are operating within the liberalised energy market. If so, the "environment demands a commercial or businesslike attitude" [18] because ECs are required to compete with other market players. This is the case in places such as Denmark, the Netherlands, and Sweden, for example.

The focus for pioneer communities is now on flexibility, market access, and tax policies [4]. All three require a certain level of professionalism in the EC to act like market players and appropriate business models to support the differing revenues.

As with collaboration, the drive or ability to achieve professionalisation is not always present in reality. The results of a survey of Swiss ECs [15] showed that, while the capacity for voluntary work within cooperatives was reaching its limits, greater than 75% of respondents stated they expected to still be reliant on voluntary work in five years' time. At the same time, "half sees an increasing professionalization of their organization, the other half does not" [15].

Collaboration, professionalisation, and commercialisation of ECs are intrinsically linked as innovations and adaptations ECs will need to make in the future to effectively adapt to a flexible energy and policy environment. Standalone ECs will still be possible, but if an EC wants to grow, collaborating, learning, and partnering with other ECs and EC organisations will be necessary.

5.3 Heterogeneity & Homogeneity

The current landscape for ECs is diverse. The breadth of terms used to describe energy communities (see Table 1) is a clear representation of the heterogeneous environment that currently exists. This environment could continue to exist in the future or a move towards homogeneity of the EC landscape might occur. Most likely is a mix – a shift towards homogeneity in some areas with continued heterogeneity in others.

The current and continuing heterogeneous landscape is mainly due (according to the reviewed literature) to the breadth of legal definitions of ECs and the differences in funding and regulatory structures that exist across regions. A persisting heterogeneous EC landscape manifests itself in three main ways. Firstly, with the continued existence of a variety of EC types, both legally recognised and grass-root organisations (see Table 1). Secondly, with differing penetration levels achieved by ECs as a whole, i.e. how much impact the energy community concept has on the energy sector [6]. Do ECs remain a niche mechanism or do they become a mainstream contributor that large proportions of the population are involved in? Thirdly, the differing relative importance of the various types of ECs to the energy sector [6], i.e. some types are of high importance (e.g. ECs that offer flexibility services) while some remain of less importance (e.g. ECs that purely focus on environmental goals for their own members and not on contributing to regional energy security).

A different form of heterogeneity that was seen to be important to the success of ECs in pioneering countries is that of the types of members and end-users involved in a community. Having a diverse mix of energy users allows for greater flexibility and improved self-consumption within the community. Energy access and energy availability are also improved by having multiple types of members and users [4]. The energy balance is more efficient when different types of demand are made (e.g. timing, amount, quality, supply versus demand curves, etc.).

This diversity of demand leads to the idea of sector coupling as a form of energy system heterogeneity. By collaborating with industry, communities can have a more diverse range of generation assets and consumption needs, leading to more efficient use of available energy at any given time. Tailoring the community business model to a sector coupling approach would allow the community to meet its goals in a wider set of ways and contribute to the energy targets of the wider region as well.

A convergence of EC types and goals, i.e. the homogenisation of the EC landscape, is also possible. This will occur due to the harmonisation of legal definitions of ECs across Europe and in other regions that choose to adopt standardised regulatory frameworks [6]. An increase in the common understanding of the EC concept and the solidification of best practices for EC development will also contribute to this homogenisation. The introduction of the two overarching EU EC legal forms (CECs and RECs) and the four EU EC types as part of the CEP (see Section 4.4 and Table 3) has already created a suitable environment for this to happen. However, further homogenisation is reliant on feedback from the way Member States currently implement the directives and if there is clear agreement that “a harmonised approach is better or is actually necessary to achieve fundamental EU goals” [6].

This homogenisation is most likely in regions that share “the specific endowment of renewable energy sources or the presence of a strong cooperative movement” [6]. As ECs professionalise and move into the commercial space, there will also be a need for some standardisation within ECs to enable them to compete with other energy players. This might take the form of standardised commercial agreements, following industry-wide data standards, or adopting the standard ways of working and communicating of the more mature energy industry players, as examples.

The evolution of the heterogenous and homogenous aspects of the EC landscape will directly affect the impact ECs can have on the energy transition. To what extent will depend on which aspects, at any given moment, are of most importance to policy makers, financiers, and citizens. Creating a set of future energy community scenarios that combines the expectations of the future from this chapter with the enabling environment factors described in Chapter 4 is the final stage of GENTE’s dive into the history and future of ECs in Europe.

6 Future energy community scenarios

Success factors for energy communities (ECs) are changing as regulations, uptake, acceptance, geopolitical factors, energy prices, and knowledge change. While it has not been possible within the scope of this task's research to generate numerical predictions of the future penetration of ECs, scenarios that consider potential futures for ECs from the literature were reviewed and a new set created within GENTE.

This chapter briefly mentions future EC scenarios from two reviewed papers and then describes the scenarios developed by the authors of this report for use within the GENTE project. The GENTE scenarios, which focus on the enabling factors for EC growth discussed in Chapter 4 and how they map to the core aspects of future evolution discussed in Chapter 5, are presented as the culmination of research into ECs development.

6.1 Penetration and Key goal scenarios

The following two reviewed papers create and discuss their own scenarios for ECs in Europe. The focus of the scenarios developed in these papers are briefly discussed in this section as complimentary information to the scenarios developed within GENTE. Further details of the scenarios can be found in the papers themselves.

