



Original research article

# How can energy become a community endeavor in Europe? Consortium benchmarking strategies for the mobilization of collective action initiatives

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## ABSTRACT

A consortium benchmarking (CB) approach was used to conduct a study on development mechanisms and best practices for Collective Action Initiatives (CAIs) in the energy sector. National research teams (NRTs) were created in six European countries (Belgium, Estonia, Italy, the Netherlands, Poland, and Spain) each of which consisted of approximately five CAIs, as well as other stakeholders, governing bodies, and academic researchers. In total, 32 CAIs served as case studies. Each of the NRTs co-created research questions and methodologies to address the issues relevant to the case study CAIs. The results were then synthesized with respect to the dimensions of CAI mobilization (alignment of interests and engagement, organization and governance, resources, external actors and institutions, and policy and regulation) and how they contribute to the development and proliferation of CAIs. From the empirical findings, we reflect on the usefulness of the CB approach as a tool for engagement in research and derive recommendations for how CAIs can be better supported. We find that the CB approach was effective at engaging the CAIs in the research and strengthening their networks. Such networks, as well as collaboration with external actors, are vital for the success of CAIs through assisting with specialized skill sets, developing strategies for attracting a representative and diverse membership base, for securing financing, and for gaining political and social legitimacy. These networks can provide critical support to CAIs to navigate the dimensions of mobilization and allowing for the CAI to flourish.

## 1. Introduction

An important trend in the sustainable energy transition is the development of distributed power generation through energy communities and prosumer networks. Generally, this increases the flexibility of energy systems and raises efficiency by reducing the need to transport

energy over long distances. Increasing the share of distributed, citizen-led energy production is challenging, but the European Union (EU) supports and promotes such projects. In particular, the EU Renewable Energy Directive (RED II) [1] gives citizens and communities the right to produce, store, consume, and sell renewable energy, as well as other rights, such as consumer protection and access to all energy markets either directly or through third parties [2]. Up to half of the citizens of

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### Abbreviations

CAI	Collective Action Initiative
COVID-19	Coronavirus Disease 2019
CB	Consortium Benchmarking
COMETS	Collective Action Models for Energy Transition and Social Innovation
EDM	Energy Demand Management
EU	European Union
GDPR	General Data Protection Regulation
NRT	National Research Team
PV	Photovoltaic
RED II	Renewable Energy Directive of the EU
REScoops	Renewable energy cooperatives

the European Union could be energy self-sufficient, thereby supplying 45 % of final energy demand by 2050 [3].

Citizen-led energy initiatives often take the form of community-driven energy projects, which are typically involved in energy generation and conservation, but recently also in innovative energy-system services such as energy storage and electricity demand-side flexibility [4]. These projects are often referred to as community energy [4] or, as in our paper, collective action initiatives (CAIs) [5]. Collective action is the solution that humans embrace in order to cope with problems that they cannot solve as individuals [5,6]. Energy CAIs are energy cooperatives, prosumer networks or other citizen-led energy projects. They involve social innovation [7] in how they organize and gain power through a social movement mechanism. Though there is no universal agreement about the definition, scholars describe social innovation as the novel development of activities and services where social mechanisms or processes are used to meet social needs and build the capacity for action [8]. Energy CAIs are typically characterized by a focus on the community, open and voluntary participation, democratic governance, and autonomy and independence [9]. The social benefits of these CAIs include developing local economies, addressing energy poverty, raising awareness about sustainable energy, promoting energy justice, giving a voice to the community, developing local skills, and promoting social cohesion [10–18]. It has even been argued that citizen-led energy initiatives in Europe ‘converge towards a transformative social movement’ [19].

Research on energy CAIs concerns how CAIs are defined [20] and how they mobilize and acquire power [7]. Other studies trace their development within specific contexts or geographical areas [21], or show how they influence or are affected by national energy policies [22]. Some scholars use organizational and institutional theory to understand their historical development [23] or performance [24] arguing that the normative aspects of shared identity and shared objectives are more important than environmental and technological motives in the mobilization of CAIs [23]. They also find that support structures tailored to energy CAIs and a balance between top-down and bottom-up measures are necessary for promoting community energy projects and local acceptance of renewable energy. Although the mobilization of CAIs is a complex multi-dimensional and social phenomenon, it has become an active area of current research efforts.

Our study builds on [7], which discussed how four dimensions shape the mobilization of energy CAIs through their corresponding internal and external power relations: 1) interests, motivations and values; 2) organization; 3) resources; and 4) opportunities and risks. Internal power is conceived of as a CAI’s ability to align its members’ interests; organize, structure, and govern the organization; and mobilize resources, i.e., any physical, financial, social, or political assets or capabilities that contribute to collective action [7]. External power, on the other hand, is a CAI’s ability to seize opportunities and overcome

barriers [7]. This model was adopted within the framework of the COMETS project to feed a dedicated survey about CAIs’ evolutionary trajectories and determinants. The results of the survey (see [25] for details), conceived as a test for the robustness of the model provided in [7], highlighted some limitations such as the underestimation of the role of networks and relations with external actors that were not fully accounted for. The model was therefore updated to account for these shortcomings and six dimensions for CAIs’ development and establishment were identified and adopted in the participatory fieldwork described in Section 2: alignment of interests and engagement; organization and governance; resources; external actors and institutions; policy and regulation.

Fig. 1 shows how these dimensions of mobilization are linked to community-energy outcomes in terms of the development and proliferation of CAIs. Because the effective participation of members is the basic requirement for CAIs to exist, in the study attention is also paid to the recruitment strategies adopted by CAIs and to how they relate and interact with the six dimensions identified.

Built on this conceptual framework, this study has two objectives. The first is to investigate the different dimensions of mobilization and show how they support the development and proliferation of CAIs in terms of increasing the number of CAIs, scaling up or diversifying their activities, increasing the benefits of participation, or other forms of development and growth. In this endeavor, we explore the dimensions of mobilization in greater depth by understanding partnerships, such as local governments and umbrella organizations, and by analyzing the CAIs’ strategies in navigating policies and regulations. To do this, we adopted a consortium benchmarking (CB) approach. The second objective is to use the findings from this approach to distill the best strategies for supporting the mobilization of CAIs based on experience with them in six EU countries.

