The Development Of Energy Communities In Europe

History, Success Factors, Future Perspectives

SUMMARY

Developed by GENTE researchers, this paper presents an overview of the development of the energy community (EC) concept in Europe, including the change in numbers of ECs, reasons for that change, factors that influence EC success, and potential evolutions of the concept in the future.

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Abstract

The energy community (EC) concept is a key mechanism in Europe's energy transition. Legal frameworks exist that enable citizens to join forces to generate energy for self-consumption and/or for commercial opportunities. Research into the underlying concept, the numbers of ECs in existence, and the historical context in the EU, Germany, Switzerland, the Netherlands, the United Kingdom, Denmark, Sweden, and Spain was undertaken, in the form of academic and grey literature review, to determine what factors create an enabling environment for EC success.

Positive growth in the number of active ECs in Europe was found, namely an increase of 1,531 between 2014 and 2022 (63% increase), with growth rates differing between countries. A decline in growth was experienced in some countries. The factors that affect the growth trends group into the following categories: governmental, financial, policy & regulation, social & behavioural, and energy industry related. Legal recognition and the consistency, stability, and clarity of regulations and financial support mechanisms were the prominent enabling environment factors.

The future for ECs is expected to be influenced by topics of collaboration, professionalisation, and commercialisation. Legal definitions that allow for ECs to participate in energy markets provide new forms of business model, enabling ECs to be applied to a wider set of situations, such as sector coupling and energy services. The heterogeneous nature of the EC mechanism is expected to continue due to this broadening of scope. Some harmonisation could happen with more common legal definitions across Europe and in regions that standardise regulatory frameworks.

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List of Abbreviations

CAI	Collective Action Initiative
CEC	Citizen Energy Community
CEI	Community energy initiative
CEP	Clean Energy Package - EU
CIES	Community integrated energy system
COMETS	COllective action Models for Energy Transition and Social Innovation
co-op	Cooperative
CRE	Community renewable energy
CREP	Community renewable energy project
DSO	Distribution system operator
EC	Energy community
ED 2019	Energy Market Directive - EU
EEG	Renewable Energy Sources Act - Germany
EPI	Energie Partagée Investissement - France
EU	European Union
EVS	Einspeisevergütungssystem – Switzerland | Feed-in remuneration system
FiT	Feed-in tariff
GenG	Genossenschaftsgesetz – Germany | Cooperatives Act
GI	Grassroots (energy) initiative
GW	Gigawatt
KEV	Kostendeckende Einspeisevergütung - Switzerland | Compensatory feed-in remuneration scheme
kWh	Kilowatt-hour
kWp	Kilowatt peak
LE	Local energy
LEC	Local energy community
LEG	Lokale Elektrizitätsgemeinschaft - Switzerland | Local Electricity Community
LLCEI	Local low-carbon energy initiative
PV	Photovoltaic
RE	Renewable energy
REC	Renewable Energy Community
RED II	Renewable Energy Directive - EU
RES	Renewable energy source
ROI	Return on Investment
SFOE	Swiss Federal Office of Energy
SME	Small-medium enterprise
TSO	Transmission system operator
UK	United Kingdom
VESE	Verband unabhängiger Energieerzeuger | Association of Independent Energy Producers
VZEV	Virtuell Zusammenschluss zum Eigenverbrauch - Switzerland | Virtual Self-Consumption Association
ZEV	Zusammenschluss zum Eigenverbrauch - Switzerland | Self-Consumption Association

1. Introduction

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 [1], contributing more than 6.3 GW of renewable energy capacity to the energy mix, mainly in the form of solar photovoltaic (PV) generation [2]. Energy communities (ECs) are one realisation of such community energy initiatives. To date, over 1,900 community energy projects have been reported, involving more than 1.25 million European citizens [3]. The introduction of two legal definitions relating to energy communities – Citizen Energy Communities (CECs) and Renewable Energy Communities (RECs) – in European Union (EU) law in 2018 is evidence of the relevance of the concept [4].

It is anticipated that over 264 million citizens in the EU (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 [3]. ECs are anticipated to play a central role in the decarbonisation of the European energy system, with about 37% of RE being produced by collective projects such as citizen cooperatives [4]. 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 RE 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 [5].

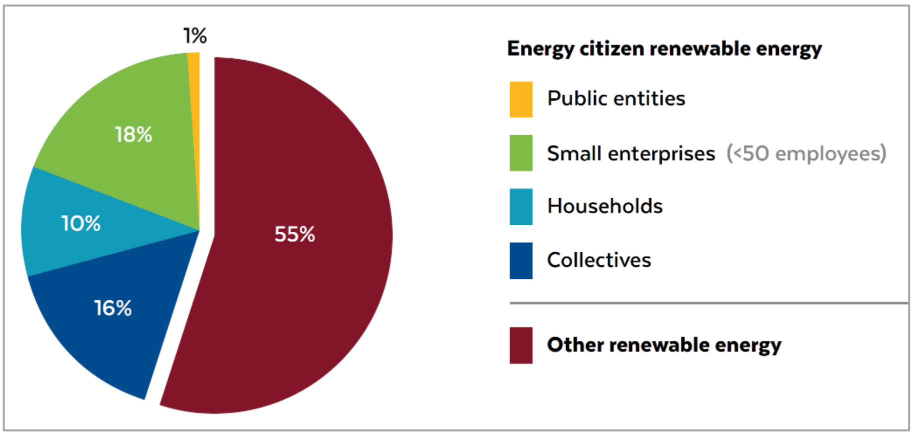

Figure 1 - Predicted share of electricity production by investor type in EU-28 in 2050. Image source: [6] - Dirk Vansintjan and REScoop.eu

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 [1].

An understanding of the factors that influence the success of ECs 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 ECs. This paper investigates the principal drivers for the growth and decline of community-focused energy initiatives in Europe, considering, in particular, ECs . The historical context of ECs in Europe, along with a comprehensive gathering of the factors that influence the success of ECs, is used to provide context to their past, present, and future development.

1.1 Methodology

The methodology adopted for this research comprised a literature review coupled with an initial, high-level analysis of the COMETS project public dataset of community energy initiatives in Europe. An approach called *directed discovery* was used. This involved the following top-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.

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 A** along with the inclusion criteria for the database search results in **Appendix B**. A set of Python scripts were created to automate the execution of search functions on the Clarivate Web of Science platform[1] using the generated search phrases and inclusion criteria. 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.[2] 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. The questions can be seen in **Appendix C**. More papers were sought out and reviewed during the analysis phase to enhance understanding of the topics extracted from the initial literature dataset.

Comprehensive analysis that provides an accurate number of ECs in Europe is limited. COMETS, a Horizon 2020 project [3], 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 [1] and available at [7]. The COMETS scope covers Collective 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 inventory is comprehensive and involved detailed analysis of databases, interviews, and websites. Some challenges exist in conducting aggregation of numbers across countries, or comparison of values between countries, as definitions were not always consistently applied between jurisdictions, and fields in the database were not always completed, as comparable data were not available 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. 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 Switzerland, Sweden, Spain, and countries where there has been significant growth in energy communities, or policy targeting them - Great Britain / United Kingdom (UK), Denmark, the Netherlands, and Germany.

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[1] https://www.webofscience.com/wos/

[2] Initial dataset creation was performed in 2022 and 2023. Today (2025), AI-based research tools would be used instead of custom search scripts.

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

1.2 Terminology

There is no broadly accepted definition of what comprises an energy community. Two legal definitions have been adopted in EU law - CECs and RECs (see **Section 2.2.1** for detailed definitions). However, even these do not fully address the diversity of community energy initiatives that have been observed in countries across Europe.

The following general definition of energy communities is adopted in this paper:

> "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" [8].

The EC 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 ECs has increased manifold since the beginning of the 2000s [9]. 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 [10]. 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 EC [9]. Consensus appears in the consideration that the members of an EC 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 within the community [10]. As [11] argues, trying to offer a universal definition for energy communities makes little sense and would obscure the great variability of the real-world phenomena which are referred to by the term.

The breadth of definitions and terms can make it difficult for ECs to define themselves, i.e. find the best way to organise (e.g. what business model and organisational models to apply); what financial support is available to them; and know how they can, and want to, interact with the wider energy system [12].

Given the breadth of EC definitions, it is no surprise the terminology used to refer to ECs is also diverse. It is often applied inconsistently, meaning it can be difficult to determine the boundaries associated with papers describing numerical growth of ECs. **Table 1** lists the common terms used in literature to describe an EC as a way of visualising the variety. In this paper, the term 'energy community' is generically adopted as an umbrella term to encompass the diverse set of names.

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) [4]	Collective Action Initiatives (CAI)
Energy cooperatives	Collective for Citizen Energy

[4] Legally defined term in the EU

How energy communities are referred to in literature	
Renewable energy cooperatives	Community integrated energy systems (CIESs)
Renewable Energy Community (REC) [4]	Local energy communities (LEC)
Sustainable energy community	Grassroots energy initiatives (GIs)
Community energy	Community power
Prosumer communities	Community energy enterprises
Community energy initiatives (CEIs)	Local low-carbon energy initiatives (LLCEIs)

1.3 Structure

This paper is organised as follows: In the Introduction, the context for the research into the development of ECs in Europe is given, with an overview of the diverse terminology used. The methodology applied is described. In Chapter 2, an exploration of the historical growth and decline in growth of ECs is undertaken, looking at overall numbers of ECs and exploring the reasons for the EC development trends in key European countries. In Chapter 0, the factors that influence the success of ECs are developed further and an enabling environment for EC growth is defined. In Chapter 4, the topics that were seen to be vital to how ECs will develop in the future are explored. A conclusion finalises the paper giving a summary and further research recommendations.

2. Growth and decline in growth of energy communities in Europe

The development of ECs in Europe has been diverse, with some countries pioneering their use and others trailing behind. Each country's EC history is affected by some common and some distinct influences and factors, such as cooperative traditions, diverse implementations of regulations, a range of financial measures from supportive to restrictive, and fluctuating energy prices, among others. An overview of the numbers of ECs in some key European countries is explored, followed by a dive into the historical development of ECs in those countries. Common influences are extracted with the goal of defining what factors define the success of ECs.

2.1 Number of energy communities in Europe

Comprehensive analysis that provides an accurate number of ECs in Europe is limited. Various studies have been conducted into the historical growth of energy communities in Europe. A wide range of terminology is used to define the boundaries of such studies: where numbers or graphs are provided, boundary conditions have been explained to allow comparisons to be made across different studies.

An approximate number of renewable energy cooperatives was provided by [13] and [14] for European countries in **2014**. The scope 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 in Germany, Denmark and Austria, with the greatest prevalence being in Germany.

An updated study was conducted in **2019** (and published in 2020**)** by [4]. 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. Germany and Denmark were again dominant, although a relative growth in the Netherlands and UK was also observed. Austria did not form part of the study, preventing a comparison with [15] for that country.

