New Clean Energy Communities in a Changing European Energy System (NEWCOMERS)

Deliverable 7.2

Synthesis of research results: New clean energy communities and polycentric governance thinking

Version: 2.0

WP 7: Synthesis and co-creation of policy recommendations

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Summary of NEWCOMERS

In its most recent Energy Union package, the European Union puts citizens at the core of the clean energy transitions. Beyond policy, disruptive innovations in energy sectors are challenging the traditional business model of large energy companies. One such disruptive, social innovation is the emergence of new clean energy communities ("NEWCOMERS").

The possible benefits of these "NEWCOMERS" for their members and for society at large are still emerging and their potential to support the goals of the Energy Union is unclear. Using a highly innovative holistic approach – drawing on cutting edge theories and methods from a broad range of social sciences coupled with strong technical knowledge and industry insight – the NEWCOMERS consortium will analyse European energy communities from various angles. By taking an interdisciplinary approach and through employing co-creation strategies, in which research participants are actively involved in the design and implementation of the research, the NEWCOMERS project will deliver practical recommendations about how the European Union as well as national and local governments can support new clean energy communities to help them flourish and unfold their potential benefits for citizens and the Energy Union.

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Summary of NEWCOMERS's Objectives

As subsidiary objectives, the NEWCOMERS project aims to

- provide **a novel theoretical framework based on polycentric governance theory**, combined with elements from social practice theory, innovation theory and value theory, in which the emergence and diffusion of new clean energy communities can be analysed and opportunities for learning in different national and local polycentric settings can be explored;

- develop a **typology of new clean energy community business models** which allows to assess the different types of value creation of "newcomers" as well as their economic viability and potential to be scaled up under various conditions;

- identify the **types of clean energy communities that perform best along a variety of dimensions**, such as citizen engagement, value creation, and learning, and their potential to address energy poverty, while being based on sustainable business models;

- investigate the **regulatory, institutional and social conditions**, at the national and local level which are favourable for the emergence, operation and further diffusion of new clean energy communities and enable them to unfold their benefits in the best possible way;

- explore **how new clean energy communities are co-designed with their members' (i.e. citizens' and consumers') needs**, in particular whether new clean energy communities have the potential to increase the affordability of energy, their members' energy literacy and efficiency in the use of energy, as well as their members' and society's participation in clean energy transition in Europe;

- deliver **practical recommendations based on stakeholder dialogue** how the EU as well as national and local governments can support new clean energy communities to make them flourish and unfold their benefits in the best possible way;

- offer citizens and members of new clean energy communities a **new online platform 'Our-energy.eu'** on which new clean energy communities can connect and share best practices and interested citizens can learn about the concept of energy communities and find opportunities to join an energy community in their vicinity.

Find out more about NEWCOMERS at: https://www.newcomersh2020.eu/

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NEWCOMERS Consortium Partners

Logo	Organisation	Type	Country
	Institute for Environmental Studies (IVM), Vrije Universiteit Amsterdam (VUA)	University	The Netherlands
	International Institute for Industrial Environmental Economics (IIIEE) at Lund University (LU)	University	Sweden
	Environmental Change Institute (ECI), University of Oxford (UOXF)	University	United Kingdom
	Institute of Social Sciences, University of Ljubljana (UL)	University	Slovenia
	Institute for Advanced Energy Technologies "Nicola Giordano" (ITAE), National Research Council (CNR)	Research organisation	Italy
	Leibniz Institute for Economic Research (RWI)	Research organisation	Germany
	Consensus Communications (CONS)	Private for Profit (SME)	Slovenia
	GEN-I	Private for Profit (Large company)	Slovenia

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Abbreviations

Abbreviation	Explanation and translation
CEC	Clean energy community
CEP	EU Clean Energy Package
CSC	Case study community
DE	Germany
EED	EU Energy Efficiency Directive
EU	European Union
FiT	Feed-in-Tariff
IT	Italy
NEWCOMERS	New Clean Energy Communities in a Changing European Energy System
NL	The Netherlands
PGT	Polycentric governance thinking
RED	EU Renewable Energy Directive
SE	Sweden
SI	Slovenia
UK	United Kingdom