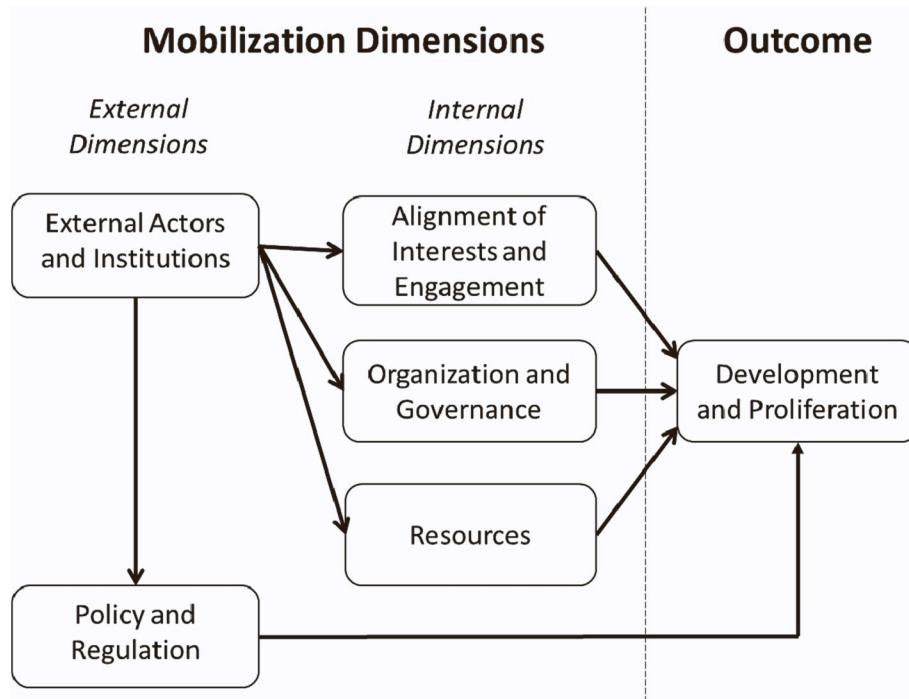
First, we describe the CB strategy and its implementation in the six different countries through the creation of a national research team (NRT) composed of CAI members, stakeholders in the energy sector, and researchers. Next, we show the distribution of specific research questions and methodologies that arose from the CB process for each of the countries. We then synthesize the results across the six countries, focusing on the aspects and dimensions of internal and external mobilization. Next, we summarize our findings on CAI development and proliferation. In the discussion, we reflect upon the CB approach used in this study and make recommendations for using it to research CAIs in the future. Finally, we present general policy-relevant strategies and best practices for CAIs in the energy sector.

## 2. Methodology

### 2.1. Consortium benchmarking

We apply CB as an intuitive strategy for understanding how CAIs function in their respective national contexts and to identify best practices while also promoting the involvement of CAIs in the research process. With CB, researchers and practitioners seek to uncover best practices and to streamline their implementation. In the context of this study, CB is seen as a way to benchmark the best practices and strategies for the mobilization of CAIs in the energy sector, thereby providing value to the CAIs participating in the NRTs, the ‘practitioners’ which serve as the units of analysis. This contrasts with ‘extractive’ methodologies, where researchers investigate phenomena with a predefined set of questions and methodologies, analyzing and interpreting the data without direct input from the CAIs. Instead, we provided a general framework to outline the basic study objectives and a staged timeline for implementation of the CB process.

The underlying philosophy of CB is collaboration and co-creation [26,27] through co-creative workshops and discussion and via the CAIs’ network within and across their respective countries. This makes it possible for shared learning and a more coordinated political voice to



**Fig. 1.** External and internal dimensions of mobilization for the development and proliferation of CAIs. Adapted from [7] and adjusted to highlight the supporting role of partnerships with external actors and institutions (e.g., umbrella organizations).

emerge. In CB: 1) the people or organizations being studied are engaged as co-researchers, and 2) the research is a team-effort that 3) uses different sources 4) with a particular focus on best-practices and 5) a

meta-discourse to produce the most relevant learning [26]. Hence, the entire research process, including formulating research questions, identifying methods, and collecting and analyzing data, is done

<b>Consortium Benchmarking</b>	
<i>Step</i>	<i>Description</i>
Preparation and Planning	<ul style="list-style-type: none"> <li>• Research background academic literature</li> <li>• Create study framework</li> <li>• Select consortium members</li> <li>• Plan organizational logistics; create sharing platform</li> </ul>
Collection	<ul style="list-style-type: none"> <li>• Kick-off meeting; formalize the research team</li> <li>• Establish learning objectives and research questions</li> <li>• Establish the methodology, adapt as needed</li> <li>• Site visits and network development</li> </ul>
Analysis	<ul style="list-style-type: none"> <li>• Share, discuss, and summarize findings</li> <li>• Formulate best practices</li> <li>• Formulate policy recommendations</li> </ul>
Reporting	<ul style="list-style-type: none"> <li>• Synthesize findings in a report</li> <li>• Lessons learned workshop</li> <li>• Discuss future adaptations, promotion of network</li> <li>• Reflection and next steps</li> </ul>

**Fig. 2.** Steps of the CB approach used in this study. Source: adapted from [26,27].

collectively. Applying the CB in the energy sector engages the CAIs by providing them with a built-in interest in the research and the results.

The intention is to gain insights into the diversity of issues that concern the CAIs within their specific contexts and to show how these relate to the national context and national energy policies. The research covered six countries: Belgium, Estonia, Italy, the Netherlands, Poland, and Spain. They were chosen for their different geographical regions and renewable energy resource potentials, different historical contexts (eastern Europe vs. western Europe) and different economic conditions. NRTs were formed in each country, which jointly developed the specific research questions, methods, and analyses for their respective case studies.

## 2.2. The research process

The study was framed as part of a larger EU-funded project under Horizon 2020: 'Collective Action Models for Energy Transition and Social Innovation (COMETS)', with the research taking place from October 2020 to April 2021. The procedure for this joint academic-practitioner CB study consisted of four phases or steps, depicted in Fig. 2. Because the study was conducted in six different countries, research coordinators were needed to administer the study. In the preparation and planning stage, the research coordinators scoped and framed the study and devised the necessary logistical structures. They also identified national researchers in each country to serve as NRT leaders and held a training workshop. In the collection step, each NRT leader identified various stakeholders and members of CAIs within their respective countries and invited them to a 'kick-off meeting.' During these meetings (one in each country), the NRTs were formalized. The NRT leaders then came to a consensus about the topics, research questions and methodologies, and how to implement them. After collecting the data, the NRTs met to discuss the analysis stage, where they refined the findings and identified best practices. The NRT leaders then consolidated and reported the results from their respective countries to the research coordinators [28], who then synthesized the findings across the countries. The process is described in the subsections below, and a full account of the research process is included in [28].

### 2.2.1. Preparation and planning

The research coordinators held a training workshop for the NRT leaders in October 2020 at which they introduced the CB approach and the aim of the study: to understand how CAIs can improve their contribution to the energy transition. To frame the discussion, the following predefined questions were provided to the NRTs: 1) What are CAIs? 2) How do CAIs work? 3) How relevant are CAIs to the energy system? 4) How can CAIs be supported? 5) What is the future of CAIs? The NRTs later used these questions to generate specific research questions.

The NRT leaders brainstormed important factors in creating the NRTs, which they decided would consist of CAIs active in the energy transition, other energy stakeholders, and researchers. The NRTs also consulted and included other national experts and academics on a more ad-hoc basis. NRT leaders preferred members who had shown interest in the project, were knowledgeable, had an innovative approach, or needed to acquire new knowledge. Achieving a good gender balance was also a priority.