The latest and most comprehensive aggregate dataset of ECs in Europe comes from COMETS (see **Section 1.1** for further details). COMETS completed an inventory of citizen-led renewable energy initiatives [16] 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. This inventory was released as a public dataset in 2022 with data up to **2021**, available at [7] and described in [16] and [1] [5]. The analysis identified over 14,000 projects that were initiated since 2000, involving more than 10,000 citizen-led renewable energy initiatives. Again, with this broader definition, Germany can be seen to dominate the numbers, with other significant countries being the Netherlands, France, and Denmark. Filtering of the dataset to count 'active' CAIs (to allow for comparison with data from the other papers), a value of **3,144** active ECs is returned. **Figure 2** shows the number of active initiatives across Germany, Denmark, France, Great Britain, Sweden,

[5] 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.

Switzerland, and Spain based on the COMETS dataset, giving a representative view of the dominance of EC uptake in Germany. The Netherlands is missing from this graph because none of the Dutch CAIs in the COMETS dataset are marked as 'active'. It can be reasonably assumed this is a gap in the data, rather than that no CAIs were active in the Netherlands in 2021. This also indicates the actual total number of active CAIs is higher than the reported 3,144.

In [17], the researchers collated data sources to come up with a count and descriptive statistics of ECs as of November **2022**. Included are only ECs that participate in generation and/or supply and efficiency measures; only active ECs (at the time of data collection); and only ECs as defined by the EU directives, namely RECs and CECs. This more limited focus saw the authors report a count of **3,931** in Europe, compared to the COMETS database's over 10,000 (broader inclusion criteria). What stands out in this dataset is the minimised gap between Germany and all other countries. This could be due to the bounded scope of the paper to focus on ECs that fit into the REC and CEC categories defined by the EU Renewable Energy Directive (RED II) in 2018.

Figure 3 collates the overall active EC numbers from the four sources to give as representative a view as possible (given the variety of EC counting methods and inconsistency in data reporting) of the development of EC numbers in Europe through the 2010s and early 2020s. **Figure 4** and **Figure 5** show historical development for multiple countries in a single plot based on the COMETS dataset. Progression over time is shown from 1990, with **Figure 4** showing the historical growth with Germany included in the data, and **Figure 5** showing historical growth without Germany. The plot without Germany allows a more detailed appraisal of other countries. [6] 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 4** and **Figure 5**). The exact numbers were not compared. Reasons for these trends are discussed per country in **Section 2.2**.

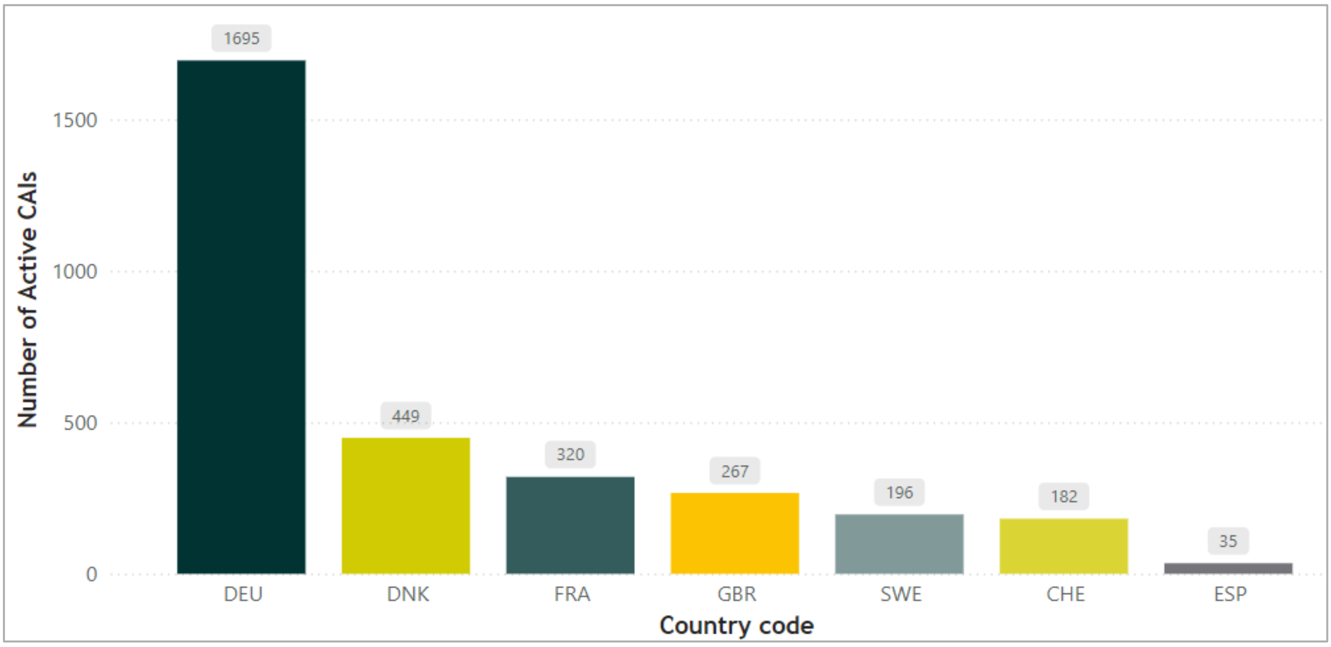


Figure 2 - Number of active Community Action Initiatives (CAIs) by country, based on COMETS inventory. Data source: [7]
Note: DEU: Germany | DNK: Denmark | FRA: France | GBR: Great Britain | SWE: Sweden | CHE: Switzerland | ESP: Spain

[6] In these 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.

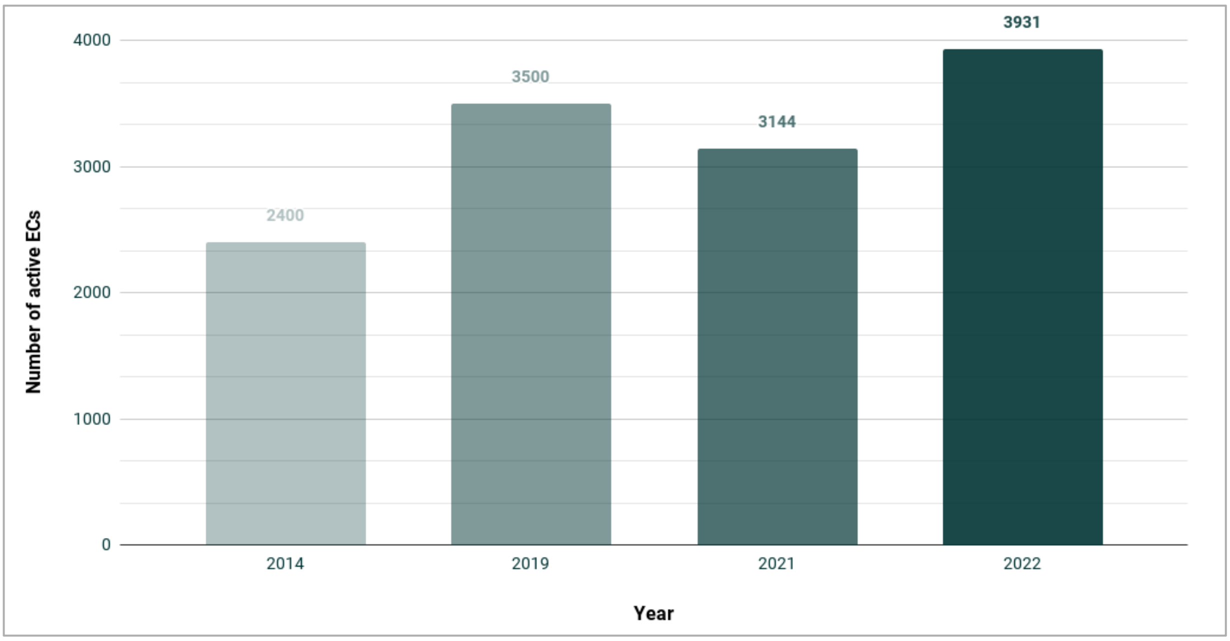


Figure 3 - Approximate number of active energy communities (ECs) in Europe in a given year. Data sources: 2014: [14], 2019: [4], 2021: [7], 2022: [17]

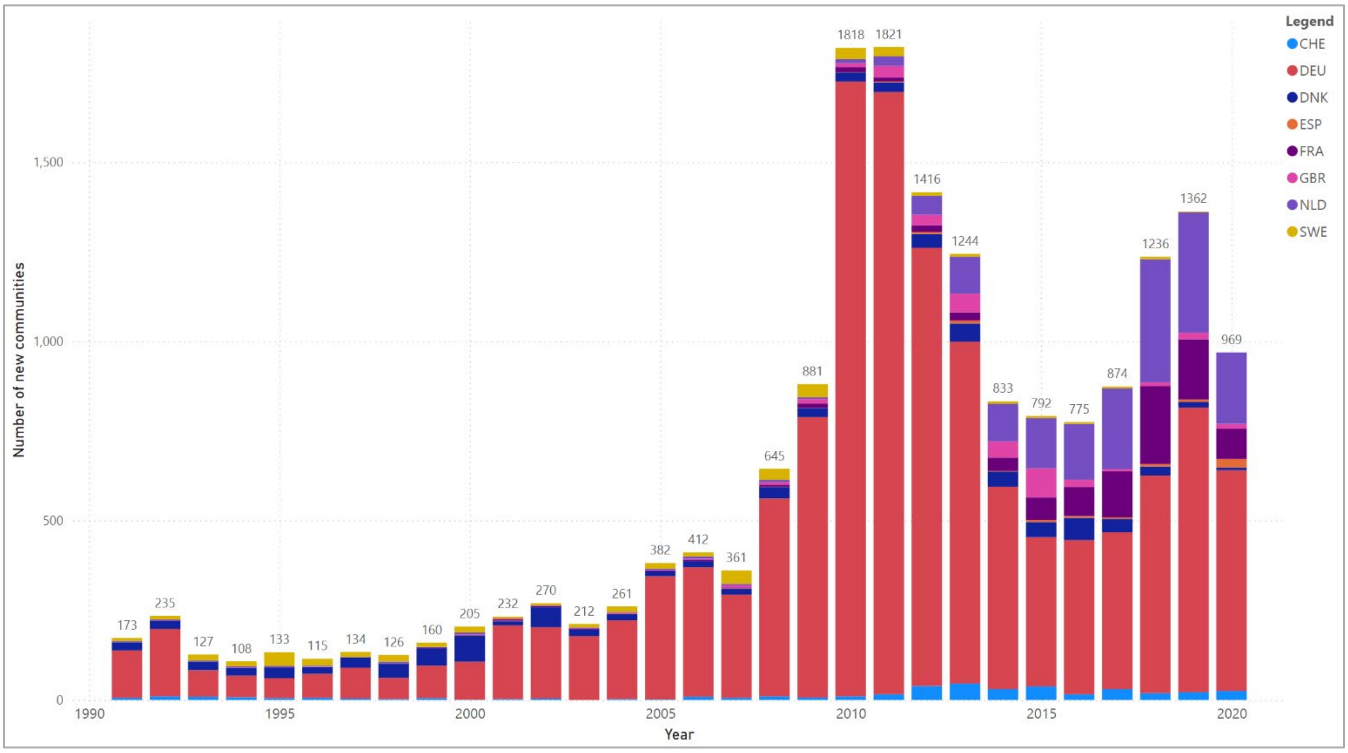


Figure 4 - Historical development of new citizen-led renewable energy initiatives since 1990 for selected countries in Europe, based on COMETS inventory. Data source: [7]