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1 EXECUTIVE SUMMARY

This deliverable assesses the relevance of polycentric governance thinking (PGT) to the emergence and growth of clean energy communities (CECs) across Europe. It is based on the testing of 12 research propositions in the various workpackages and tasks of the NEWCOMERS project, while focusing on Germany, Italy, Slovenia, Sweden, the Netherlands and the United Kingdom. The major themes of these propositions include local action, cooperation and mutual adjustment, experimentation and learning, accountability and trust, value creation, institutional frameworks, and diffusion and upscaling (see Table below). Based on the outcomes of the testing, the deliverable's objective is to provide thematic entry points for developing recommendations about how to further support the growth of CECs across Europe through supportive governance arrangements. The actual policy recommendations will be formulated in D7.3 Policy recommendations.

The assessment provides some important indications in terms of the relevance of the propositions. A high level of support refers to evidence found in five or six NEWCOMERS countries and associated case study communities (CSCs), whereas a moderate level points to evidence collected in three or four countries and a low level to evidence gathered in one or two countries only. In conclusion, we found certain levels of support for the majority of research propositions (10 out of 12) in most countries studied. This was not the case for the other two propositions where we could not identify any support, but this could be explained by the design of the study.

Support for PGT themes and propositions based on NEWCOMERS research results

NEWCOMERS themes and research propositions	Indicative level of support provided by NEWCOMERS evidence
Local and virtual action	
1-Place-based energy communities are likely to take off at a local level through processes of self-organisation by citizens	Low to moderate
2-Viable virtual communities are likely to be created, usually in a top-down manner, to deliver benefits to individual participants and to energy systems	None
Cooperation and mutual adjustment	
3-Energy communities are likely to spontaneously develop collaborations with one another, and engage in processes of mutually adjusting to each other	Low to moderate
Experimentation, innovation and learning	
4-Energy communities' willingness and capacity to experiment is likely to facilitate governance innovation and learning about what works	Moderate to high
5-Energy communities are likely to provide opportunities for learning by their members at cognitive, normative and relational levels	Moderate to high
Trust and accountability	

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6-Trust is likely to build up more quickly when energy communities can self-organise, thus increasing collective ambitions	Low to moderate
7-Trust requires people that are acknowledged to be trustworthy, and rules to safeguard community members if there are breaches of trust (people not behaving in a trustworthy way)	Moderate
Overarching rules	
8-Energy communities are likely to work best when they are bound by a set of overarching rules that enshrine the goals to be achieved, define or shape processes for achieving them, allow for conflict resolution and set penalties for actions that compromise the effective working of the community	None
9-Energy communities are hindered or facilitated by local social, economic, political, cultural and geographical factors that collectively amount to local 'sociotechnical styles'	Moderate to high
Value creation	
10-Energy communities are likely to generate value for their members and local communities	Moderate to high
11-Energy communities are likely to generate value for broader society and energy systems	Moderate to high
Upscaling	
12-Transfer of knowledge and skills between and within energy communities and through intermediaries is likely to enhance the potential for upscaling, in horizontal and vertical pathways	Low to moderate

Based on our analysis, the following key takeaway messages from D7.2 can be outlined:

- In several NEWCOMERS countries (DE, NL, SE, UK), there is a pattern emerging of polycentricity in action, with CECs playing a role in current renewable energy transitions. In other countries (IT, SI), it is too early to draw such a conclusion as the development of CECs is in an early stage and it is not possible to give a prognosis in which direction current developments are heading.
- PGT provides a useful lens to study energy communities. Inspired by this line of thinking, a narrative around self-organisation by citizens can be developed focusing on processes of value creation, experimentation and learning that may provide benefits to individuals as well as local communities, energy systems and society at large. Importantly, this narrative may also provide thematic entry points for designing effective policy interventions stimulating the emergence and operation of CECs in European countries.

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2 INTRODUCTION

2.1 Role of this deliverable in the project

This deliverable assesses the relevance of polycentric governance thinking (PGT) to the emergence and growth of clean energy communities (CECs) across Europe. It tests a set of 12 research propositions, rooted in PGT and substantiated with insights from sociotechnical systems and social innovation research, to investigate the relevance to this emerging area and to provide thematic entry points for developing recommendations about how to further support the growth of CECs through supportive governance arrangements. The actual recommendations will be formulated in D7.3 Policy recommendations.