NRT leaders created the criteria for selecting the specific CAIs for the NRT with guidance from the research coordinators. The criteria differed between the NRTs, but there was a general preference for forming NRTs representing the diversity found among CAIs. Selection criteria for CAIs included geographic coverage, participation in preliminary surveys in the COMETS project, citizens as primary beneficiaries of the initiative, interest, and availability (Table 1). Some project teams performed an initial screening of potential partners based on previous experience. Others, including the Netherlands, Belgium, and Spain, selected at least one CAI 'start-up' among the potential NRT members to give them the

**Table 1**

Criteria for selecting CAIs for the national research team in each country.

Country	Criteria used
Belgium	1) Context, e.g., transposition of RED II and EDM, COVID-19 situation, barriers/drivers. 2) Interest and availability. 3) Concern with topics that could be the subject of further research by the NRT. 4) Methodology used in the co-creation process.
Estonia	Representation of different energy experts who had a broad overview of the field, umbrella organizations, and CAIs who had taken part in a previous survey.
Italy	CAI members were selected based on year of foundation, size (members, plants, energy generation), representation of both energy CAIs and non-energy CAIs (i.e., ecovillages), outreach (local, national), and type of location (urban, rural/alpine).
The Netherlands	CAIs should be frontrunners in an area that is in urgent need of knowledge development.
Poland	NRT members were selected from among the participants in a previously completed survey, prioritizing CAI members who had been most active at a preliminary meeting.
Spain	1) The CAIs were selected based on the diversification of their activities related to the energy transition and geographical scope. 2) CAIs have citizens as targeted beneficiaries of the initiative. 3) CAIs have expressed an interest in participating in the project.

opportunity to share experiences with the more established CAIs and to have their perspectives included in the study. In Spain and Belgium, the project teams also drew up a list of potential NRT members, focusing on the geographical and political balance between the different regions in their respective countries. The Dutch team used snowballing to invite members using their contacts in the national energy community.

Thereafter, the NRT leaders contacted the CAIs and the energy stakeholders in December 2020 and January 2021, presented the concepts of the project, and explored their needs and interest in being part of the NRT. Representatives of CAIs and stakeholders were then formally invited to join the NRT at the kick-off meeting, where working groups were created for each NRT. Some NRT leaders preferred to build the NRTs in phases, so they hosted either scoping meetings or a series of bilateral information meetings.

Table 2 summarizes the composition of the NRT in each country. The size of the NRTs varied from between eight and sixteen members. Each NRT had between four and seven CAIs. These CAIs, 32 in total, served as case studies. Approximately 50 % of the NRT members were CAIs. Belgium and the Netherlands had strong participation from energy and housing cooperatives, reflecting the prevalence and influence of these organizations in these countries. NRT membership in other countries reflected the more centralized governance structure of utilities and public service provision found here. In all countries, non-CAI NRT members were typically public-sector authorities and research-based NGOs. More detail about the specific CAI case studies can be found in the Supplementary Material [28].

The research coordinators supported the process with bilateral coaching corners with the NRT leaders, virtual support meetings, and a digital sharing basket that was used to share strategies and ideas across the six NRTs. This allowed for a network to form across the NRTs and for discussion of problems as they arose. A digital platform, Communities for the Future, was also created to facilitate networking and sharing among the CAIs [29].

### 2.2.2. Collection

After their formation, each NRT organized a kick-off meeting in January 2021. The NRTs conducted all activities in their respective national languages except in Belgium, where English was used. During the kick-off meeting, the NRT was formalized, and they co-created the learning objectives and translated them into specific research questions. The latter were developed through workshop facilitation techniques, including brainstorming, world cafés, and 'dotmocracy' (voting with dots, where the participants have a given number of 'marks' to spend on the various questions, derived from a participatory design [30,31]). The

**Table 2**  
Composition of the national research teams (NRTs).

Country	Size (persons)	Number of CAIs	Energy technologies deployed by the CAIs	NRT members that are not CAIs
Belgium	11	6	Wind, solar PV, hydro, biomass heat, waste heat.	Regional government, regional associations of cities and municipalities, regional associations of energy cooperatives, academics.
Estonia	16	4	Solar PV and solar heat.	CAI umbrella organizations, local government, central government
Italy	11	7	Solar PV, hydro, energy efficiency.	Government energy authority, government energy research unit, mountain cooperative, university professor.
The Netherlands	8	4	Solar PV park, wind park, aqua thermal heat pumps, local grid balancing.	Social enterprise, energy consultant, energy researchers.
Poland	13	5	Solar PV, biomass, biogas from wastewater, geothermal heating, energy efficiency.	National energy-efficiency association, energy cluster consultant.
Spain	13	5	Solar PV, thermal energy.	National policymakers, national energy agency, association of energy cooperatives, academics.

Based on [28].

NRTs in Belgium, Spain and Poland used MIRO (a virtual noticeboard that can be used to supplement video-conferencing calls) to brainstorm ideas and discuss and agree work plans. NRTs were encouraged to use Chatham House Rule during meetings, i.e., transcribed comments were not affiliated with the speakers' names, which facilitated a free brainstorming of ideas and expression of opinions [32]. This was done to encourage openness and freer exchange of ideas by allowing participants and practitioners to state their positions without risk to their public or professional reputations.

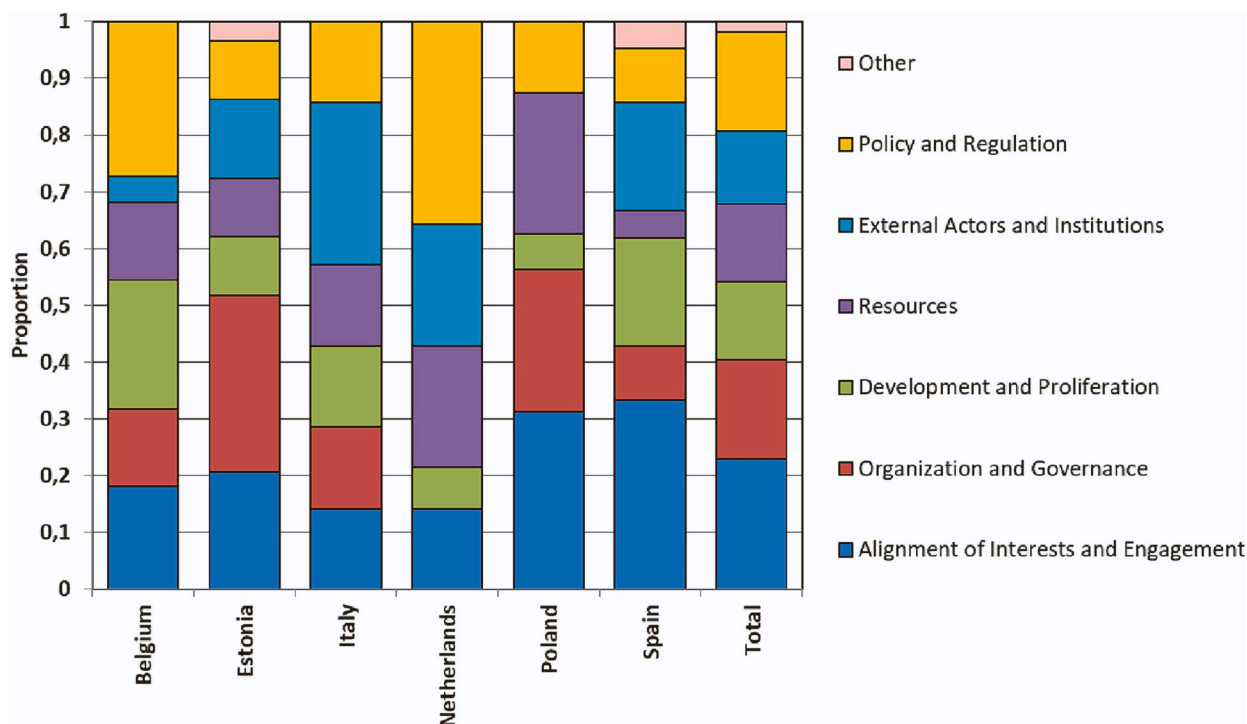
**2.2.2.1. Development of research questions.** Each NRT was responsible for the development of the specific research questions, so that NRT team members, including CAIs, would co-create and develop questions that were relevant to them. The NRTs also decided on the process for generating these questions during their kick-off meetings. The strategies involved collective decision-making to ensure transparent and fair processes and that every participant had an important role in the development of the questions.