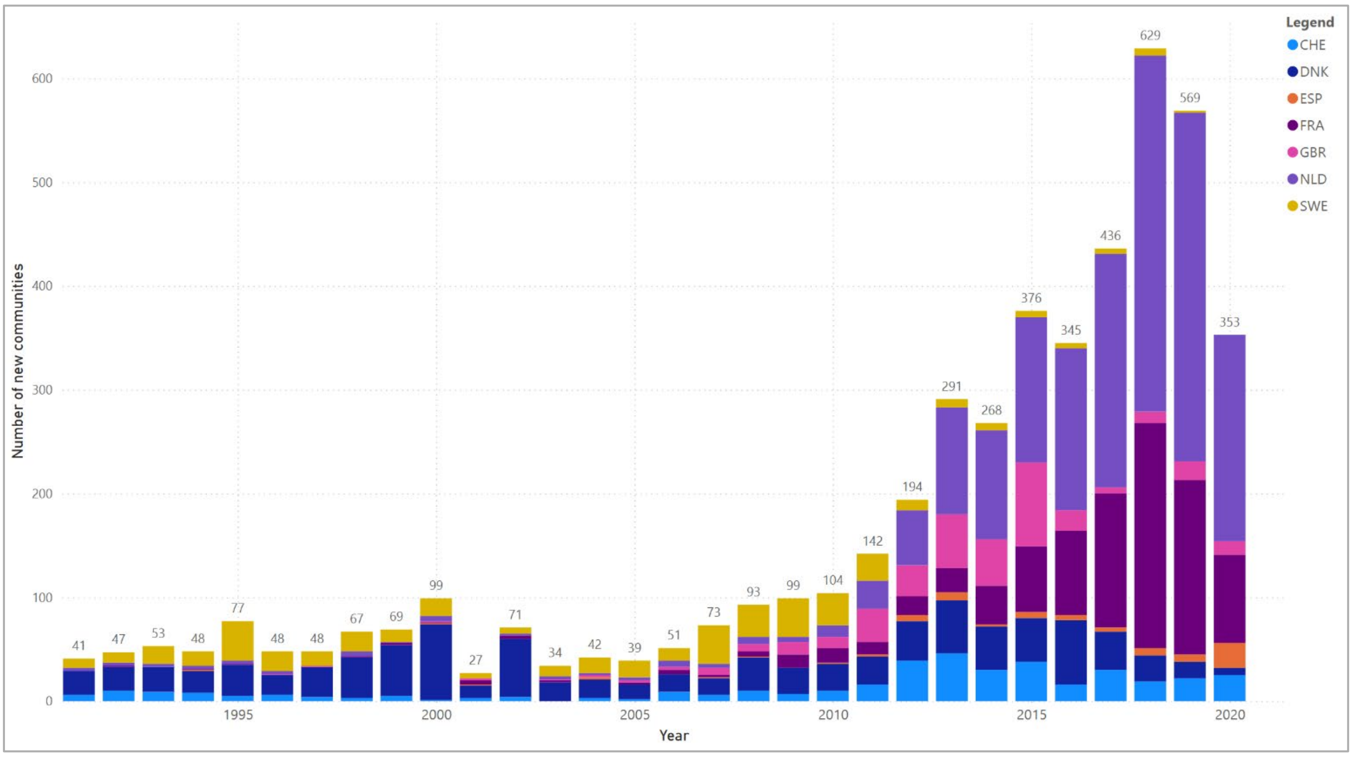


Figure 5 - Historical development of new citizen-led renewable energy initiatives since 1990 for selected countries in Europe, based on COMETS inventory, excluding Germany data. Data source: [7]

2.2 Reasons for growth and decline in growth development

A clear disparity from country to country regarding absolute numbers of ECs was identified, highlighting that the rate of establishment of new communities was not consistent from one country to the next. A growth phase was seen from the early-to-mid 2000s with a sustained decline in growth for some countries starting from early 2010s (see **Figure 4** and **Figure 5**), in both new incorporations and shutdowns of previously active ECs. The reasons for this growth pattern are various and differ per country. The evolution of ECs is significantly influenced by legislation, policies, and financial support mechanisms, all of which differ from country to country. There are also variations in the historical context in relation to establishing community initiatives. 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 ECs. Examples include Denmark and Germany, with their strong tradition of social enterprise and community ownership [4]. A variety of barriers to EC creation and operation were identified, with a small set of specific factors seen to be the cause the decline of new EC incorporations in Europe; and those countries that did not experience this phenomenon were seen to have clear reasons why. These growth and decline factors are discussed in this chapter broken down by country due to the specificity of influences on a regional level.

2.2.1 The EU

Energy communities have been legally recognised in the EU through two pieces of legislation enacted in 2018 and 2019 [18] and amended multiple times since [19]. The EU defines two forms of energy communities: Citizen Energy Communities (CECs) and Renewable Energy Communities (RECs). Both aim to facilitate market access and promote the involvement of citizens in the energy market.

The two forms of EC are distinct, but share the following characteristics:

- Energy Activities: Produce, consume, store, and/or sell energy.
- Energy Sharing: Share energy produced within the community.
- Legal Entity: Must be organised as a legal entity (e.g., association, cooperative, partnership, non-profit organisation, small-medium enterprise (SME)).
- Open Participation: Participation is open, voluntary, and non-discriminatory.
- Membership: Members can be individuals, public bodies, or small enterprises.
- Control: Must be effectively controlled by its members.
- Non-profit Focus: Prioritises environmental, economic, and social benefits over financial profit.

Despite these similarities, there are key differences between CECs and RECs:

- Activity Scope: CECs can engage in more activities related to energy distribution.
- Control: CECs are controlled by individuals, public bodies, and small enterprises, whereas RECs can also include medium-sized enterprises.
- Geographic Restriction: RECs have local restrictions, requiring members to be in proximity to the renewable projects, while CECs do not have such restrictions.
- Energy Sources: RECs produce energy from renewable sources (electricity, heat), whereas CECs engage in activities related to electricity provision, regardless of the source.
- Privileges: RECs enjoy privileges like simplified regulation, funding access, and special subsidy treatment.

These similarities and differences are visualised in Figure 6 from [12].The EU highlights the benefits of ECs for both the energy transition and citizens, including increased acceptance of renewable energy projects, local investment, grid flexibility, lower energy costs, and job creation. Before this EU-wide legal recognition, ECs had to work within the boundaries of national regulations which were often disparate, not designed for ECs specifically, or non-existent [20]. This played a role in the diversity of EC application across EU countries, which the next sections will describe.

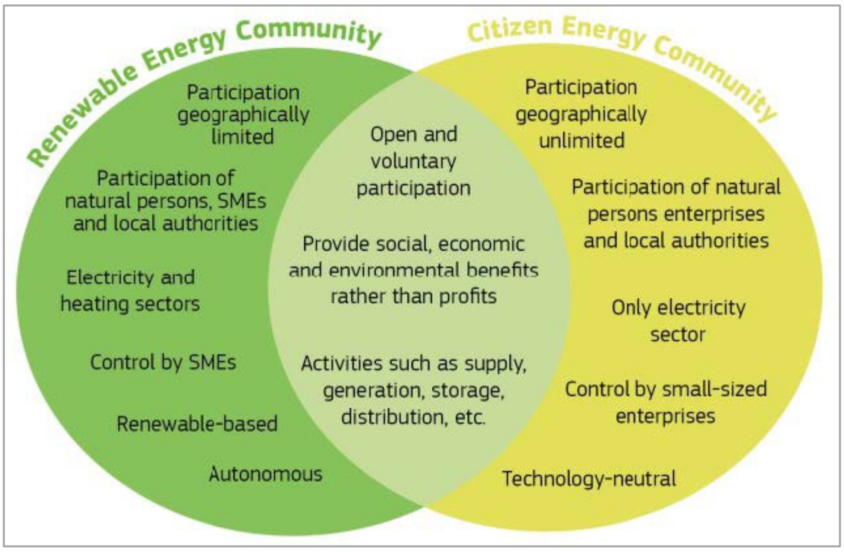


Figure 6 - Comparison of REC and CEC definitions. Image source: [12]

2.2.2 Germany

Germany has a history of establishing cooperatives. Citizens have had the right to form cooperatives to generate energy based on civil law provisions such as the Cooperatives Act (Genossenschaftsgesetz (GenG)), which first came into force in 1889, thus supporting their ability to form energy communities [21]. 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 Cooperatives Act, led to a resurgence in their application. In particular, a new energy cooperative model emerged that coincided with the 2008 financial crisis, resulting from a search for new economic models that could replace common financial practice that was evident at that time [15].

On the flip side, research has shown that communities are less likely to form where there are negative preconceptions about cooperatives and centrally planned economies. It has been observed that distrust may not be related to social activity per se, but rather in national or local political institutions [4]. This can be seen in what was formerly East Germany where ECs are less developed than the rest of the country (see **Figure 7**), attributable to the socialist era's legacy [15].