1. '*Citizen Participation in Low-Carbon Energy Systems: Energy Communities and Its Impact on the Electricity Demand on Neighborhood and National Level*' [32]
2. '*COMETS Collective Action Models for Energy Transition and Social Innovation : Report on Scenarios for CAIs' development*' [25]

The scenarios developed in [32] focus on the penetration of energy communities in the energy sector, with varying numbers of ECs predicted based on each of four scenarios. The four scenarios mention different assumed drivers developed in the openENTRANCE project [33]. The scenarios assume one of the following: (1) high societal commitment, (2) technological advances which would make renewable energy far more attractive, or (3) strong legislation requiring renewable energy production and/or ECs. The existence of a regulatory framework and the existence of established ECs in a country are also seen as drivers. [32] makes estimates for the theoretical potential number of ECs in Spain and Portugal, region by region. For Andalusia, for example, 150,000 ECs are considered possible. These figures are based purely on building stock; thus, they may be most useful as an upper limit for each scenario. The aspect that is of particular interest for GENTE is the theoretical potential for the number of ECs in a region based on certain factors as these give a sense of the potential size of the market for the GENTE toolkit.

The growth scenarios developed in [25] focus on one key goal for Collective Action Initiatives (CAIs), such as economic growth, society value growth, or alleviating energy poverty, and present a predicted growth pattern and important key performance indicators (KPIs) for each scenario. The scenarios were developed by the CAIs themselves with the guidance of the COMETS project team. The aspects that are of particular interest for GENTE are the methodology used to generate the scenarios (co-creation with members of the CAIs) and the commonalities seen between the scenarios in the key factors that were identified.

6.2 Enabling factors scenarios - GENTE

Using the information and knowledge gathered through the literature review, eight scenarios for the future development of ECs have been created within GENTE. Based on the enabling environment factors established in Section 4.4, "IF this, THEN that" statements have been created that link the enabling factors with predicted future development channels for ECs. The future energy community scenarios (FECS) are presented in Table 5, followed by commentary and reasoning for the predictions. A link is made between each FECS and the community archetypes developed in Deliverable 4.1 - *Characteristics of energy communities and motivations, engagement, and socio-economic profiles of end users* (D4.1), and a mapping is made between each FECS and the GENTE partner countries the scenario is likely to occur in (see Table 6). GENTE Deliverable 3.3 – *Definition of highly applicable use cases* (D3.3) defines the most relevant EC use cases for GENTE to focus on. A mapping between the use cases and the future scenarios (FECS) is made in that report in Section 2.5 [7].

The goal of creating these new enabling factors-based future energy community scenarios is to provide guidance for the GENTE project to tailor its toolkit and outcomes to its key audience and with the greatest possible impact. Secondly, this new take on scenarios for ECs contributes to the wider research in this topic area. These scenarios are the culmination of GENTE's current research into the future development of ECs.

While detailed descriptions of each FECS are given below, the fundamental predictions are threefold:

- an increase in the creation of new communities and growth in current communities;
- an increase in smaller, more distributed communities (as opposed to large, centralised); and
- the professionalisation, commercialisation, and federation of communities.

A visualisation of how the FECs map to these top-level predictions can be seen in Figure 20, exposing the multiple predictions manifest in each scenario.

The FECS "IF this" statements have been defined with a positive perspective. It is expected that if each is turned to the negative, e.g. if FECS 1 decreases instead of increases, that the "THEN that" statement will be opposite what is defined in Table 5. Combinations of the FECS are plausible and likely. What impact would come from combinations of the FECS was not explored in the research.

[7] Two FECS are not included in the analysis in D3.3 as they were not available at the time of writing of that report, namely: FECS 3 and FECS 5.

Table 5 - Future energy community scenarios (FECS)

Scenario label	IF this (scenario)	THEN that (prediction)
FECS 1	Financial support for renewable energy generation communities increases	Increase in creation of new energy communities and growth in current energy communities (repeat of the previously seen growth phase)
FECS 2	Direct support for cooperatives and communities as a legal form encouraged and enhanced	Increase in creation of new energy communities
FECS 3	Marketing and messaging about energy communities (e.g. awareness campaigns) increases	Increase in creation of new energy communities and growth in current energy communities
FECS 4	Energy prices remain high and/or increase further	Increase in creation of new energy communities and growth in current energy communities
FECS 5	Local optimisation behind the meter is encouraged and enabled through regulation	Increased creation of smaller, more distributed energy communities
FECS 6	Energy communities are exposed to market forces through increased access to markets	Professionalisation, federation, aggregation, and commercialisation of energy communities increases
FECS 7	Flexibility increases in importance and value to DSOs, due to high complexity at lower grid levels	Support for energy community creation to provide flexibility (and other energy) services increases Professionalisation and commercialisation of energy communities increases to take advantage of flexibility benefits
FECS 8	Sector coupling is supported and increases in application, leading to efficiencies across energy vectors	Professionalisation and commercialisation of energy communities increases to take advantage of sector coupling benefits

Table 6 - How future energy community scenarios map to GENTE archetypes and partner countries

Scenario	Archetypes most relevant for scenario	GENTE countries scenario likely to occur in
FECS 1	1 Community-led local optimization community 2 Virtual community-led local optimization community	Türkiye
FECS 2	1 Community-led local optimization community 2 Virtual community-led local optimization community 3 Business-led service-focused community 4 Virtual business-led service-focused community	Spain Sweden Switzerland Türkiye
FECS 3	1 Community-led local optimization community 2 Virtual community-led local optimization community	Spain Sweden Switzerland Türkiye
FECS 4	1 Community-led local optimization community 2 Virtual community-led local optimization community 3 Business-led service-focused community 4 Virtual business-led service-focused community	Spain Sweden Switzerland Türkiye
FECS 5	1 Community-led local optimization community 2 Virtual community-led local optimization community	Spain Sweden Switzerland Türkiye
FECS 6	1 Community-led local optimization community 2 Virtual community-led local optimization community 3 Business-led service-focused community 4 Virtual business-led service-focused community	Spain Sweden Switzerland Türkiye
FECS 7	3 Business-led service-focused community 4 Virtual business-led service-focused community	Spain Sweden
FECS 8	3 Business-led service-focused community 4 Virtual business-led service-focused community	Sweden Switzerland Türkiye