Various tools and strategies were employed by the NRTs to develop, narrow down and finalize the list of questions in what were both

divergent and convergent processes. Some NRTs (Belgium, Italy, and Spain) used virtual breakout rooms to facilitate brainstorming and question-formation, while others (e.g., Belgium) collected candidate topics and questions by email from members prior to the meeting.

Another technique was to adopt a categorical (thematic) approach to developing questions, e.g., political, organizational, technological, social, etc. The NRTs would then develop and select the most important questions within each theme. All NRTs used some thematic grouping process to help develop their questions, either by first choosing the themes and developing questions (Estonia), or by first brainstorming questions and then grouping them into themes (e.g., the Netherlands and Spain), or by synthesizing them into a few topical questions (Italy). Some, such as the Belgian NRT, also used an iterative approach, by which topics of interest were chosen from a previous survey to inspire questions that were then clustered around new themes.

As more research questions emerged than could feasibly be addressed in the research, the NRTs devised methods for making collective decisions about which to focus on. These included grouping similar questions together to condense them and using a dotmocracy process. Other voting techniques included participant scoring (Spain)



**Fig. 3.** Thematic distribution of research questions by NRT. Raw counts are given in the overlaid text. Compound questions were counted as one. Based on [28].

and ‘priority’ weighted voting (Italy). In all NRTs, 69 % of the potential questions that were brainstormed were ultimately selected, resulting in a total of 109 questions.

2.2.2.2. *Thematic distribution of research questions.* The research coordinators, together with the NRT leaders, clustered the 109 research questions around the six internal and external dimensions of CAI mobilization adapted from [7] and reported in Section 1.

Fig. 3 summarizes the distribution of the research questions by these dimensions for each NRT and across all NRTs. A full list of questions by NRT and dimension are included as Supplementary Material. Alignment of Interests and Engagement, and Organization and Governance dominate the research interests of the NRTs, together comprising 44 out of the 109 questions. Poland, Estonia, and Spain exhibit a relatively high interest in these issues, but the Netherlands only a low interest. Policy and Regulation (including legal issues) account for 19 questions overall, with the Netherlands and Belgium showing more interest than the other NRTs. Questions about Resources concern mainly financial issues and constitute a small number of questions: only about 10 % address this dimension, with the highest interest being from Poland and the Netherlands. In Belgium and Spain, relatively more questions address External Actors and Institutions.

2.2.2.3. *Methods of data collection.* Some of the NRTs (Belgium, Estonia, the Netherlands) developed the research methodology during the kick-off meeting, while others convened a second workshop to define the methodology or validate the methodology proposed by the NRT leaders in advance. The NRT considered several issues in preparing for data collection: Which data need to be collected? What methods are available? What is feasible within the given time and resources?

On this basis, the NRTs selected the appropriate data-collection methods, shown in Table 3 below. Semi-structured interviews use a topical interview protocol but allow freedom in the dialogue and how it progress. The interview is concluded when the topics included in the protocol have all been sufficiently covered. Thematic presentations consist in a practitioner making a presentation to the NRT on an area of their expertise or best practice. Q&A sessions involve a specific practitioner fielding open questions from the other NRT members. In discussion forums, a topic is chosen by the NRT leader, and the practitioners discuss it openly and summarize their conclusions. A questionnaire-based survey is a written survey with open-ended questions given to the practitioners by the NRT leader. Virtual visit tours consist in a video-based presentation (either live or pre-recorded) by a practitioner to the other members of the NRT. Secondary material concerns a review and examination of external documents and materials, e.g., legal documents, technical diagrams, etc.

The NRTs collected data from the participating CAIs (the case studies) from February to March 2021. The most common method used to answer the specific research questions the NRTs developed were semi-structured interviews with the participating CAIs. The NRTs recorded the interviews, and some transcribed them, completely or in part. In addition to interviewing, some NRTs created a workshop framework, in which CAIs made thematic presentations followed by a question-and-answer session. The Netherlands, for example, used this approach as

the primary method. Similarly, the Belgian NRT used discussion forums to supplement the interviews and found them more useful in addressing the themes of citizen participation and engagement, development and proliferation, and financing. Virtual visits were also employed, e.g., by Italy, in which each CAI made a presentation to the rest of the NRT. In contrast, the Estonian NRT used a questionnaire-based survey as the main data-collection tool. Three NRTs received documentary materials from the CAIs in the form of annual reports, statutes, organizational charts, description of processes, etc., which were used to provide context to the analysis, e.g., in Spain.

Originally, visits to the different CAIs were planned to aid network building and finalize data collection. In-person meetings are an important aspect of the CB approach and network formation. However, due to COVID-19, all interviews, presentations, and discussion forums were conducted online. This carried some disadvantages, including fatigue, inattention, restricted personal interaction, etc., while the advantages were increased participation, and easier transcription and record keeping. All interviewees signed an Informed Consent Form in line with the European Union General Data Protection Regulation (GDPR).

2.2.3. *Analysis and reporting*

After analyzing the data, each NRT reported: 1) the process of forming the NRTs and selecting the CAIs; 2) the engagement strategies used; 3) the research questions; 4) the methodologies; 5) the summarized findings; and 6) reflections on the CB process. The research culminated in lessons-learned workshops in April 2021. Their aim was to discuss, validate and integrate the results of the study and to identify lessons learned and policy recommendations. The research coordinators then merged and synthesized the findings across the six counties. In the following section, we present the results of this analysis with respect to the internal and external dimensions of mobilization as outlined in Fig. 1. We first describe how CAIs recruit new members and then treat each dimension in turn and note its implications for the development and proliferation of CAIs.