Polycentricity has been advocated as a promising form of governance to tackle the climate emergency (E Ostrom, 2010). This line of thinking emphasizes the need for a multifaceted approach to governance that starts from the notion that governance increasingly emanates from the lowest possible level, whilst flexibly moving to higher scales as the need for coordination requires. Polycentric governance was subsequently employed as a potentially useful theory of governance that might help develop insights into the creation of supportive governance arrangements capable of facilitating the empowerment of citizens within energy communities.

When taking a sociotechnical perspective on energy communities, the interlinkages between society and technology are the focus of the analysis, together with the systemic relationships between them. In this perspective, technical and social components interact with each other in non-linear ways. Related to the emergence of CECs, it means that an energy community operating within a sociotechnical system is largely determined by its characteristics. The concept of sociotechnical styles was introduced by Hughes (1983) to mark the historically and geographically conditioned character of any technical system.

Empirically, the NEWCOMERS project aimed to analyse and evaluate several forms of clean energy communities (CECs) in terms of social innovation and their performance along dimensions, such as citizen engagement, value creation, and learning (cp. Blasch *et al.*, 2021). To this end, the project investigated to what extent these CECs meet their members' (i.e. citizens' and consumers') needs and whether they have the potential to increase the affordability of energy, their members' energy literacy and efficiency in the use of energy, while enabling participation in clean energy transitions in Europe. With this, our focus was on Germany (DE), Italy (IT), the Netherlands (NL), Sweden (SE), Slovenia (SI), and the United Kingdom (UK).

The analysis in the project was based on empirical data collected in the work packages (WPs) 2 to 6 and especially the research that has been carried out in 10 case study communities (CSCs) across the six NEWCOMERS countries. Our research methodology consisted of a socio-economic and institutional analysis at country level (WP3), an in-depth analysis of the CSCs through document analysis, interviews and workshops (WP4), and two surveys, one among CSC members and the other among the general population of nine European countries (the six NEWCOMERS countries plus France, Poland and Spain) (WPs 5 and 6).

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2.2 Approach

Governance can take a variety of forms, whether initiated by governments through centralised hierarchical systems, by market mechanisms, through networked collaborations (Bevir, 2012), or hybrids. Governance through centralised systems has been criticised for the possibility of vested interests from bureaucrats and a preference for short-term policy priorities of governments in power (e.g. Birkland, 2014). This is considered counterproductive for dealing with complex issues such as climate change and renewable energy transitions, which require long-term planning and consistency. Steering through market mechanisms may also have disadvantages as it strongly relies on the logics of the market and pricing mechanisms to create change. Instead, forms of networked governance have been suggested as better options because complex environmental problems require a diverse range of actors and institutions that collaborate and bring different specialisations into the networked system (Klijn & Koppenjan, 2012)).

In 2010, Elinor Ostrom (E. Ostrom, 2010) advocated polycentric governance as a specific form of networked governance to tackle climate related issues. She suggested that new and more dynamic forms of bottom-up, dispersed, and multi-level governance could be more effective than top-down management of climate issues via governments. She argued that polycentric governance can work well when certain central goals – such as fighting climate change - are shared, when actors develop trust because of their continued mutual interactions in local initiatives, and when systematic evaluations take place and translate back to the identification of best practices that can be scaled up.

While E. Ostrom had a positive view on polycentrism, she highlighted the importance of studying the strengths and the weaknesses of polycentric governance empirically (E. Ostrom, 2010). Jordan *et al.* (2018) took up this challenge by publishing the book "Governing climate change. Polycentricity in action?", in which an explorative analysis of relevant issues is made. In the book, the authors argue that such empirical studies should be done with an open and critical eye, claiming that too many researchers seem to treat E. Ostrom's predictions as things to be empirically confirmed rather than to be rigorously tested for.

For the NEWCOMERS project, a novel theoretical framework was developed that was inspired by PGT (van der Grijp, *et al.*, 2019). As a foundation, the five research themes were used as identified by Jordan *et al.*, including local action, mutual adjustment, experimentation, trust, and overarching rules. They formulated these themes in the form of propositions that can be tested when doing research in specific domains in order to help refine the theory and advance it further.