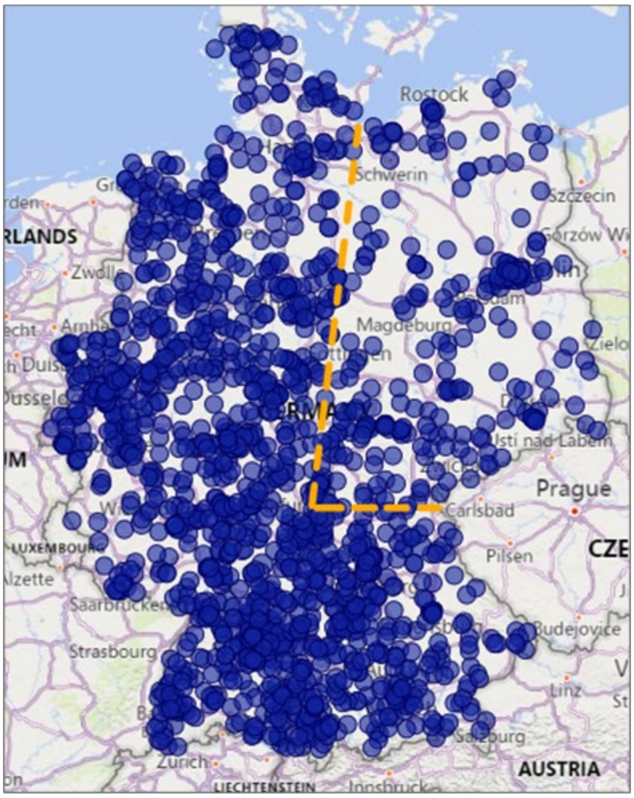


Figure 7 - New citizen-led renewable energy initiatives by founding date, since 2000, with approximate location of border between East and West Germany, based on COMETS inventory. Data source: [7]

Financial support mechanisms have played a critical role in the development of ECs, often in tandem with supportive legislation. In Germany, the Renewable Energy Sources Act (EEG), implemented in 2000 following the liberalisation of the energy market in 1998, played a crucial role in fostering the development of renewable energy. The EEG introduced financial support through feed-in tariffs (FiTs), which, coupled with a priority feed-in mechanism for energy from renewable sources, significantly reduced market risks and increased investment security by guaranteeing offtake conditions. This comprehensive support system, bolstered by loans with preferential conditions and refinancing possibilities provided by Deutsche Ausgleichsbank (now Kreditanstalt für Wiederaufbau (KfW)), created a stable and broad base for community-focused initiatives within the banking sector [15]. The amendment of the GenG in 2006 further contributed to this supportive environment [22]. These measures collectively facilitated the rapid development of renewable energies.

The impact of FiTs was also evident in the growth of solar cooperatives in Germany. In 2007, there were only four solar cooperatives, but this number surged to 200 by 2010. Between 2008 and 2014, during the period when FiTs were available, a steep increase in solar cooperatives was observed. Changes to the EEG throughout the 2010s led to capped FiTs and then a complete replacement of FiTs with an auction-based tendering system for renewable energy grid feed-in rights [23]. While small-scale installations were exempt from this auctioning process, no suitable financial incentive was forthcoming to support ECs. The regulations became geared towards larger, market-level RE production. This market premium scheme penalised small-sized generation plants by rendering them less competitive [10]. 2015 saw the number of new cooperatives fall 25% compared to 2014 [4]. This was the start of an ongoing drop in new energy communities [22]. **Figure 4** and **Figure 8** show a strong visualisation of this decline. Despite this shift, the initial support provided by FiTs was instrumental in developing a diverse ecosystem of power generators. An overview of Germany's EC development can be seen in **Figure 9**.

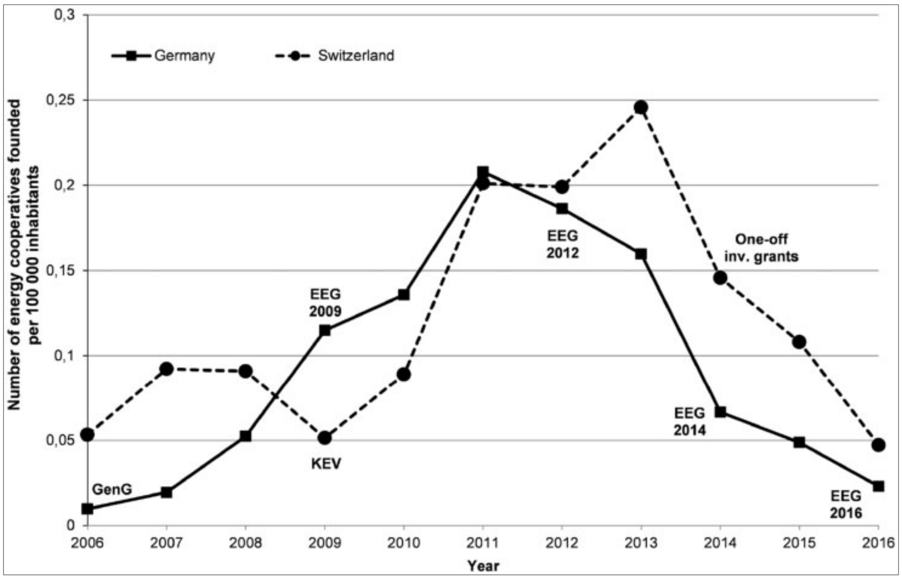


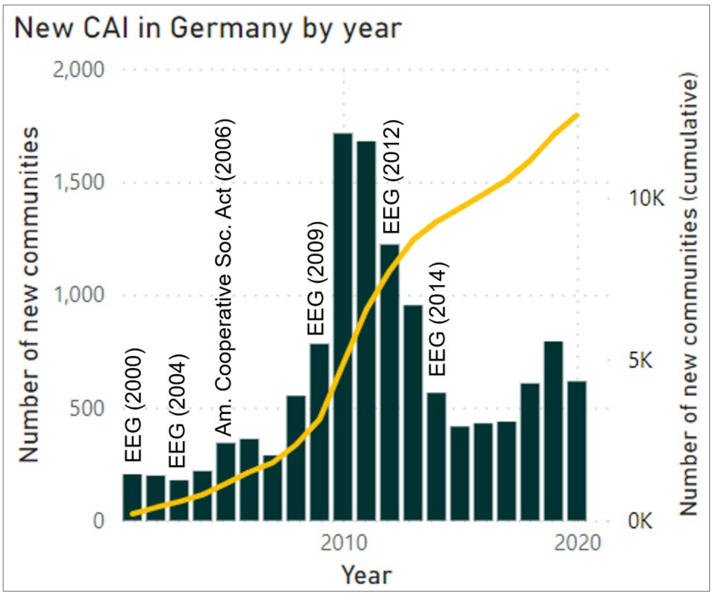
Figure 8 - Number of newly established energy cooperatives per 100,000 inhabitants per year in Germany and Switzerland from 2006 – 2016. Image source: [22]

Note: EEG = Renewable Energy Sources Act; GenG = Amendment of the Cooperatives Act; KEV = compensatory feed-in remuneration scheme

The 2018 RED II brought new definitions and support measures for citizen energy companies, but the government did not fully transpose these provisions, leading to a complaint filed with the European Commission in 2021 [24]. Progress has been made under the coalition government elected in September 2021, which aligned legal definitions of citizen energy companies with RECs as defined in RED II. Via an amendment to the EEG, labelled EEG 2023, solar and onshore wind citizen energy projects up to a specific size are exempt from auction and tender participation, making them eligible for a market premium based on previous auction results [25]. FiTs are available for installations under 100 kW, a market premium guarantee is received for installations under 1 MW, and for installations greater than 1 MW, a price based on winning bids from tenders under the regular competitive process is given. A new grant-to-loan programme was also introduced to provide investment support for planning and approval of new onshore wind citizen energy projects up to 25 MW. The Federal Network Agency now also has an obligation to report annually to the Federal Government on progress towards increasing citizen participation in the energy transition [26]. The EEG 2023 policy took effect on 1st January 2023.

Germany has yet to fully address collective consumption and shared use, and the concepts of open and voluntary participation from RED II are not explicitly addressed. There are plans to first reform the electricity market design, including grid charges, before introducing energy sharing. There are concerns that reduced charges for RECs might increase system costs for non-participants and doubts about the benefits of energy sharing [25].

Germany



CAI: Community Action Initiative

- 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.

Figure 9 - Development of ECs in Germany. Data source for graph: COMETS inventory, described in [1] and available at [7]

2.2.3 Switzerland

In Switzerland, where cooperative business models form a core part of the economic and political structure [27], cooperatives played an important role at the end of the 19th century in the construction of distribution grids in rural areas [28]. Switzerland's system of direct democracy has been identified as a positive factor in establishing citizen-led energy initiatives [22]. Recent energy-focused cooperatives have been primarily concerned with the production of renewable energy to address environmental objectives [28].

The implementation of the Kostendeckende Einspeisevergütung (KEV) ('compensatory feed-in remuneration scheme' in English) in 2009 led to a significant increase in installed RE capacity, primarily solar, with some minor additions in wind capacity. Under this scheme, every kilowatt-hour (kWh) fed into the grid was incentivised, which spurred considerable growth in the adoption of solar PV systems across the country.

Similarly to Germany, changes and uncertainty in Swiss energy policies in the early to mid-2010s led to a decline in newly incorporated ECs (see **Figure 8** and **Figure 10**) [22]. A significant waiting list for gaining government financial support via KEVs developed by 2013 [28]. [22] 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)” [28], 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 [28], 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) [22] exacerbated the decline in new ECs in Switzerland by keeping them isolated and lacking wider support.

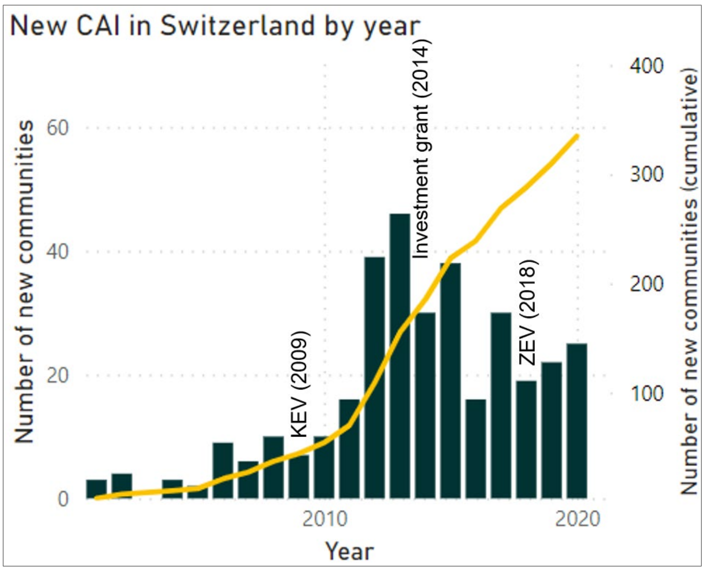
By 2018, a new scheme was introduced that marked a strategic shift from incentivising feed-in to promoting self-consumption [29]. This new scheme, known as the Einspeisevergütungssystem (EVS) (‘feed-in remuneration system’ in English), provided subsidies for PV installations with a fixed amount covering up to 30% of the installation costs. This legislative change made self-consumed kWh more profitable than those fed into the grid, thereby encouraging homeowners and businesses to maximise the direct consumption of the electricity they generated. The higher the proportion of electricity consumed directly on-site, the quicker the PV system could be amortised. An overview of Switzerland’s EC development up to 2020 can be seen in **Figure 10**.