3. Results

3.1. Alignment of interests and engagement

3.1.1. Participation and engagement

Many CAIs offered numerous opportunities for members to participate in their activities. This was especially the case for CAIs with a diversified portfolio of projects and activities, or for those wanting to diversify their activities. In some CAIs, the activities went well beyond renewable energy generation. For example, the Italian ecovillages promoted broad changes in lifestyle, and the Italian cooperative *énostra* had developed an official participation plan. This led to the construction of territorial groups through ‘communities of practice’ that can create projects and information activities on a broad range of topics and diffuse culture and create a community around them.

Building on common values, both social and environmental, in connection with the local area was a central tenant of engagement. In the Spanish NRT, for example, a sense of belonging was a factor in enrolling and maintaining active CAI members, highlighting that,

Table 3  
Methods used by the NRTs to address the research questions.

National research team	Semi-structured interviews	Thematic presentations	Q&A sessions	Discussion forums	Questionnaire-based survey	Virtual visits	Secondary material
Belgium	X			X			X
Estonia					X		
Italy	X					X	X
The Netherlands	X	X	X				
Poland	X						
Spain	X			X		X	X

Based on [28].

beyond the energy and environmental benefits, it is also essential that a community is created based on common values.

Yet not all CAIs had the intention or capacity to achieve deep or diversified participation from its members. In Estonia's apartment associations, for example, members were motivated mainly by financial incentives, and engagement was limited to board membership. The Polish NRT observed that all the initiatives in the energy transition are top-down and that, even though environmental awareness may be increasing, and citizens are becoming more active in this transition, citizens' groups still wait for external support before mobilizing. Time commitments on the part of both board members and ordinary members was a key factor limiting active participation in CAIs in all countries.

### 3.1.2. Participation of different social groups

Most of the CAIs were aware of the need to be more inclusive with respect to vulnerable groups, yet few had developed systematic approaches to achieve this. In Spain, some activities had targeted vulnerable members or groups, and affordable membership fees had been created. But overall vulnerable groups tended not to participate in energy communities for a variety of reasons that warrant further study.

Only the Spanish NRT reported on the gender dimension of participation in the CAI case studies. While some Spanish CAIs had achieved a gender balance in their governing bodies, there was a need to involve more women in management functions and to increase female participation in CAIs. The Spanish CAIs considered their projects attractive to women because they emphasized values that are traditionally considered feminine in Spanish culture, such as sustainability, proximity, and community. One CAI observed that, when women participate, they do so proactively and take on leading tasks. Lack of time and the prioritization of other activities contributed to the low participation of women in energy communities. Another reported factor was that women believed the topic of energy to be a masculine domain.

### 3.1.3. Leadership participation

The initiative and actions of enthusiastic individuals or small groups were often central to initiating and driving CAIs and their projects. However, such individuals may still need support, including training in organizational, technical, and financial matters, or peer-to-peer guidance.

## 3.2. Organization and governance

The study included different types of CAIs; most were focused exclusively on energy, while others had broader aims, with energy playing a minor role in their portfolio of activities. Below we outline the organizational characteristics and forms of governance of these two main types.

### 3.2.1. CAIs focused on energy only

Energy cooperatives follow established, national and international models of governance (e.g., that of the International Cooperative Alliance [9]), complemented by informal forms of interaction, for example, cooperative members' evenings. These coops constitute a large part of the studied CAIs in Belgium, Italy, the Netherlands, Poland, and Spain.

Several NRTs pointed to the advantages of stronger collaboration among CAIs within sub-national regions, including sharing knowledge and experience, and here umbrella REScoops can play a key role (see Section 3.4.3). In Italy, the energy initiative Kennedy Energia started as an initiative promoted by the Municipality of Inzago (Metropolitan City of Milan). It decided to become a limited liability company after considering alternative organizational forms such as the cooperative and the trust. Similarly, in Flanders, Belgium, two CAIs had created non-profit organizations for implementing specific energy projects.

In Poland, the energy CAIs are either informal energy communities or formal energy clusters. The latter are mainly commune-owned or private-local government civic agreements. They are created primarily

from a top-down perspective, with the local government and businesses seeking to create an organization that can apply for government support to invest in renewable energy resources.

### 3.2.2. CAIs with broader aims

CAIs with aims beyond energy production were among the case studies in Estonia, Italy, and Poland especially. In Estonia, the CAIs were apartment associations, whose governance is stipulated by law and includes elected board members. These CAIs had few skills and resources relating to energy and could not draw on the expertise of any umbrella organization. One of the CAIs in Poland was a housing association that had created an energy project involving the digitalization of heating processes, including the replacement of a coal heating system and the installation of 500 PV panels. This occurred after younger people had joined the association's supervisory board and convinced the community to engage in renewable energy.

The Italian ecovillages displayed a more complex formal architecture, that is, networks of associations, which mirror the variety of their objectives. Their complex architecture is also reflected in the lack of an official institutional acknowledgment of ecovillages. Some Italian CAIs also considered changing their legal form to broaden their social engagement by forming renewable energy communities.

## 3.3. Resources

### 3.3.1. Finance

The economic dimension was an important motivation for citizens to join a CAI, as they saw in it an opportunity to receive a return on an investment. Many CAIs depended on government incentive schemes and favorable tax programs, but also aspired to become more financially independent and robust and to have funding schemes that do not depend on the vicissitudes of government policy. Most CAIs relied on the financial participation of local citizens, and most often CAI membership relied on the purchase of shares sold by the CAI to co-finance renewable energy projects.

**3.3.1.1. Public financing.** Many CAIs took advantage of tax incentives for start-ups to raise social capital. Some had also obtained start-up funding and money for activities from local municipalities. While this can enable new CAIs to become financially self-sufficient, the NRTs found that there was insufficient financial support for mature CAIs. CAIs within shared apartment buildings could apply for building-renovation grants to improve energy efficiency or to install solar PV panels or heat pumps. This type of investment tends to be safer than stand-alone energy projects, as it adds to the collective debt of the association, which often enjoys more favorable lending terms in the real-estate market.

Some CAIs received funding from public and private research and innovation funds to explore new technologies and business models. Attracting this type of funding lends legitimacy to the CAI, although it also places high administrative burdens on CAI members.

**3.3.1.2. Private financing.** The sale of shares in a CAI's energy production facilities to its members was the primary source of project financing for most CAIs. Some CAIs established a legally independent company for new projects that were financed through the sale of such shares. This financing model reduces the level of debt to the CAI. To prevent speculation and to ensure financial stability, some CAIs required investors to keep shares for a minimum number of years.

CAIs do not have the same status and legitimacy as private companies in the eyes of investors, which reduces their access to private project finance. This was particularly the case for wind projects, due to the high capital costs, the long and uncertain processes for obtaining permissions, and the reputational risks related to the social acceptance of wind turbines. Similar challenges were identified for district heating

projects. For other technologies, such as solar PV, recent years had seen a significant fall in capital costs, and CAIs were able to pay off loans over a few years with the revenue from energy generation.