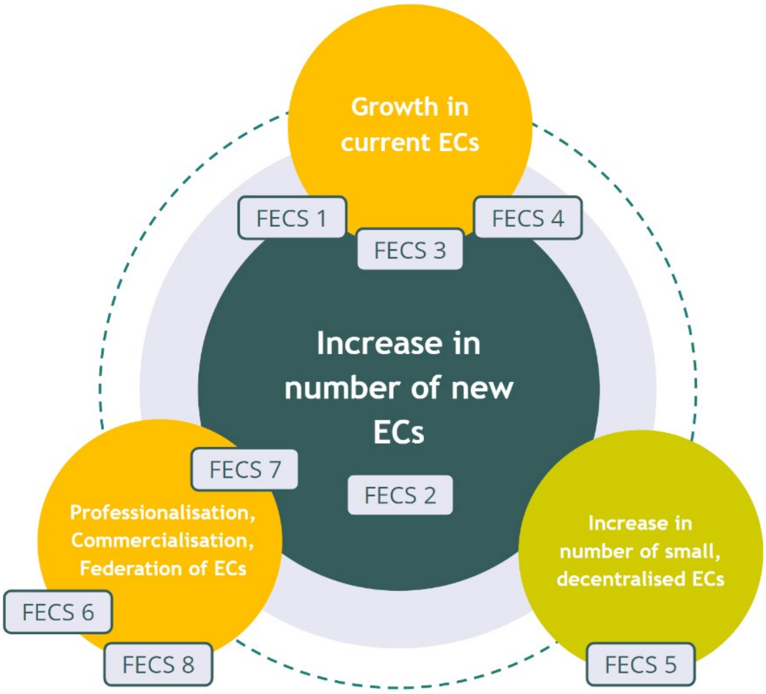

Figure 20 - Mapping of FECS to prediction outcomes
NB: difference in circle colours represent the difference in number of FECS that associate with that prediction outcome

6.2.1 FECS1

FECS1 focuses on the financial support that is available for renewable generation sources and technologies. If this kind of support (see Section 4.2 for details) is maintained and/or increases in availability and uptake, it is predicted that a new growth phase in energy community incorporation and development will occur, similar to the pattern seen in Denmark in the 1990s and the UK and Germany in the 2000s/2010s. However, this scenario is considered unlikely to occur with PV and wind technologies in regions where the cost reductions have already been realised and governments have moved away from direct subsidies for these energy generation technologies.

Of the GENTE partner countries, Türkiye is the most likely location for this scenario to occur because PV installations are still in an initial growth phase meaning financial support of the types that most attract ECs is still upcoming or still in place. If emerging energy technologies, such as vehicle-to-grid (V2G), power-to-gas (P2G), home batteries, and heat pumps, are supported financially in similar ways to how PV was in pioneer and early adopter countries, a route opens up for this scenario to occur in regions further into the energy transition or where PV and wind are already maxed out, such as the other GENTE partner countries Spain, Sweden, and Switzerland.

This scenario will most benefit the *Community-led local optimization community* and *Virtual community-led local optimization community* archetypes (as developed in D4.1) because financial support to cover the high upfront costs of setting up a community and buying the energy assets is key to ECs that are not focused on revenue generation through providing energy services.

6.2.2 FECS2

FECS2 focuses on energy communities becoming legally recognised and direct support for ECs as legal forms being enhanced. This is occurring across EU countries with the implementation of RED II and ED 2019 directives of the Clean Energy Package (CEP) into national legislations with two legally recognised forms of EC (see D4.1 Section 2.5 for details of these types). It is also occurring in Switzerland with, for example, the regulations to support self-consumption associations (ZEVs). If this scenario occurs, it is predicted that there will be an increase in the creation of new ECs in general. This is because the barrier to entry for new ECs will be reduced given that a legal framework providing clarity and direction for incorporation will be in place. See Section 4.3 and Section 4.4 for more detailed information about regulatory mechanisms impact on ECs and their growth. This scenario could occur in all the GENTE partner countries because legal recognition for ECs in some form has already happened or is in progress now. This scenario will benefit all four GENTE archetypes (as developed in D4.1) as no limitation on the main activity, governance structure, or connection type of ECs is dictated by the scenario.

6.2.3 FECS3

FECS3 focuses on an increase in the marketing and messaging about energy communities to the public, politicians, and industry. Increasing awareness about ECs, their purpose, how they provide local value, their impact on local issues, and how to get involved increases ECs potential for behavioural and societal impact. See Section 4.1 and Section 4.4 for more details on this. If this scenario occurs, it is predicted that there will be an increase in the creation of new ECs and a growth in current ECs, particularly in membership numbers. This scenario could occur in all the GENTE partner countries because knowledge sharing is a global activity, common to all regions. This scenario will most benefit the *Community-led local optimization community* and *Virtual community-led local optimization community* archetypes (as developed in D4.1) because awareness campaigns and local marketing are likely to have a larger impact at the individual level, rather than institutional level. This means a likelihood of more community-led initiatives.