The EVS also introduced the concept Zusammenschluss zum Eigenverbrauch (ZEV) (‘self-consumption association’ in English). This innovation allowed for the aggregation of multiple consumers not only within the same building but also across several properties. By joining together, these associations could significantly increase their self-consumption rates, making PV installations even more attractive and economically viable. This collaborative approach helps optimise the use of generated solar power, reducing reliance on the grid and enhancing the overall efficiency and financial returns of solar energy investments. According to the Swiss Federal Office of Energy (SFOE), there were 17,152 active ZEVs in 2023, an increase of 40% from 2022 (12,189) [30].

Despite these advancements, the development of ECs and the broader adoption of PV systems in Switzerland have not been without challenges. Regulatory barriers remain a significant hurdle, as navigating the complex and sometimes restrictive legal framework can be daunting for community projects. Financial constraints also pose a challenge, as securing the necessary capital for initial investments and ensuring long-term financial sustainability can be difficult, even with available subsidies and support mechanisms.

To address some of these challenges, the Federal Act on a Secure Electricity Supply from Renewable Energies was adopted in June 2024. This act encompasses a variety of changes to energy laws which will come into effect in January 2025 and January 2026 [31]. Two new types of ZEVs will be introduced, Virtuell Zusammenschluss zum Eigenverbrauch (VZEV) (‘virtual self-consumption association’ in English) and Lokale Elektrizitätsgemeinschaft (LEG) (‘local electricity community’ in English), enabled by a new rule that allows the low-voltage grid (below 1 kV) to be used for self-consumption between local parties without additional costs for VZEVs and with preferential grid rates for LEGs. This change opens up the self-consumption community concept to a wider variety of participants, such as apartment buildings in the same neighbourhood that are not physically connected, municipalities who own and manage real estate, and even buildings without solar installations who want to join forces with nearby buildings that do generate solar power [32].

Switzerland



CAI: Community Action Initiative

- 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-2010
- 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

Figure 10 - Development of ECs in Switzerland. Data source for graph: COMETS inventory, described in [1] and available at [7]

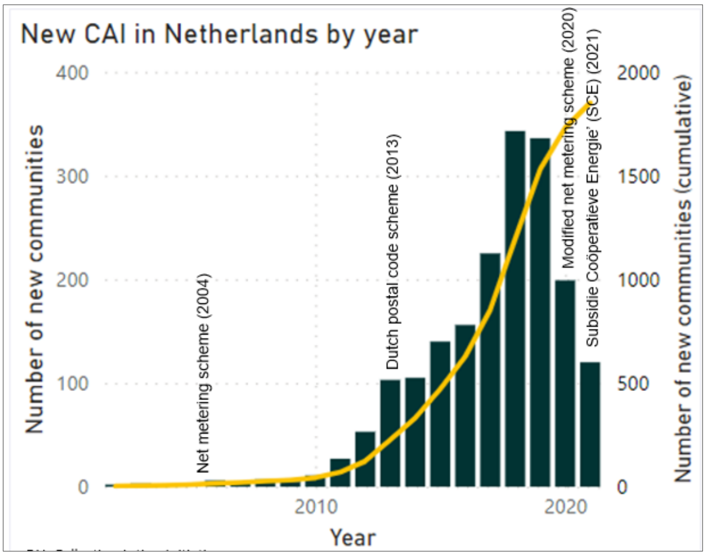
2.2.4 The Netherlands

The Netherlands can be considered one of the pioneers in the field of energy communities [3] and has cultivated a well-developed policy landscape that not only includes appropriate financial incentives, but also emphasises citizen involvement in ECs. Strategies and tools for effective communication with citizens were created to boost engagement and awareness of EC schemes. Additionally, platforms providing comprehensive guidelines were established to inform and support prospective ECs, highlighting the benefits of initiating such projects. Research indicates that these efforts significantly contributed to the growth of ECs [33].

Critical to this development were financial incentive schemes. The introduction of net metering in 2004 allowed produced renewable energy to be offset against consumed energy, effectively eliminating the tax component in energy tariffs. Another key initiative was the 'Dutch postal code scheme' in 2013 and its successor, 'Subsidy Cooperative Energy Production' in 2021. These schemes provided financial incentives for the creation of ECs that collectively invest in energy production within a designated geographical area, defined by postal codes. This arrangement allowed community members to benefit from RE investments without needing to install PV panels on their own roofs [3]. These combined efforts have been pivotal in fostering the growth and success of ECs in the Netherlands.

The general legislation transposing the RED II provisions for RECs through a revision of the Dutch Energy Law is still pending. A draft version of the new Energy Law was published in July 2022, indicating a delay in the complete transposition. This draft introduces the concept of an 'energy community,' merging the EU definitions of REC and CEC into a single entity that can participate in energy markets. These 'energy communities' are proposed as new market actors with the same rights and obligations as other market participants, ensuring equal treatment. Despite the pending transposition of the REC definition, the Netherlands already boasts a comparatively advanced enabling framework for community energy [25]. A historical dominance of centralised fossil-fuel institutions and a focus on being competitive on an international scale [33] meant the EC movement only took hold in the late 2000s and 2010s. Barriers to the creation and operation of ECs were identified in the research (see [34]), but they are not unique to the Netherlands so will not be discussed here. An overview of the Netherlands' EC development can be seen in **Figure 11**.

The Netherlands



CAI: Community Action Initiative

- 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)
- Subsidy Cooperative Energy Production in 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

Figure 11 - Development of ECs in the Netherlands. Data source for graph: COMETS inventory, described in [1] and available at [7]

2.2.5 United Kingdom

In the UK, where no specific cooperative law exists, large companies traditionally dominate the energy markets, and the electricity system has been (and remains) heavily centralised. Government policies aimed at liberalising and privatising energy infrastructure and supply capabilities have, however, paved the way for the formation of markets that encourage community and local ownership of renewables. New laws were enacted to support this transition, enabling the formation of small-scale energy generation companies, including community energy groups, through mechanisms like community shares [4]. This legislative shift was complemented by a mix of grants and tax advantages to further bolster a feed-in tariff system [35].

There was a particular push towards decentralisation during the Conservative - Liberal Democrat coalition years of 2010 to 2015, realised via generous FiT payments, no feed-in caps for small-scale producers, and tax reliefs. This led to an increase in EC incorporation. The UK's Feed-in Tariff Scheme, launched in 2010, played a crucial role in this transformation. It led to rapid growth in the community energy sector, particularly in solar electricity generation in England and wind generation in Scotland. By reducing investment risks for new projects, the scheme improved access to capital, facilitating the entry of new projects into the market [35].

One significant initiative was the publication of the UK government's Community Energy Strategy in 2014. This strategy aimed to enhance engagement and communication with prospective communities, fostering the development of networks and facilitating the transfer of knowledge within the community energy sector. This approach was crucial to the growth of the sector [35].

Community revenue in the UK has primarily come from supply-side income, although grant funding has also been vital for energy efficiency projects and general start-up costs. Early in the sector's development, supply-side income was especially important [35]. Additionally, government-led financial support, such as the Enterprise Investment Scheme and the Seed Enterprise Investment Scheme, provided tax relief to investors in early-stage companies, further supporting community energy initiatives [23].

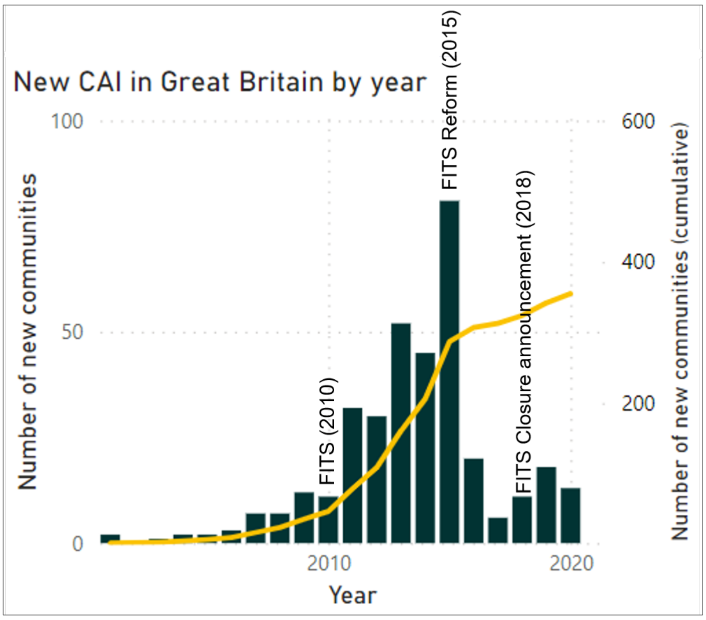
However, the setting of energy policy and regulation remained at the national level throughout, so when government policy shifted away from the localisation movement at the end of the coalition in 2015, a significant drop in new ECs entailed (see **Figure 12**). A serious reduction in FiT payment levels, 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 [23]. Policy shifted to encourage large-scale energy infrastructure projects [35]. 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 [35].

The regulatory environment has also not been entirely favourable. The UK Financial Conduct Authority has previously blocked the official registration of renewable energy cooperatives, arguing that members would not participate sufficiently in organisations focused on energy supply [36]. Furthermore, UK regulations prevent energy cooperatives from acting as small-scale energy suppliers because they are too small to apply for supplier licenses, which has been detrimental to the sector's growth [15]. An overview of the UK’s EC development up to 2020 can be seen in **Figure 12**.

Even with minimal governmental support, the community energy sector grew during 2022 and 2023. 61 MW of renewable energy capacity were installed, a greater than 9% annual growth rate, and an 18% increase in community energy organisations occurred [37]. In 2023, towards the end of the Conservative government’s term, a £10 million government fund, called the Community Energy Fund, was opened to support local energy projects with feasibility and development costs. However, this amount was significantly less than the previous FiT scheme, limiting the potential for EC growth in the UK [38]. At time of writing in February 2025, £4.5 million has been allocated to 108 projects, with a closing date for applications of 31 March 2025 [39].

The Labour government that came to power in 2024 has significantly increased the government's commitment to local communities with their Local Power Plan. Great British Energy, the new publicly-owned clean energy investment company [40], will allocate £600 million to local authorities for local energy projects and up to £400 million each year in low-interest loans for community energy – two orders of magnitude greater commitment – with the goal to deliver 8 GW of renewable capacity [41]. The effective ban on onshore wind projects in place since 2015 was also removed, opening a previously blocked avenue for ECs to explore [42]. Historically, the energy system in the UK has not been that influenced by the EC movement and ECs remain niche [35]. The impact of these recent increases in governmental commitments remains to be seen.

UK



CAI: Community Action Initiative

- Feed-In Tariff Scheme in 2010
  - First support mechanism aimed at smaller scale renewables, with tax incentives and public loans
- Schemes also been 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
- UK does not have a specific cooperative law:
  - In 2014, government blocked several RE cooperative applications, saying members would not participate enough

Figure 12 - Development of ECs in the UK. Data source for graph: COMETS inventory, described in [1] and available at [7]

2.2.6 Denmark

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 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 [15].