### 3.3.2. Skills

Establishing and managing a CAI is knowledge- and skills-intensive. Some of the activities that participating CAIs were engaged in required specialized skills that typically only a few members possessed. Often the need to hire professional assistance for project development came up against a dearth of relevant local expertise. External help was especially needed in upscaling current activities, diversifying into advanced energy technologies, and collaborating with commercial actors. Still, many NRTs highlighted the value of members contributing with their professional skills and knowledge, as in the technological, legal, financial, administrative, and communicative domains. CAIs also used regular training and knowledge-exchange sessions to engage their members.

### 3.3.3. Regional networks

Many of the CAIs in this study draw on histories of cooperative movements dating back to the late 1900s [21]. Their sizes vary from less than a hundred members to several thousand, and while most of them are of small geographical extent (villages or municipalities), others cover entire regions (e.g., South Tyrol or Flanders). Their connections to cooperative umbrella organizations or networks at the regional, national, or EU levels were clearly an advantage, as these facilitated access to knowledge, project partners, policymakers, and other resources. The European Federation of Energy Cooperatives, or REScoop.eu, is one such network, with a membership of 1900 European energy communities, including in Belgium, the Netherlands, Italy, and Spain, but none as yet in Estonia or Poland [33]. REScoop.eu was instrumental in the creation of one of the CAIs in Italy, *enostra*. NRTs also highlighted the importance of regional REScoops, e.g., in Flanders and Wallonia in Belgium.

In fact, many CAIs found support through regional networks and umbrella organizations such as REScoops. These networks were useful for advancing their social agendas, e.g., addressing energy poverty. Networks built on shared values were particularly important for the ecovillages in Italy. CAIs also benefitted from collaborating with each other, especially the smaller, newer CAIs, whereas the larger and more established CAIs found cross-CAI collaboration and umbrella organizations less useful.

## 3.4. External actors and institutions

The engagement of a CAI with stakeholders depended on its specific characteristics and mission, and CAIs needed to balance such engagement to maintain their autonomy. In this context, regional networks of CAIs can help amplify their collective voice and reinforce shared values. However, the CAIs' relationships with government and commercial actors were more ambiguous and delicate, as explained below.

### 3.4.1. Government

Cooperation at the regional, provincial, and national levels of government requires considerable financial support and time resources. As such, CAIs tended to focus on local activities and on their relations with local governments and public administrations.

Municipalities were important actors for CAIs, particularly in the start-up phase. Municipalities could provide early financial support and help communicate and promote CAIs to the citizens, helping to create legitimacy. Strong energy CAIs, particularly ecovillages, could also create a sense of identity for a municipality, especially in rural areas, by creating events such as summer festivals. Nonetheless the relationship between local governments and CAIs involves many uncertainties. Local governments are swayed by political forces and are susceptible to public pressure, e.g., opposition to wind turbines. There were also cases of public authorities acting opportunistically, e.g., showing support for CAIs only after they had proved to be successful and popular. NRTs

observed that shifting political attitudes can be detrimental to the long-term viability of CAIs that rely too much on local government support.

### 3.4.2. Private actors

**3.4.2.1. Local populations.** The more localized a CAI is, the less resistance it will generally encounter, especially if local stakeholders are involved in the early stages of its development. Trust among the local population can be built if these early interactions are characterized by transparency and accountability. However, changing social perceptions of wind power have resulted in increased legal action being taken against onshore wind projects. This trend has also impacted CAIs in terms of delays, costs, and access to funding.

**3.4.2.2. Private firms.** As renewable energy technologies such as wind turbines and rooftop solar PV mature, governments are phasing out production price subsidies, such as feed-in tariffs, replacing them with investment subsidies implemented through auctioning or tendering programs. This means that CAIs must compete with often large commercial actors in auctions or tendering processes. The NRTs observed that these firms are often reluctant to accommodate or cooperate with CAIs in their business models. In some cases, however, large companies see an opportunity in involving a CAI in energy projects to improve their image and garner better public acceptance. Yet often CAIs make up only a very small share of such projects and serve more as token actors. Other commercial actors are now offering 'turn-key' solutions for green community energy without the element of social investment by the energy consumers. This project model can be a threat to CAIs, as it undermines collective action and social engagement.

### 3.4.3. Regulatory entities and research institutions

Regulatory entities, particularly the TSO and energy agencies, can support CAIs through meetings and conferences, link CAIs to other important energy stakeholders, and in some cases serve as a political lobbying body. Research institutions can provide technical assistance in new energy projects. They can also evaluate project partners, perform feasibility assessments of tasks, and assess replicability and potential systemic impacts, e.g., on the energy grid.

## 3.5. Policy and regulation

Changing energy policies can have a significant influence on the creation and scaling up of CAIs [22]. The NRTs identified policy factors that either enabled or constrained their project activities and long-term development (Table 4). Several enabling financial factors were identified, including state support, feed in tariffs, net metering, and the availability of private funds accessible to CAIs. The NRTs also observed deteriorating access to public financial support because of changes in subsidy schemes for renewable energy technologies, particularly the phasing out of green certificates and the replacement of feed-in tariffs with auction-based schemes. The NRTs' perception that changing policies affecting financial incentives can have a large impact on CAIs is confirmed by a European study showing a high correlation between the number of CAIs and the introduction or removal of different energy policies and incentives [22]. The CAIs also found that bureaucratic risks and obstacles, including long processes to obtain permissions, EU GDPR rules, and complicated or seemingly arbitrary rules and procedures, constrained their project development and placed heavy demands on their professional capacities.

## 3.6. Development and proliferation of CAIs

The CAIs differed in how they envisaged their future and how they defined and implemented development strategies. The cooperatives that were at the early stage of their development were focused more on their

**Table 4**  
Policy and regulatory factors affecting project activities and the long-term development of CAIs, according to the national research teams.

Effect of factor on CAI	Description of factor	Type of factor
Enabling	Laws governing apartment associations and policies providing state support to the renovation of apartment buildings, which have both stimulated and financially supported energy-efficiency investments as part of the renovation projects, as in Estonia.	Financial
	Feed in tariffs for small-scale renewable energy systems and/or net-metering.	Financial
	Access to affordable financing for CAIs by dedicated banks or fund managers familiar with the profile, business models and risks of CAIs.	Financial
Constraining	The phasing out of simple subsidies such as green certificates in Belgium had a negative impact on the renewable energy technologies used by CAIs, especially large roof-top PV systems.	Financial
	The switch to auction-based subsidy support for investment in renewable energy technologies in countries such as Belgium creates complications for CAIs that lack the capacity to participate in a support scheme designed for large-scale commercial projects.	Financial
	Uncertainties and long waiting times in local permitting processes for certain technologies, especially wind turbine projects.	Bureaucratic
	Seemingly arbitrary minimum-size limits of households that can participate in district heating projects, e.g., the Heat Act 2.0 in the Netherlands.	Bureaucratic
	Bureaucratic procedures that slow down or complicate CAI project development, e.g., GDPR regulations as applied in Poland, and the complicated procedures and language used by authorities in Spain.	Bureaucratic

short-term day-to-day operations. They devised more pragmatic strategies to create opportunities for renewable energy projects and to realize a more predictable and stable revenue flow to support their professionalization and future development. The lack of specialized knowledge and technical experts was identified as an important barrier to the growth and diversification of energy communities across the study countries.