6.2.4 FECS4

FECS4 focuses on the impact of high energy prices on the growth of ECs. It is predicted that if prices remain high and/or increase further there will be an increase in the number of new ECs being incorporated and a growth in existing ECs, in member numbers in particular. More people would be expected to explore alternative options, such as ECs, for fulfilling their energy needs. Of the GENTE partner countries, this scenario could occur in all of them. With market energy prices being highly influenced by, if not directly tied to, the global trade in oil and gas, every GENTE country is exposed to the fluctuations in this market to fulfil their citizen’s energy needs. This scenario could benefit all four

GENTE archetypes (as developed in D4.1). Both individuals and businesses are exposed to energy price uncertainties so the exploration of alternatives could occur across user groups.

6.2.5 FECS5

FECS5 focuses on the priority of regulation and policy being local optimisation behind the meter, i.e. self-consumption of locally generated energy. This enables the energy produced by distributed renewable sources, which distribution system operators (DSOs) lack visibility into due to minimal sensor coverage of the low-level grid, to be kept off the grid, simplifying grid management. If this priority is set up and maintained, it is predicted that smaller, more distributed energy communities will be created. This is due to geographical and connection type constraints of keeping locally produced energy behind the meter and off the distribution grid [29]. A focus on self-consumption means a more internal perspective, focusing on community capacity and efficiency rather than an external perspective such as providing energy services. High retail energy prices encourage local optimisation as importing electricity from the grid can be avoided. A reduction in the cost of technologies such as e-mobility and energy storage could also drive a focus on self-consumption as these technologies become more widespread. This scenario could occur in all the GENTE partner countries and is already indicated in Switzerland due to the ZEV mechanism. This scenario will most benefit the *Community-led local optimization community* and *Virtual community-led local optimization community* archetypes (as developed in D4.1) because the focus is on internal optimisation rather than serving external industry needs.

6.2.6 FECS6

FECS6 focuses on the extent to which communities are exposed to energy markets. Different regions have varying requirements and regulations regarding the level of integration ECs must have with the markets. For example, Switzerland, a country with only a partially liberalised energy market [34], has regulation allowing only companies whose consumption is over 100,000 kWh per year to freely choose their electricity supplier on the open market. This restricts access from smaller communities and favours commercial-scale operations. In the Netherlands, where a fully liberalised energy market exists, anyone can participate, but to do so with sustainable economic viability is difficult for smaller communities because they are in competition with larger operations who benefit from economies of scale. If this scenario occurs, it is predicted that the professionalisation, federation, aggregation, and commercialisation of ECs will increase. An increase in the number of ECs focused on commercial operation could also occur, along with changes to the business models of existing ECs. The scenario favours larger, more integrated communities. This is likely to be the case in the UK, for example, where the approach of the energy regulator is very market-oriented (see Section 3.1). A negative impact might be felt on the growth and sustainability of smaller, locally focused, traditional ECs.

Of the GENTE partner countries, Sweden and Spain are the most likely locations for this scenario to occur because both countries have fully liberalised energy markets which ECs can participate in if they so wish [35] [36]. This scenario will most benefit the *Business-led service-focused community* and *Virtual business-led service-focused community* archetypes (as developed in D4.1) because of their focus on for-profit businesses providing energy services to the grid. To offset the potential negative impact on traditional ECs, specific policies to support smaller, locally focused ECs could be implemented, such as the ZEV mechanism in Switzerland.

6.2.7 FECS7

FECS7 focuses on an increasing importance and value of flexibility to DSOs due to increasing complexity of the lower grid levels with the increasing share of renewable energy sources (RES). Flexibility services provide another tool for controllers to keep the grid balanced. If this scenario occurs, it is predicted that support for the creation of ECs with the purpose of providing flexibility services to the grid will increase. Growth and revenue in existing ECs that provide flexibility services would also increase. DSOs will encourage community creation to help manage the complexity. An increase in hybrid style communities with direct commercial relationships with energy retailers and operators and co-development/co-ownership style communities (see Section 5.2) is expected. The mechanisms that enable this scenario are not part of this prediction, such as whether it is about flexibility market control, or high retail prices, or trying to encourage behind-the-meter optimisation, or how the value is presented to ECs, or the need for additional self-consumption incentives in places with significant grid constraints, etc. It is also not predicted how this scenario will impact the size of communities as any size of community could, in theory, provide this service; it just depends on the community's defined purpose and goals.

Of the GENTE partner countries, Spain, Sweden, and Switzerland could all see this scenario occur. This is because all three are enabling the installation of RES on the low-level grid which leads to an increasing need for flexibility by default. This scenario will most benefit the *Business-led service-focused community* and *Virtual business-led service-focused community* archetypes (as developed in D4.1) because providing energy services is a revenue generating activity by its nature.

6.2.8 FECS8

FECS8 focuses on the impact of increasing support and implementation of sector coupling. Sector coupling could take two main forms: (1) the combination of varying energy supply and demand options across sectors with the goal of increasing usage efficiency and optimisation across energy vectors [37], and/or (2) "multisector market measures" [29] in which the markets of different sectors (such as heating, communication, mobility, etc.) are coupled allowing for "cross market settling that achieves the lowest cost across multiple markets" [29]. If this scenario occurs, it is predicted that the professionalisation, federation, aggregation, and commercialisation of ECs will increase to take advantage of the benefits of sector coupling. An increase in the number of ECs focused on commercial operation could also occur, along with changes to the business models of existing ECs. The scenario favours larger, more integrated communities. A negative impact might be felt on the growth and sustainability of smaller, locally focused, traditional ECs. A new form of EC that focuses solely on sector coupling and the aggregation of energy technologies could also appear. These effects could also be observed if/when the Technology Readiness Level (TRL) of emerging energy technologies increases and the Levelised Cost of Energy (LCOE) decreases. This would unlock new technology configurations enabling this new form of EC. It is not expected to see future subsidies for PV generation (due to the already highly decreased prices for

PV panels and installation in Europe), but emerging technologies, such as V2G, P2G, and heat pumps, may be subsidised. These could support the growth of this new EC type.