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 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 [10]. By 2010, it was estimated that 15% of all wind turbines in use in Denmark were owned by cooperatives [15].

This promotion of wind power ownership by local citizens, companies, and cooperatives has been a key strategy. Early on, the Danish government implemented planning schemes and specific regulations that allowed local residents to invest in shares in wind farms built in or near their municipalities [4]. Initially, ownership of wind turbines was restricted to local actors living or registered in geographical proximity to the turbine they owned, resulting in high levels of local ownership [33].

Historically, Denmark's main support mechanisms, particularly targeting wind turbines, included investment grants from the Danish state, tax exemptions for income generated from wind turbines, and, from the mid-1980s, feed-in tariffs. These FiTs included guaranteed grid connection, offtake obligations, and priority terms for network use. The combination of tax exemptions and FiTs created assets with high investment security, providing guaranteed, stable incomes. This, in turn, supported low-cost financing from banks, fostering the growth of energy cooperatives. Legislation that gave consumers the freedom to choose their electricity provider and promoted a certificates-based quota system for renewable energy encouraged the creation of community energy initiatives [23].

Two factors drastically reduced the occurrence of ECs (an 88% drop since the year 2000 according to [23]): a shift in political discourse against green energy [33] and the liberalisation of the European energy market, both occurring in parallel during the 2000s. This decline is visualised in **Figure 5** and **Figure 13**. The FiT 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" [4].

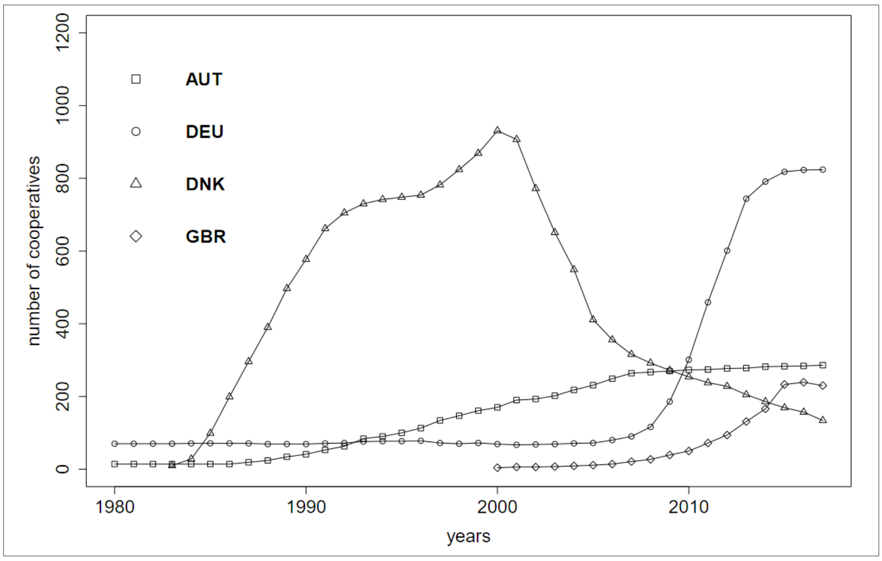
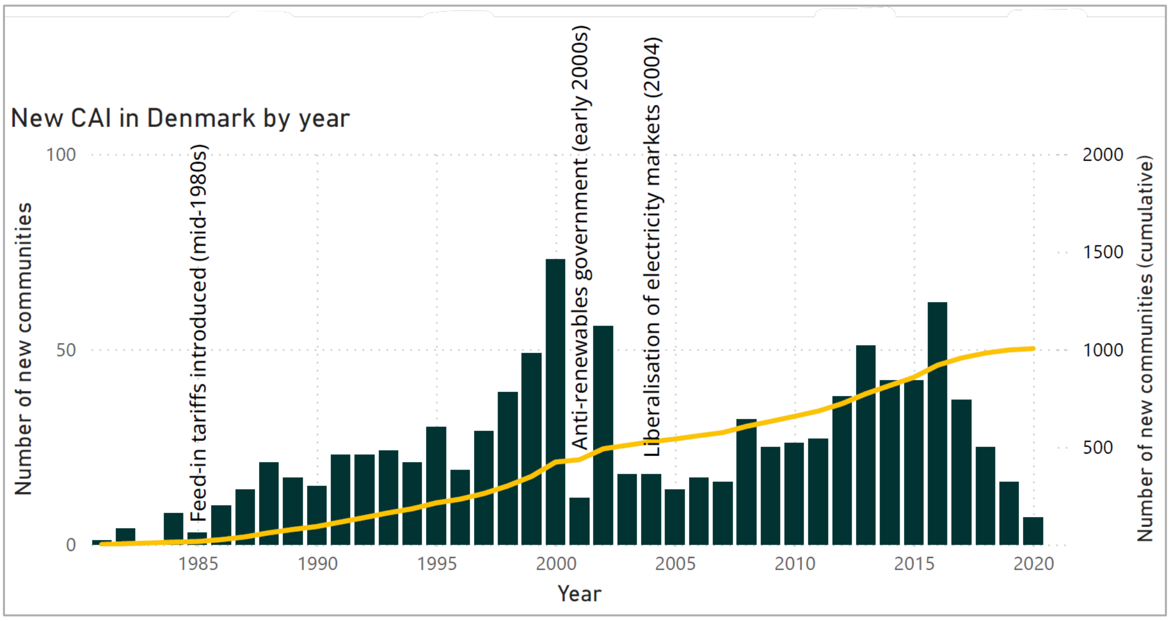


Figure 13 - Number of energy cooperatives in Austria (AUT), Germany (DEU), Denmark (DNK) and Great Britain (GBR) per year from 1980 – 2018. Image source: [23]

With the liberalisation of the energy market, previously favourable conditions for the creation and operation of ECs were demolished. "A focus on international competitiveness creates pressure to establish competitive energy prices in order to have the national industry compete internationally" [33]. This led to "low spot prices on the common electricity market" [33] and exposure to the price volatility of the markets [15]. 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" [15] 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 [15].

However, a steady increase in new ECs from the late 2000s can be attributed to: (1) the Danish Renewable Energy Act which, since 2009, requires that all new wind energy projects have at least 20% citizen cooperative ownership [43], and (2) the Danish Energy Agency's DKK 4 million annual finance pool dedicated to supporting local energy communities [44]. An overview of Denmark's EC development up to 2020 can be seen in **Figure 14**.

Denmark



CAI: Community Action Initiative

- Wind power technology becoming suitable for cooperatives and an oil crisis coincide in the 1970s pushing people to look for alternatives to the normal energy system
- The concept of civil society entrepreneurship was prominent from the 1970s to 2010s
- Feed-in tariffs were introducted in the mid-1980s and were in effect until 2003
- An anti-renewables government was elected in the early 2000s
- Liberalisation of the electricity markets occurred in 2004

Figure 14 - Development of ECs in Denmark. Data source for graph: COMETS inventory, described in [1] and available at [7]

2.2.7 Sweden

The concept of energy communities is emerging in Sweden, though current initiatives do not yet align with the EU definitions of CEC or REC [45] [46]. The Swedish electricity market, deregulated since 1996, offers competitive electricity sales with EC models such as wind power cooperatives, eco-villages, and solar power cooperatives being the most prevalent [47]. Significant legal and practical challenges need addressing for broader implementation.

There is no comprehensive database of active ECs, though a 2017 study identified 140 active initiatives [47]. ECs in Sweden typically operate as incorporated associations, non-profits, or tenant-owned apartment associations, producing renewable energy for their members [47]. Key regulatory bodies include the Swedish Energy Agency and the Swedish Energy Market Inspectorate, alongside Distribution System Operators (DSOs) and Svenska Kraftnät, Sweden's Transmission System Operator (TSO).

In 2003, the Electricity Certificate System was introduced, providing financial incentives for RE producers, including solar. This system aimed to increase the share of RE in Sweden's electricity supply [48]. In 2009, a direct capital subsidy for solar PV installations was introduced, initially covering up to 60% of installation costs for residential, commercial, and public buildings. The subsidy programme remained in place until 2021, although it was modified several times, including reducing the level of support to reflect falling technology prices and increased market demand [49].

Legal barriers, including the requirement for network concessions, monopolistic DSO positions, economic constraints, and low public awareness, hinder the growth of ECs, as do Sweden's strong welfare state and low carbon energy mix [47]. 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 [33]. This lack of community focus, in the energy sector specifically, is likely due to state institutions being "very active" [33] in the energy transition, with municipalities taking a leading role as suppliers of all forms of energy [50]. The low carbon energy mix Sweden already benefited from - hydro and nuclear power being 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 [33] [47].

Even with these small numbers of ECs, the influence of changing regulation in Sweden can be seen on the number of new community initiatives setup (see **Figure 5** and **Figure 15**). 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 [47]. It is not discussed in the paper that **Figure 15** is from what might have caused the steep decline between 1999 and 2001. However, currently rising energy prices and decreasing solar panel costs are driving increased interest. Interviewees in [51] suggest that regulatory adaptations could soon enable broader implementation of ECs, enhancing financial benefits, renewable energy production, and local energy stability. An overview of Sweden's EC development can be seen in **Figure 16**.