The better-established energy cooperatives had been growing in a more organic way and had a more structured and strategic approach. For example, some CAIs conducted a strategic exercise to come to a clear vision, mission, and strategy for their long-term development. Many CAIs attempted to develop new renewable energy production facilities and business models, although most started with a single technology. Some took a proactive approach in creating opportunities by e.g., lobbying, applying for pilot projects, highlighting good practices, and setting up networks. In Estonia, for example, the average time from idea to implementation was three to five years. One CAI had developed renewable energy projects in three stages since 2012: first solar thermal collectors, then PV rooftop panels, and finally solar panels for balconies financed from the profits of previous energy projects. Most Estonian CAIs wanted to expand their solar parks but were constrained by a lack of space and high debt burdens from past renovation projects.

Some CAIs found it difficult to position themselves on the question of growth, as the concept itself may contradict the basic values on which they were established, such as ‘limits to growth’. In Belgium, for example, none of the CAIs sought to expand their geographical coverage beyond their initial areas of operation, although one CAI covered the entire Flanders region. Instead, the focus was on maintaining local identity and maintaining links with local citizens and the local context. In Belgium, to ensure a broad outreach and membership base, the

statutes of the CAIs limited the amount of capital (shares) that could be invested by each cooperative member.

The ability to scale up depends on the opportunities for investment and the available capacity in the energy cooperative to develop new projects. Most CAIs depended on voluntary labor or had a few full-time equivalent staff. Some CAIs emphasized that professionalization is necessary for carrying out their activities and for increasing the number of projects, noting also that a stable revenue flow is needed to maintain professional staff.

### 3.7. Recruitment of members for a CAI

Based on how the different dimensions are performed and experienced within the specific CAIs development trajectories, the study identified strategies and mechanisms for recruiting members in the start-up phase of a CAI (Table 5). The strategies link to different dimensions of the conceptual framework, from alignment of interests and engagement, governance and exploiting resources to seizing opportunities from external actors and institutions such as umbrella organizations and local governments.

## 4. Discussion

### 4.1. Strategies for the development and proliferation of CAIs

#### 4.1.1. Engaging members

CAIs frequently depended on hiring external experts to provide niche skills. If these are unavailable within the CAI membership, then relationships with external partners will be required. When facing these challenges, CAIs are recommended to consult with public authorities, knowledge institutions, and umbrella organizations (like the cooperative associations in Belgium). This would allow these resources to play a stronger role in facilitating access to such expertise for energy communities.

Time constraints and different social priorities were identified as barriers to the participation of women in CAIs. In this light, there should be a stronger focus on engaging women in energy communities from both an equity and a performance perspective. This could be done through better targeted communication and an improved awareness of how masculine and feminine framings and their associated perceived value structures can impact on gendered engagement in CAI activities. More knowledge is clearly needed on this topic. Still, CAIs should lead this shift towards gender parity and make it an integral part of their strategy for recruiting members.

Cooperation with other CAIs in the local area was often an important part of the growth and diversification of CAIs, e.g., regarding the establishment of energy storage facilities, joint solar parks, and common charging facilities for electric vehicles. Such neighborhood cooperation would improve both livability and the value of the buildings. Cooperation among several communities would improve these efficiency gains. Thus, it is important for CAIs to build networks and establish forums for collaboration.

#### 4.1.2. Financial resources and incentives

Securing funding from public and private sources (e.g., research and innovation funds) can be a double-edged sword for CAIs. On the one hand, it gave the CAI resources and legitimacy, while on the other hand increasing their administrative burdens. Simplifying the application formats and procedures could help CAIs secure external funding. There is also a clear need for more innovative financing models, combined with a stronger acceptance of CAIs as a legitimate economic entity. Without these, CAIs will struggle to compete with private actors and to attract a diverse membership base in terms of age, gender, and skills. A high personal financial risk of joining a CAI will reduce its social aspect, limit the level of community engagement, and ultimately undermine the long-term viability of CAIs. CAIs, through their networks and with the

**Table 5**  
Strategies and mechanisms for recruiting new members for a CAI.

Strategy	Key mechanism	Links to the mobilization dimensions
Adapt the communication to different target groups; consider that engagement can be motivated by different economic, environmental, and social factors.	Use of effective and appropriate means of communication	Alignment of interests and engagement
Consider how to involve vulnerable groups as members, e.g., by offering shares at lower costs, collaborating with financial institutions for the provision of affordable credit, and adapting the communication to reach these groups.	Use of social criteria in recruitment	Alignment of interests and engagement
Recruit members from personal and professional networks and build out from there. CAIs that have closer relationships between their members are more successful.	Use of social networks	Alignment of interests and engagement
Build on the traditions, strengths, and networks of local organizations (neighborhood associations, other cooperatives, etc.).	Building on local organizations	Organization and governance
Link a well-known or famous person to the project as part of the advertising.	Use of celebrity endorsements	Resources
Use a variety of analogue and digital communication channels; advertising may be necessary to raise large amounts of capital.	Use of effective and appropriate means of communication	Resources
Learn from the experiences of other energy cooperatives in the region or country.	Learning from peers	Resources
Rely on umbrella organizations (e.g., regional or national cooperative societies) or social enterprises with specialized knowledge on energy and energy communities.	Mobilization of expert knowledge	External actors and institutions
Seek support from local governments, which can assist in the recruitment to and otherwise help establish the CAI, e.g., by publicly endorsing the CAI, using its communication channels, making land available, providing small start-up grants, etc.	Mobilization of public resources	External actors and institutions
Exploit available income-tax reductions of members' investment in the energy cooperative (e.g., start-up tax facility).	Exploitation of tax laws	External actors and institutions

support of umbrella organizations, need to demonstrate the financial viability of their endeavors, possibly through the documented successes of other CAIs in their network. At the same time, they should emphasize the value of community energy to local communities in the form of social cohesion, while local engagement could increase local awareness of and investment in CAIs.

**4.1.3. Cooperation with government and industry**

One strategy for remaining competitive in the energy market is cooperation among CAIs in choosing external partners. By working together and pooling resources, CAIs can have greater influence on local

permitting authorities while also improving access to professional expertise. The strength and uniqueness of CAIs compared to commercial developers is that the customers are at the center of both their activities and their governance. Public authorities and knowledge institutions could also play a stronger role in facilitating CAIs' access to expertise.

Local government support can be an attractive source of funding for CAIs, yet it may also put the long-term viability of the CAI at risk due to the vicissitudes of politics. It is thus important for CAIs to maintain the bottom-up approach by striking a balance between independence and support from local authorities.