Of the GENTE partner countries, Sweden and Switzerland are the most likely locations for this scenario to occur. Both countries have manufacturing and industry sectors with a broad variety of energy demand and supply potential meaning the value of sector coupling is easy to sell to potential partners. Both countries also have the regulatory environment to enable sector coupling style arrangements. There is potential for this scenario in Türkiye as well due to a growing industrial sector, increasing electrification of energy end-use sectors, and a diverse climate leading to a range of heating and cooling requirements. However, according to [38], regulatory changes, new market designs, and commitments to minimum technical standards, among other things, have been identified as necessary for sector coupling based on demand-side response to be viable and are "by no means assured" [38].

This scenario will most benefit the *Business-led service-focused community* and *Virtual business-led service-focused community* archetypes (as developed in D4.1) because successfully integrating several sectors together, especially the inclusion of industry partners, would require a commercial mindset with permanent staff to manage the operation.

7 Conclusion

The scope of the impact energy communities can have on the energy transition in Europe is extensive. With predictions of 37% of renewable energy in the EU coming from collective initiatives such as energy communities (ECs) by 2050, understanding their history and what enables them to evolve into the future is vital to their success. The research undertaken as part of the Deliverable 3.1 - *Future Scenarios for Local Energy Systems with Increased Renewable Share* in the GENTE project aimed to understand these aspects of ECs.

Local energy communities are an established concept with a long history. The definitions and terms used for energy communities are diverse and not aligned across Europe. GENTE settled on a definition to use within the project, in collaboration with researchers working on Deliverable 4.1 - *Characteristics of energy communities and motivations, engagement, and socio-economic profiles of end users*, namely: "Energy communities involve groups of citizens, social entrepreneurs, public authorities and community organizations who participate directly in the energy transition by jointly investing in, producing, selling and distributing renewable energy" [11]. However, to ensure a breadth of available knowledge was reached, a range of terms was used during the discovery phase of the research.

The most recent count of ECs in Europe from the COMETS project stands at greater than 8,400 communities, with the large majority in Germany and most using solar PV as their main renewable technology. Research into the history of the EC concept exposed some key factors that influenced the rise and fall of their usage within Europe. New and existing communities are sensitive to economic, legal, and regulatory changes, and a link between these aspects is indicated – if regulations are supportive, financial support is more readily available, and vice versa. If policies that affected ECs were unsettled or shifting, the uptake and growth of ECs was slower.

Regional differences can be observed and linked to differences in national and local policy, financial support, and cultural attitudes towards cooperatives in general. For example, Switzerland's positive attitude towards cooperatives has led to a significant uptake in ECs, while Türkiye's negative attitude has led to resistance to the format. Sweden, with a strong welfare state (and a centralised energy industry), is neutral towards cooperative forms meaning only a small uptake in the EC concept.

A link between energy prices and the cost of renewable energy technologies and the growth / decline in ECs was also seen. If energy prices go up (or remain high), the uptake of ECs increases, and vice versa. If the cost of renewable energy technologies goes down, the uptake of ECs increases, and vice versa.

The factors that influence the growth and decline of EC incorporations were used to define an enabling environment for the growth of new and existing ECs which includes:

- sustaining / rethinking / reintroducing government-supported financial incentives;
- setting and keeping in place long-term supportive policies;
- continuation and increase in financial support for EC types;
- development of dedicated awareness campaigns to boost social awareness;

- increasing importance of flexibility to grid operators due to increasing share of renewables; and
- increasing viability of sector coupling.

Looking to the future development of ECs, three core topic areas became apparent: collaboration between ECs, the professionalisation and commercialisation of ECs, and the continued heterogeneity development versus a move towards homogeneity of ECs. Collaboration between ECs has the goals to increase operational efficiency, increase member numbers, benefit from economies of scale, and increase the clout of EC representation within industry and government.

Professionalisation and commercialisation is indicated for regions with a more mature EC environment. It has the goals of enabling ECs to take advantage of new business opportunities, increasing the ROI for members, and increasing adaptability to changing regulations. This is mainly expected to take the form of ECs becoming energy service providers, e.g. flexibility services and aggregation services. Standalone ECs will still be possible, but if an EC wants to grow, collaborating, learning, and partnering with other ECs and EC organisations will be necessary.

The continued heterogeneity of the EC concept is expected in both a variety of definitions, terms, and implementations used to refer to ECs and in the diversity of members and end-users involved in communities. The latter of these leads to sector coupling as an important future energy system heterogeneity for ECs to start exploring - ECs have the potential to be the drivers for sector coupling in their localities. Increasing homogeneity in some areas of the EC environment is expected as well. In particular, standardisation of some implementations, commercial agreements, data standards, and ways of working and communicating will be necessary as ECs professionalise and move into the commercial space to enable them to compete with other energy industry players.

Making Europe-wide projections into EC future growth is challenging as local policies are diverse and subject to political intervention. Combining the enabling environment for EC growth factors and the future development topics, a set of eight future energy community scenarios (FECS) were developed. These take the form of "IF this, THEN that" statements: what is a likely outcome (prediction) if a given situation is experienced or comes to fruition (scenario). The predictions can be grouped into three fundamental outcomes:

- an increase in the creation of new communities and growth in current communities;
- an increase in smaller, more distributed communities (as opposed to large, centralised); and
- the professionalisation, commercialisation, and federation of communities.