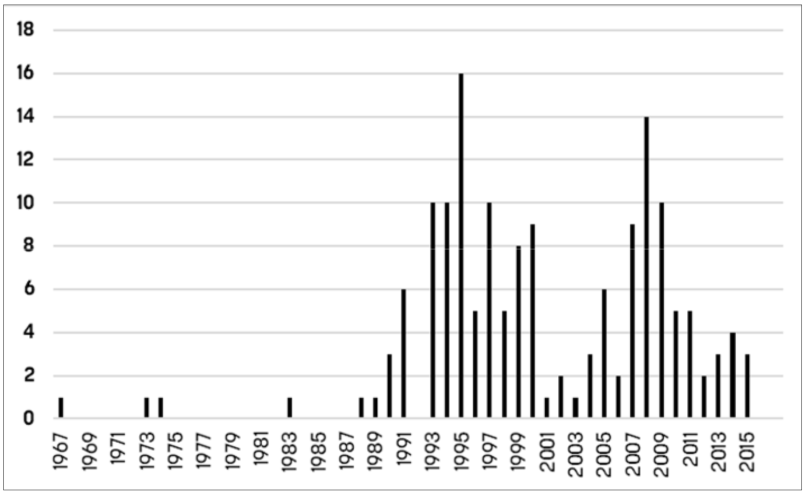
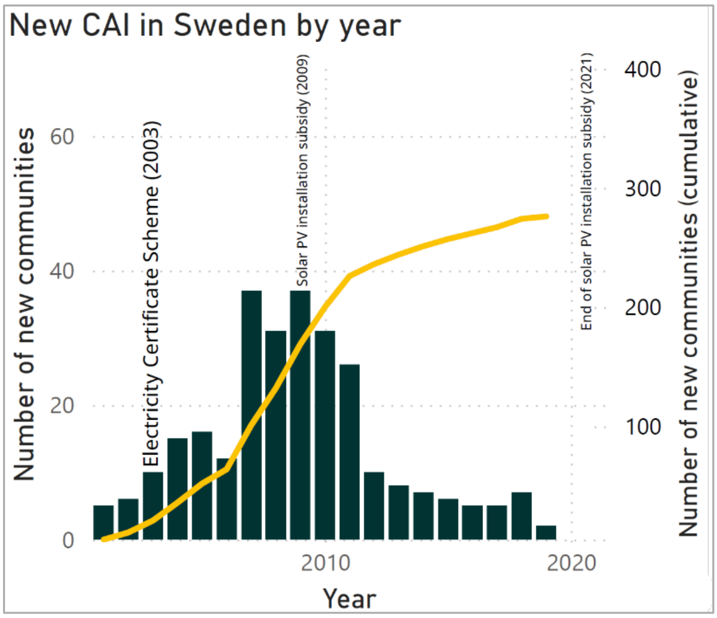


Figure 15 - Number of community energy initiatives starting each year in Sweden from 1967 – 2015. Image source: [47]

Sweden



CAI: Community Action Initiative

- The energy market was deregulated in 1996
- Electricity Certificate System was introduced in 2003 providing financial incentives for RE producers
- Solar PV installation subsidy was introduced in 2009 and was available until 2021

Figure 16 - Development of ECs in Sweden. Data source for graph: COMETS inventory, described in [1] and available at [7]

2.2.8 Spain

In Spain, the right to participate in electricity generation has historically been limited, although this changed at the end of the 2010s. Cooperatives had no authority to generate electricity, only being allowed 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 [21]. Spain's EC journey has also struggled against a cultural scepticism of cooperatives [52] and from delayed regulation that would enable community participation in energy production [53].

Introduced in June 2020, Royal Decree-Law 23/2020 defined RECs in Spanish law, aiming to utilise renewable energy from ECs and increase participation of citizens and other actors in community energy projects [54]. As one of the few EU Member States that allows collective self-consumption schemes to make use of the public grid [25], the inclusion of no grid fees or taxes on shared energy is particularly appealing for ECs [55]. However, the focus remains on renewable self-consumption [54] and solar PV [17], with no formal support scheme for RECs and only limited auction capacity set aside for citizen-led PV projects in 2021 (300 MW) and 2022 (150 MW) [55].

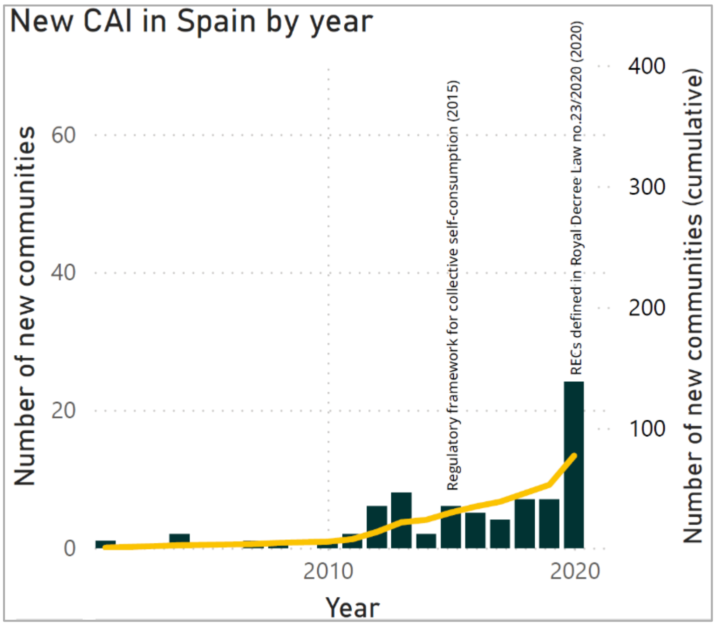
Due to limitations in how the law specified certain operational aspects (such as unclear governance principles and allowed market activities, no assigned regulatory authority for compliance checking, and ambiguity in the types of actors that could get involved), regulatory uncertainty remained, with potential communities reverting to the use of pre-existing collective self-consumption regulations instead. Technical limitations also dampened REC uptake, such as connection only to the low voltage grid, a geographical inclusion zone within 500 m for participation, and a 100 kW maximum installed capacity [25].

Commitment to making community energy viable in Spain continues. The Recovery, Transformation, and Resilience Plan (originally adopted in 2021 and with a 2023 amendment) established a dedicated fund of

EUR 100 million for the development of RECs in Spain, filling a gap left by Royal Decree-Law 23/2020. Royal Decree Law 18/2022 expanded the participation radius to 2000 m in October 2022 [25] meaning larger catchment areas for potential members. Regional and local authorities are also using European Regional Development Fund resources (such as grants and technical assistance) to foster RECs in their areas [25]. A new chapter of Spain's implementation of the REPowerEU objectives, which came into force in 2024, includes scaled up support for ECs to setup off-grid renewable energy projects [56] [57].

While the uptake of the EC model in Spain remains limited, growth is happening with the continuing iterations of the REC framework in national law [17]. An overview of Spain's EC development up to 2020 can be seen in **Figure 17**.

Spain



CAI: Community Action Initiative

- Focus on self-consumption and solar PV
- Regulatory framework for collective self-consumption introduced in 2015
- Royal Decree Law 23/2020 defined RECs in law, but lacked details causing uncertainty and with technical limitations such as a maximum installed capacity of 100kW
- Royal Decree Law 18/2022 expanded the radius for eligible participation in an REC from 500m to 2000m
- Recovery, Transformation and Resilience Plan (2021 and 2023) provides a dedicated funding channel for RECs
- REPowerEU objectives updated in 2024 scale up support for off-grid renewable energy projects

Figure 17 - Development of ECs in Spain. Data source for graph: COMETS inventory, described in [1] and available at [7]

3. Factors that influence the success of energy communities

Despite the decline in energy community growth seen in some European countries, the EC model is still appealing and continues to be adopted by many communities across Europe. With the implementation of RED II and the Energy Market Directive (ED 2019) as part of the Clean Energy Package (CEP) [21], the EU gave 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 source] communities for most, if not all, of the decade up to 2030..." [10]

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 and any remaining barriers to creation and operation need to be overcome.

3.1 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 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 [58].

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 [12], [58], and [59] 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;
- an appropriate market structure is in place; and
- innovation and exploration of new renewable energy sources, technologies, and solutions.

These factors can be grouped into five areas:

1. Governmental and political engagement
2. Legislation and regulation
3. Social engagement
4. Financial and economic support
5. Technical solutions

What can be seen from these lists 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” [3] 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." [3]

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 [5]. 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." [3]

Many of the key barriers to the growth of new and existing ECs (which are discussed in detail in various papers including: [5], [52], [54], [60], [61], [62], [13]) 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.

3.2 Financial support and changing business models

Much of the reviewed literature (including [4], [2], [3], [5], [12], [28], [35], [58], [53], [63]) 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, 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 [3]) 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 [3].

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, [5] describes a French 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)" [5] as options available for ECs to gain funds – a mix of both public and private support; while [35] 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" [35].

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 [28]. 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 [4]. 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 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" [53]) 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 [53]. 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. Suitable market structures need to be in place to enable different EC types to participate and also ensure ECs can act as "reliable players" [12] in those markets [12].

Currently, some market-based remuneration mechanisms can "pose certain restrictions for energy communities because of their small size and resources" [4]. 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 [3]. 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" [4]. 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 [4]. 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" [4].

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 (ROI) 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" [5]. Financial support for ECs is tied to how the public perceives 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 [58]. 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.

3.3 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 [3], [10], [22], [28], [35], [58], [64], [53], [63].

> "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)." [22]

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" [10]. 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 [10]. 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 [64]).

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 [10]. It has been suggested that "local governments are best positioned for collaboration with community energy" [22], but it remains important to highlight that "local energy governance arrangements must be understood in the context of multilevel governance, which includes federalist systems" [22]. 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 [10].

The timing and order in which measures are implemented by policymakers can affect the growth trajectories of ECs. "...policymakers should be cognisant 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" [53]. 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 ROI timescale for EC investments is in the decades. This means that any fluctuation in the support and regulations that the community must adapt to could negatively impact this ROI, making initial commitments less attractive to all actors. The Swiss ECs surveyed in [28] emphasised that "...the energy policy environment must be geared to the longer term in order to promote renewable energies and energy cooperatives" [28].

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" [58]. 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" [58], 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" [28] were identified in [28] 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" [28]. However, as part of RED II, Member States have to "ensure the removal of unjustified regulatory and administrative barriers" [10] 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 [28]. These limiting factors can breed frustration and lead to a tumultuous situation for ECs [28], 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 [28]. 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 [35]. 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 and operate ECs. One example seen in the research was from the results of a survey of Swiss ECs [28] in which a regulation that 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 adoption.

Regulations also impact on the financial aspects of ECs. For example, in RED II, 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)" [10], ensuring that Member States consider financial aspects in their implementation of the directive into national regulation and policy.

3.4 Energy prices & Renewable energy technology costs

Energy prices and the cost of RE technologies can also play a role in supporting the growth of energy communities, in addition to governmental support for renewables through financial incentives and 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 [4]. 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 [58]. 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 [23].

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" [15]. The Feed-in Premium system provides some protection for RE generators against fluctuations in energy prices.

ZEV communities in Switzerland 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 [29]. This means 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.

3.5 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 and 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 [3], [12], [22], [64], [53], [59], [63].

As stated in [36], the effectiveness of any measures aimed at enabling the growth of the "extraordinarily multifaceted phenomenon" [10] 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" [4]; and the wide breadth of factors that influence their potential for growth. Measures can be supportive or unsupportive. **Section 3.3** discussed that the way regulations are implemented can impact how supportive (or unsupportive) an environment for ECs could be. [10] takes a deep dive into how Member States could implement the CEP to be more or less supportive of ECs in national policy. [59] identifies and develops the concrete mechanisms that need to be in place to scale ECs. Both these papers are particularly informative in understanding factors that create an enabling environment for ECs.