**4.1.4. The role of umbrella organizations**

The initiative and actions of enthusiastic individuals or groups were often central to initiating and driving CAIs and their projects. However, such champions often need support, including training in organizational, technical, and financial matters, or peer-to-peer guidance. These services could be offered by cooperative umbrella organizations or government agencies, and it is important for CAIs to seek these out.

Umbrella organizations played an important role in the success of CAIs. One surprising finding was the high importance of umbrella organizations in supporting the foundation and development of CAIs. This includes networking, lobbying, knowledge-sharing, and skills development, as well as lending legitimacy to new CAIs when they start up. In general, umbrella structures can organize activities and provide expertise more efficiently, thereby reducing the costs to individual CAIs.

With respect to the mobilization dimensions, umbrella organizations are interesting enablers of both internal and external power. As enablers of internal power, they can assist with member recruitment and retention, skills development, knowledge-sharing, legal support, and advising the governance about CAIs. Externally, they can help create networks and lobby policymakers and the private sector. Umbrella organizations thus provide both resources and opportunities for CAIs, and they can help mobilize public support through national and local policies. Conversely, by aligning themselves with energy-cooperative umbrella organizations such as REScoop.eu, CAIs can add their insights and experience to the umbrella organization, thereby increasing the legitimacy of both. This leads to a strengthening of the umbrella organizations with respect to their ability to provide professional expertise (technical, legal, market, etc.) and training to *all* their member coops, lobbying for their interests at the national and EU levels.

**4.1.5. Policy and regulation**

Through umbrella organizations, CAIs should lobby governments over the proliferation of CAIs as part of a decarbonization strategy. In particular, they should demonstrate the added value of citizen participation when designing tendering procedures and policy frameworks. This can also include tax incentives and streamlined approval processes. Regarding 'soft' policy support, CAIs should push for better access to knowledge and expertise about renewable energy – specifically about how to create an energy cooperative – as well as about technical energy solutions in general and knowledge-sharing at the community level.

**4.2. Reflections and considerations of the CB approach as applied to CAIs**

The NRTs found the CB approach fruitful because it helped bridge the gap between knowledge generation and knowledge transfer, allowing the CAIs to cooperate, work together, and share knowledge and expertise. The CAIs found the process either relevant or very relevant in two polls made by the Belgian NRT, providing a good experience for newcomers. The Spanish, Italian, and Dutch NRTs all reported positive feedback and a high level of engagement and commitment from their members. In Poland the NRT members were from different sectors, and the best practices identified were not always applicable; they nevertheless found the networking valuable, since all the CAIs were relatively new. In the Estonian NRT, the networks were already well established, and the experts already known. Here, the CB strategy served to reinforce

a pre-existing network.

However, because the CB approach is oriented around identifying best practices for the participants of the consortium, the outcome of the process risks being one-sided or limited in scope, particularly regarding policy measures. In our case, the focus is on CAIs and the best strategies for their mobilization, and the findings thus tend to emphasize their interests and perspectives. It is therefore important that the research teams in CB processes include a variety of practitioners (in our case CAIs and other energy stakeholders) that represent different levels or types of establishments, organizations, resources, technologies, and knowledge. Conversely, if the selection of team members is biased, innovative and groundbreaking strategies may be overlooked. Indeed, research teams dominated by well-established CAIs with similar structures may simply enshrine the status quo. For example, the Belgian NRT members focused more on solar panels and wind turbines than on district heating or electric mobility, which could reflect a limited perspective on technological innovation. While the Polish NRT noted that the transfer of best practices is more effective across similar CAIs, e.g., energy clusters or housing communities, the Dutch NRT appreciated the diversity of perspectives and experiences among the members of the NRT.

Since it was the NRT members who formulated the specific research questions, they also tended to focus on issues or topics in which they lacked specific knowledge. Therefore, the empirical focus of our study inevitably reflects the composition of the NRT teams: a different team composition may have scoped the study differently. For example, the Dutch NRT recognized that the team could have benefited from a member with legal experience in the energy field, and this could have meant more or different questions on legal issues. We therefore recommend that future studies using the CB approach exhibit flexibility in research team membership, such as through an iterative process between question formation and member recruitment.

As mentioned, this study is part of a larger research effort on CAIs under the COMETS project and was designed to provide in-depth insights that complement the results from a systematic survey and a comparative analysis of the participating countries' historical, economic and cultural backgrounds [21,34]. By having six NRTs across different cultures, historical backgrounds, economies, and legal frameworks, we have attempted to achieve a high level of diversity in the results, thereby being able to identify innovative approaches that may more easily be adapted and applied universally. The trade-off, however, was a limited ability to perform a comparative analysis of the results across the countries because, according to the CB approach, the six NRTs were free to formulate their own research questions. To address this shortcoming, future research could constrain the choice of research questions and methodologies, e.g., by establishing some fixed questions and methods, and allowing for freedom in others, or combining research teams into one larger team.

The study has arguably affected the CAIs in several ways. Participation in the case studies gave them significant networking and learning benefits. They were involved in discussing research questions with other NRT members, collecting data, and interpreting the results. Their interest in co-creation was more oriented towards knowledge development and sharing than process development, and the NRTs therefore had to strike a balance between giving space to co-create knowledge and ensuring a conducive environment for this process. The CAIs also gained increased visibility and recognition, expanded their networks, and contributed to the learning and growth of CAIs in their countries. The CB approach was instrumental in bringing about the above benefits. Most CAIs continued to stay engaged within their networks, with the discussions extending beyond the formal conclusion of the NRTs. NRT members felt that this strengthened the network between the CAIs, facilitating a continuous sharing of best practices. We therefore recommend that forums and platforms for this type of collaboration be facilitated by cooperative umbrella organizations, energy agencies, and other national or supranational actors.

## 5. Conclusion

CAIs can increase the share of low-carbon energy in national energy portfolios while raising public awareness and engagement in the low-carbon energy transition. They provide an avenue for people to move from being passive consumers (who can feel helpless in the face of the climatic and environmental challenges) to proactive actors taking responsibility for finding local solutions to their energy issues in a collective and democratic way. CAIs increase the diversity of market participants, increase local autonomy, diversify risks, and reduce dependence on large companies. They provide local capital and contribute to a sustainable local economy. Finally, they contribute to a greater sense of community and social cohesion. Therefore, the development and proliferation of CAIs were issues of interest in the NRTs.

CAIs must balance their growth or diversification with maintaining the local character and identity of their initiatives. Diversity of membership in terms of gender and age are important if the CAI is to support the social cohesion of the local community. The CAI must also formulate visions, missions, and goals aligned with its members' interests, and develop a long-term financing plan to meet these. The dimensions of mobilization leading to the development and proliferation of CAIs are supported through networks and relationships with external actors and institutions. The latter are an essential resource for assisting with local skills development, strategies for organization and governance, securing financing, and lobbying for favorable policies and regulations. Umbrella organizations were vital in fulfilling this supporting role. Policy and regulation can support the proliferation and development of CAIs through financial frameworks and knowledge products that incentivize and simplify the collective ownership of local renewable energy systems.

## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Data availability

Data will be made available on request.

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## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.erss.2023.103005>.

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