The goal of these scenarios is to provide context for the development of the GENTE energy community toolkit and help inform the development of technology, modes of community engagement, and recommendations for exploitation that form important parts of the GENTE project.

8 Recommendations for further research

A few topics area that could warrant further exploration and research came up during the process of completing D3.1. Firstly, the federation of communities is an area that was parked for later exploration due to the breadth of information already obtained about the core topics of EC history and development. The literature search did not include terms about federation. To be able to comment on the role of EC federation on the future development of ECs, this topic should be researched as a standalone area of interest.

The COMETS dataset has huge potential to expose interconnections between EC dimensions and inform the future development of ECs in Europe. GENTE only did a high-level analysis as part of D3.1. A more in-depth dive into the data is recommended, in particular: an exploration into if it is possible to use the COMETS data to enhance the future energy community scenarios (FECS) to produce trend lines for EC growth, numerical predictions for growth, and define likelihood percentages for the FECS predictions. An extension of the started country case studies (see Appendix – Case studies) using the COMETS data that graph the number of new ECs per year with the cumulative number of ECs and include notable years for policy changes for the remaining GENTE countries (Sweden, Spain, Türkiye) would also be valuable as these are a useful way to visualise the impact of regulatory changes on EC incorporation. Creating graphs using other datapoints, such as resource types, technology mix, and activities / purpose, and graphs that compare country data would also be beneficial to understanding patterns and potential connections. It would also be interesting to compare absolute numbers of ECs to country size (in terms of population) to create a form of 'energy community participation index', inspired by the civil participation index as seen in Figure 4.

While the impact of energy prices on growth of ECs was touched on in the research for D3.1, it would benefit from specific research as a standalone topic. This is due to the broad focus of the research for this report meaning the detail of the influence of energy prices on ECs was not delved into.

It would also be useful to broaden the scope of research into ECs resource types and technology mixes to include demand-side management and optimisation. The research in D3.1 found information mainly on generation source, which, while useful, does not give the full picture of what ECs are doing technology-wise.

The role of ECs as enablers for sector coupling was indicated (see Section 5.3 and Section 6.2.8). Due to the perceived positive potential for this form of collaboration and commercialisation for ECs, it would be beneficial to explore this topic further within GENTE and beyond.

Finally, [16] discusses the role of federalism when it comes to ECs' governance and attractiveness by using Switzerland and Germany as use cases. However, it did not compare federalist states to unitary states and how they differ in their support of ECs. D4.1 touches on how local government influences the development of ECs, but it would be interesting to explore further the role of political organisational structure on EC development.

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10 Appendix - Methodology

Details from the methodology applied for the research of D3.1 is given in this appendix.

10.1 Search term syntax and phrases

As part of the initial phases of work on GENTE, how the project would define the term 'local energy community' (LEC) for use across the work packages was determined (see Section 1.4). However, to ensure the most relevant data were captured during the discovery phase of the D3.1 research, search terms are based on the understanding that the term 'energy community' is broad and variably defined.

10.1.1 Search term syntax

The terms follow a structure (as below) that varies the phrase used to refer to 'local energy' (LE), varies the phrase used to refer to 'community(ies)', varies how scenarios are referred to, does/does not include specific reference to the future, does/does not include specific reference to growth of/in ECs, and does/does not include reference to the creation of ECs.

```
[LE phrase][community phrase] + scenario[s]
[LE phrase][community phrase] + future + scenario[s]
[LE phrase][community phrase] + growth
[LE phrase][community phrase] + creation
[LE phrase][community phrase] + creation + scenario[s]
[LE phrase][community phrase] + creation + growth + scenario[s]
```

Two syntax phrases (as below) were removed after initial searching because they were found not to affect the results returned by the database.

```
[LE phrase][community phrase] + growth + scenario[s]
[LE phrase][community phrase] + future + growth + scenario[s]
```

A syntax relating to the federation of communities was not included as the research into this topic was parked for the time being.

```
[LE phrase][community phrase] + federation
```

10.1.2 Search term phrases

The specific phrases used for data discovery are as follows:

Local energy (LE) phrases:

- energy
- local energy
- regional energy
- renewable energy
- citizen energy

Community phrases:

- community(ies)
- initiative(s)
- cooperative(s)
- organisation(s)
- ~~island(s)~~
  - Removed as too specific. Add back in if need more results.
- ~~network(s)~~
  - Removed as results are related to distribution networks and networking, not communities
- ~~association(s)~~
  - Removed as inclusion did not bring any results that mentioned associations
- ~~market(s)~~
  - Removed as results focused on energy markets, not communities

Search terms outside of syntax:

- Replace `[LE phrase][community phrase]` with `community energy initiative` in the syntax and then use all syntax variation endings.

10.2 Inclusion criteria

Filtering / sorting on the database platform to refine the returned results was performed using the defined inclusion criteria (AKA search filters and sort type). The criteria used are:

- Timeframe
  - 2018 - 2022 (5 years)
  - Energy systems tend to have long operational timeframes → searching for relevant papers and content from up to 5 years ago feels appropriate given they may contain scenarios up to 2050 and beyond and huge amounts have changed in the last five years

- Article type
    - ScienceDirect
        - Review articles
        - Research articles
        - Book chapters
        - Conference abstracts
        - Book reviews
        - Case reports
        - Conference info
        - Data articles
        - Editorials
        - Errata
        - Mini reviews
        - News
        - Patent reports
        - Practice guidelines
        - Product reviews
        - Short communications
        - Other
    - Web of Science
        - All Document Types
- Subject areas
    - Any
- Sorted by
    - Relevance

Manual filtering after the search was complete was performed for the following criteria (as it was not possible to define these in the initial search filters due to limitations on the Web of Science API):