The impact of the factors on the types of ECs is an area that warrants further investigation. [53] 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." [53]

Table 2 - Enabling environment factors for energy communities

Category	Factor
Societal & Behavioural	Increasing knowledge base, knowledge access, and knowledge sharing about and between ECs
	Introduction and performance of community leadership training for individuals about ECs
	Increase the capacity of EC umbrella organisations
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
Financial	Continuation and increase in financial support for EC types
	Access to suitable energy markets for appropriate EC types
	Energy prices remaining high, leading towards people exploring alternatives such as ECs

Category	Factor
	Renewable energy technologies continue to decrease in price, reducing the upfront costs
	Increasing ability to accurately estimate the cost of EC setup and operation
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 • “are interoperable and fit-to-purpose targeting specific actors at specific scales (from local, through regional, to national)” [59] • “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” [63] • 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” [63] • “take a ‘whole society value’ approach and recognise the benefits community energy brings to other policy areas (local economies, health and wellbeing, etc.)” [63] • promote a strong local community mindset • work towards the democratisation of community energy
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

4. Evolution of energy communities 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 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 are one of these forms, allowing ordinary citizens to play a role in the energy transition. 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.

4.1 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 [5], [34], [35], [58]) include:

- to increase 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 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" [10].

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 [34]. These forms take two main types according to [34]:

1. Alliances and partnerships
2. Cooperative development agencies

Type (1) leads to an increase in professionalisation. Type (2) target 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 3**.

The importance of learning from peer groups was highlighted in the literature [5]. Both collaborative forms make use of knowledge sharing as a tool. One of the outcomes from [3] 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.

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 [28] 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 [60]. 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 ECs 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.

Table 3 - 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"" [5]
Umbrella organisations	1	Facilitate knowledge sharing between ECs Example: REScoop.EU [7]
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) [28]
Local capacity builders	1	ECs that become catalysts for other ECs to be created in their region [8] 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 [35]

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

[8] "...some CREPs [community renewable energy projects] 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." [5]

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)." [35]
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

4.2 Professionalisation & Commercialisation

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. Commercialisation for ECs involves, for example, offering energy services, such as flexibility, to grid operators and operating on energy markets. Professionalisation is a prerequisite for commercialisation.

There is an expectation seen in the literature that communities will professionalise [65]. ECs will transform from single cooperatives (co-ops) focused on hyper local goals run by volunteers to neighbouring co-ops working together to gain more benefits for their members to co-ops acting as energy companies with paid employees, fulfilling a broader set of objectives, such as providing balance and energy management services.

In a 2024 report written for the European Commission regarding the impact ECs could have on the electricity grid [12], a version of the development stages of ECs is presented (see **Figure 18**). Apart from the first phase which covers basic operation, the remaining three phases all represent professionalisation and commercialisation requirements for ECs, showing how vital these processes will be for the future development of ECs.

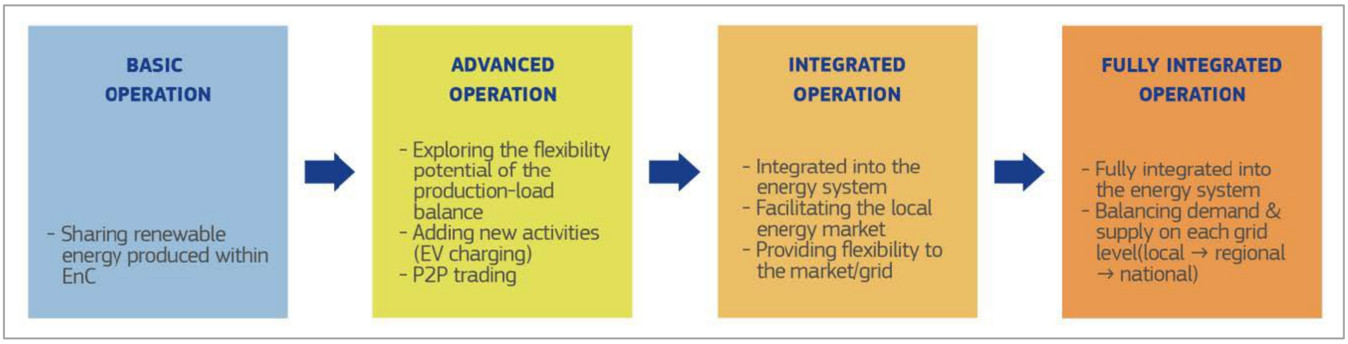


Figure 18 - Phases of energy community development. Image source: [12]

The goals that community professionalisation is trying to fulfil and the forms this can take have been distilled from the literature. 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 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 3** 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. It is recommended for further exploration as part of an assessment of potential and future business models for energy communities.

[34] 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” [34] 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.

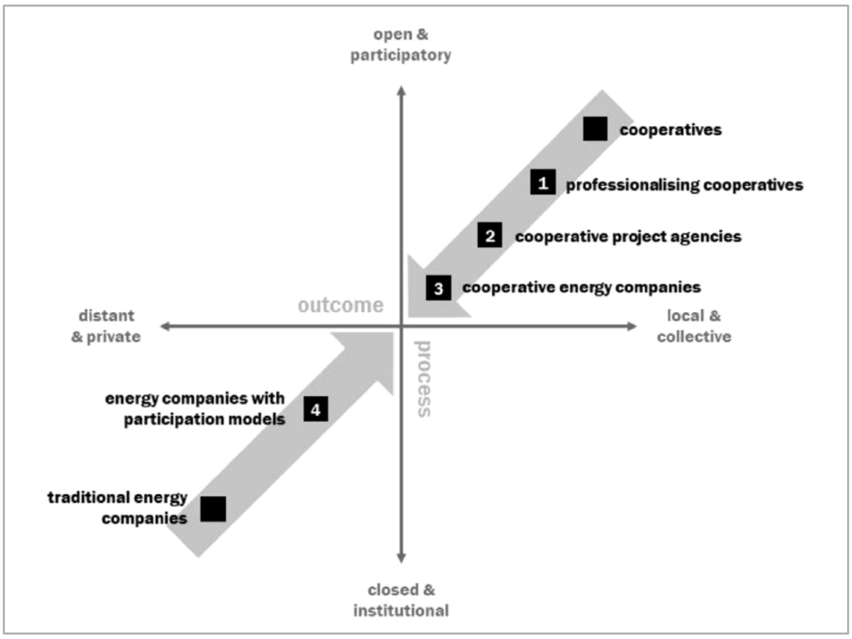


Figure 19 - Professionalisation movement of energy communities. Image source: [34]

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" [33] 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 [3]. 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 [28] 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" [28]. Also, how professionalisation will affect the makeup of communities in terms of settlement patterns and regional locations is not clear at this point.

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.

4.3 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. Secondly, with differing penetration levels achieved by ECs as a whole, i.e. how much impact the EC concept has on the energy sector [10]. 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 [10], 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 [3]. The energy balance is more efficient when different types of demand are made (e.g. timing, amount, quality, supply versus demand curves). 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 [10]. 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) 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” [10].

This homogenisation is most likely in regions that share “the specific endowment of renewable energy sources or the presence of a strong cooperative movement” [10]. As ECs professionalise and move into the commercial space, there will also be a need for some standardisation 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, 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.

5. Conclusion

The development of energy communities in Europe has been diverse. Influences such as cooperative traditions, diverse implementations of regulations, a range of financial measures from supportive to restrictive, and fluctuating energy prices have all impacted the uptake of the EC concept. Analysis that provides an accurate number of ECs is limited due to the diversity of what is considered an energy community in different regions and inconsistent or non-existent documentation of their application. A few studies attempted to rectify this, with the latest count (from a 2022 study) being 3,931 active ECs. The overall trend is positive, with an increase of 1,531 between 2014 and 2022 (63% increase). Germany dominates in all studies, with Denmark and the Netherlands swapping between 2nd and 3rd depending on how the studies defined their inclusion criteria.

The historical perspective of EC development was explored for a subset of European countries. The overarching and common factors that affected positive EC growth in Europe were seen to be (in no particular order):

- legal recognition at intra-national, national, regional, and local levels;
- a propensity for cooperative structures;
- supportive legislation and clear regulations;
- effective financial support mechanisms;
- strategic, long-term thinking;
- a focus on effective communication with and between citizens; and
- high energy prices.

On the flip side, 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, and Spain, 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
- a high trust environment with a strong welfare state.

With a view to establishing what an enabling environment for ECs looks like and how that evolves into the future, the factors identified as causing or exacerbating the decline of new ECs were compared with factors identified as important for EC growth. Consistent and considered long-term regulations and financial support mechanisms were seen to be the most prominent factors for EC development, with a high energy price and declining cost for renewable generation technologies contributing major drivers. The identified factors for an EC enabling environment were summarised and categorised into governmental, social & behavioural, policy & regulation, financial, and energy industry related groupings.

The importance of the way measures are actually implemented was stressed as this can be done in both supportive and unsupportive manners.

Success factors for ECs are changing as regulations, uptake, acceptance, geopolitics, energy prices, and knowledge change. The importance of collaboration between ECs for their future development and success was clear from the research, to achieve goals such as increasing operational efficiency and boosting the number of members. The expectation seen in the literature was that ECs will professionalise and move towards commercial operation with the offering of energy services such as flexibility. Goals such as being able to take advantage of new business opportunities, increasing the ROI for members, and increasing the impact of ECs to the energy transition were seen to be the drivers for professionalisation and commercialisation.

The heterogeneous EC environment is expected to continue due to the current (and increasing) breadth of applications of the EC model and due to the ever-present diversity of energy demand across different types of energy system actors. Some homogenisation is possible, in particular due to potential harmonisation of legal definitions across Europe and in regions that choose to standardise regulatory frameworks.

The future for ECs in Europe looks assured with its prominence in EU regulation and continuing appeal of the concept as country- and region-specific regulations start to become solidified. However, careful and considered application of enabling factors and measures needs to occur. To further understand how impactful ECs could potentially be on the energy transition, further research is indicated in the following areas:

- trend analysis of EC development to create quantitative future development scenarios for ECs;
- how enabling environment factors affect the creation of different types of ECs and how that informs policy setting at the appropriate level; and
- further exploration of the federation of ECs as part of an assessment of potential and future business models.

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Acknowledgements

The authors would like to acknowledge and thank members of the Digital Energy and Electric Power research group (CC DEEP) at Hochschule Luzern (HSLU) for their help with data extraction and review.

Funding

This work was supported by the GENTE project, which received funding in the framework of the joint programming initiative ERA-Net Smart Energy Systems' focus initiative Digital Transformation for the Energy Transition, with support from the European Union's Horizon 2020 research and innovation programme under grant agreement No 883973.

Disclaimer

The content and views expressed in this material are those of the authors and do not necessarily reflect the views or opinion of the ERA-Net SES initiative. Any reference given does not necessarily imply the endorsement by ERA-Net SES.

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Appendices

A - Search term syntax and phrases

To ensure the most relevant data were captured during the discovery phase of the research, search terms were based on the understanding that the term 'energy community' is broad and variably defined.

A1 - 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]
```

A2 - Search term phrases

The specific phrases used for data discovery are as follows:

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
- 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.

B - 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

C - 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