- Regions of article content
    - Europe
    - Spain
    - Sweden
    - Switzerland
    - Türkiye (spelled: Turkey)
- Language of articles
    - English
    - Consider other languages if the results of the first review are not representative

10.3 Questions used to review chosen literature

Due to the broad scope of the available research on energy systems and communities, a set of questions was created based on the data and information that needed to be extracted from the literature to answer the research topics well enough without going too deep in areas that were of less relevance. The questions are:

- Which **countries** and **regions** does the paper discuss?
- What **technical characteristics** of ECs are mentioned, if any?
  - e.g. resource types available to the EC, types of technology used, generation capacities, self-consumption levels, P2P trading levels, sold to grid volumes, etcetera
- What **structural** and **operational characteristics** of ECs are mentioned, if any?
- What **social** and **governance characteristics** of ECs are mentioned, if any?
- What **regulatory characteristics** of ECs are mentioned, if any?
- Does the paper contain **case studies** of ECs?
  - If yes, how many; which countries; what kind of data is included about the communities?
- Does the paper **compare ECs across regions**?
  - If yes, provide details of what aspects are compared and any identified differences.
- Does the paper discuss **collaboration between ECs** (e.g. ecosystems of ECs, federation of ECs, collective action)?
  - If yes, what is identified as important for the collaboration; what drives it and what blocks it; and are there specific requirements for the type of collaboration?
- Would you **recommend this paper for further reading**?
  - Base your decision on how relevant you think the paper is to the objectives of understanding ECs more deeply.
- Any further notes

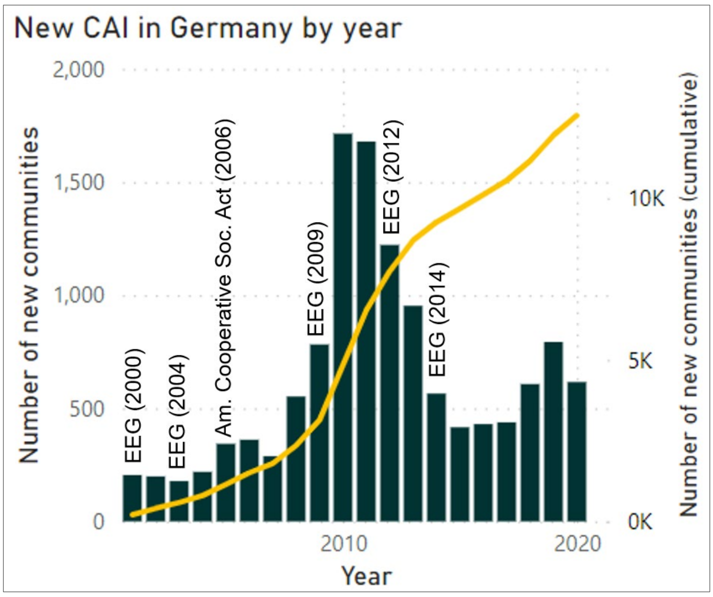
11 Appendix - Case studies

Graphs were produced for four countries with interesting energy community development histories (Germany, the UK, the Netherlands, and Switzerland) showing the number of new ECs per year, the cumulative number of ECs per year, and indicating when important regulations came into effect. Notes on the development are provided next to the graphs.

Future work would include creating graphs for the remaining GENTE countries (Sweden, Spain, Türkiye) and creating graphs using other interesting datapoints from the COMETS dataset, such as resource types, technology mix, and activities / purpose. Graphs comparing countries would also be valuable. The required normalisation of the COMETS data to make this comparison possible has been achieved, but unfortunately at too late a stage of the research to be included in this report.

11.1 Germany

Germany



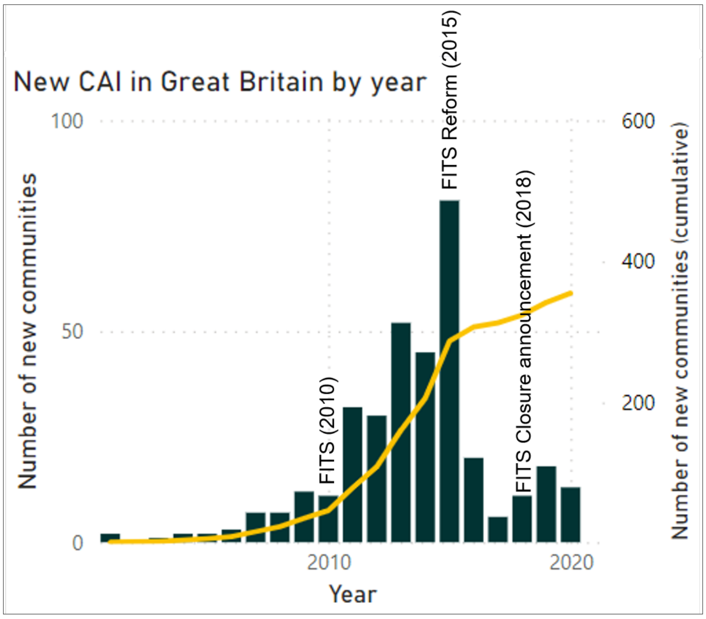
CAI: Community Action Initiative

Data source: COMETS inventory, described in [2] and available at [10]
Image source: HSLU/GENTE

- Germany has seen very large growth of (mostly solar) community energy initiatives.
- In 2000, the Renewable Energy Sources Act (EEG) was first implemented. Granted RE power plants **fixed tariffs** combined with **priority feed-in**, de-risking projects.
- **Steep increase** in solar cooperatives between 2008 and 2014 during the period when feed-in tariffs were available.
- **Marketing campaigns** led by cooperative associations, connected with the 2006 amendment of the Cooperative Societies Act
- Maintained until the EEG replaced the feed-in tariff scheme with a market premium scheme in 2012
- The regulations became geared towards **larger, market-level** renewable energy production.
- This was the start of an **ongoing drop** in new energy communities.

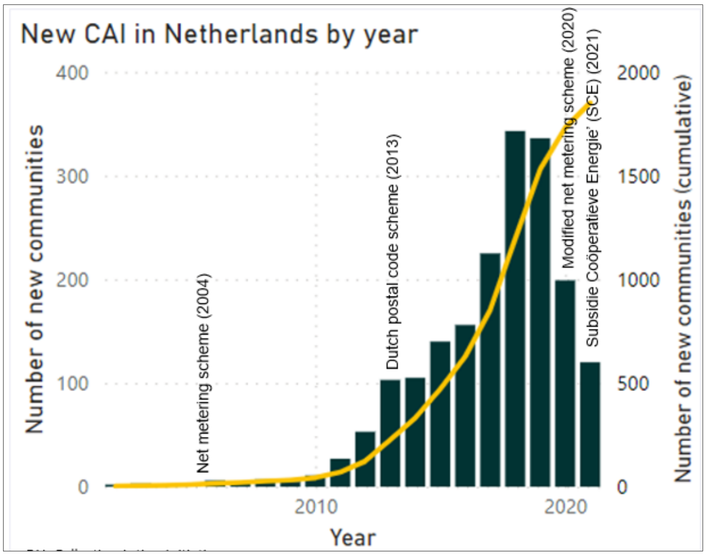
11.2 United Kingdom

UK	


CAI: Community Action Initiative
 	
Data source: COMETS inventory, described in [2] and available at [10]
Image source: HSLU/GENTE
	• Feed-In Tariff Scheme in 2010
	  ○ First support mechanism aimed at smaller scale renewables, with tax incentives and public loans
	• Schemes also benefited from the Enterprise Investment Scheme and the Seed Enterprise Investment Scheme tax relief
	• Successive reviews of the Feed-In Tariff Scheme took place from 2011 onwards:
	  ○ affected new projects
	  ○ delay between financial changes being implemented and impact on market
	• 2009 – 2014: the total amount of installed community-owned energy capacity almost quadrupled.
	• 2015: deep reform to RES support, switch to renewables obligations and contracts for difference, more suited to large-scale projects
	• 2019: Feed-In Tariff Scheme closed to new applications for electricity from solar
	• Also: UK does not have a specific cooperative law:
	  ○ In 2014, government blocked several RE cooperative applications, saying members would not participate enough

11.3 The Netherlands

The Netherlands



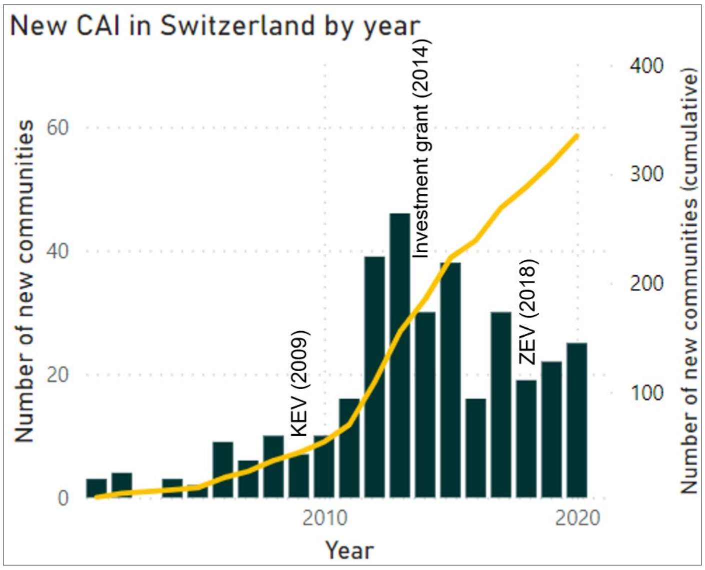
CAI: Community Action Initiative

Data source: COMETS inventory, described in [2] and available at [10]
Image source: HSLU/GENTE

- The most relevant recent initiatives in the Netherlands are:
  - “net metering”: allowed produced renewable energy to be crossed out against consumed energy, which eliminates the dominant tax component in energy tariffs (2004, currently being modified / withdrawn)
  - “Dutch postal code scheme” incentivised creation of local ECs that collectively invest in RE somewhere nearby, without necessarily having PV on a member’s roof (2013)
- SCE (Subsidy Cooperative Energy production (2021) – volumetric subsidy for energy cooperatives and associations. Demarcated by postcode range, guaranteed for 15 years
  - Includes guarantees of origin
  - Top-up above basic energy price

11.4 Switzerland

Switzerland



CAI: Community Action Initiative

Data source: COMETS inventory, described in [2] and available at [10]
Image source: HSLU/GENTE

- Feed-in tariff introduced in 2009 to promote electricity generation by RES (compensatory feed-in remuneration scheme (KEV))
- Led to mostly producer cooperatives accessing feed-in amounts
- Changes and uncertainty in Swiss energy policies in the early to mid-2010s
- KEV effectively capped, reducing the likelihood of support for new projects
- A significant waiting list for support via KEVs developed by 2013
- Alternative was introduced in 2014 in the form of a one-off investment grant
- Important development took place in relation to local energy communities in 2017
- Introduction of legislation relating to clean energy consumption in community – ZEV (adoption in 2018)
- **ZEV – a self-consumed kWh is more profitable than a feed-in kWh**