Building on this, the choice was made in the NEWCOMERS project to work with research propositions but to focus them more strongly towards the specific characteristics of CECs. Compared with the set proposed by Jordan *et al.* (2018), the NEWCOMERS team reformulated several research propositions in line with terminology that is commonly used when studying CECs as well as added themes and research propositions to better accommodate the focus of the project on processes of citizen engagement, value co-creation and learning.

In sum, this exercise led to the formulation of a set of 12 research propositions with a specific focus on energy communities which were arranged under seven different themes (see Table 1). To test these research propositions, each was operationalized into research questions, to be addressed within the empirical WPs. This deliverable D7.2 will discuss these themes and associated research propositions separately as well as in a more integrated manner.

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Table 1. Polycentric governance related themes and research propositions (inspired by Jordan et al, 2018)

PGT theme	NEWCOMERS research propositions
Local and virtual action	1-Place-based energy communities are likely to take off at a local level through processes of self-organisation by citizens
	2-Viable virtual communities are likely to be created, usually in a top-down manner, to deliver benefits to individual participants and to energy systems
Cooperation and mutual adjustment	3-Energy communities are likely to spontaneously develop collaborations with one another, and engage in processes of mutually adjusting to each other
Experimentation, innovation and learning	4-Energy communities' willingness and capacity to experiment is likely to facilitate governance innovation and learning about what works
	5-Energy communities are likely to provide opportunities for learning by their members at cognitive, normative and relational levels
Accountability and trust	6-Trust is likely to build up more quickly when energy communities can self-organise, thus increasing collective ambitions
	7-Trust requires people that are acknowledged to be trustworthy, and rules to safeguard community members if there are breaches of trust (people not behaving in a trustworthy way)
Overarching rules	8-Energy communities are likely to work best when they are bound by a set of overarching rules that enshrine the goals to be achieved, define or shape processes for achieving them, allow for conflict resolution and set penalties for actions that compromise the effective working of the community
	9-Energy communities are hindered or facilitated by local social, economic, political, cultural and geographic factors that collectively amount to local 'sociotechnical styles'
Value creation and distribution	10-Energy communities are likely to generate value (or co-benefits) for their members and local communities
	11-Energy communities are likely to generate value (or co-benefits) for broader society and energy systems
Diffusion and upscaling	12-Transfer of knowledge and skills between and within energy communities and through intermediaries is likely to enhance the potential for upscaling, in horizontal and vertical pathways

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2.3 Structure of the document

This deliverable is structured as follows. Section 3 reports on the examination of the research propositions according to the PGT themes. Section 4 discusses the findings at the thematic level as well as in an integrated manner. Section 5 presents conclusions.

3 EXAMINATION OF RESEARCH PROPOSITIONS

This section discusses the PGT themes and associated research propositions separately. For each proposition, the discussion will start with a short explanation of the proposition's origin, followed by its examination in the light of our NEWCOMERS research results, and a conclusion.

3.1 Local and virtual action

3.1.1 Proposition on local action

Explanation of the proposition

As explained in Section 2.2, polycentric governance is being brought into practice when local initiatives are developed that aim for shared goals, such as climate change. In fact, local action is one of the major themes of PGT and suggested by Jordan *et al.* (2018) as deserving further investigation with respect to its added value in terms of climate governance. In their book, they stipulated that governance initiatives are likely to take off at a local level through processes of self-organisation and added that local action will result in collective changes to the overall system through the steady accumulation of marginal changes by each participating unit -with a unit being a place-based CEC in terms of the NEWCOMERS project. A degree of organisation would seem to be fundamental for each CEC; without it, a community cannot function effectively. But there are still questions about the origins of that organisation: how much is imposed from outside and how much is developed from within the community?

For the NEWCOMERS project, we started our research from the following proposition:

> *Place-based energy communities are likely to take off at a local level through processes of self-organisation by citizens*

To test the proposition, we analysed our case study communities (CSCs) in terms of:

- the actors and technologies involved (who and what needed to be organised, and who was doing the organisation?);
- knowledge and skills that might be relevant to organising a CEC (how much did these rely on local actors?);
- business models, which reflect the organisational plan that enables an CEC to function and develop (how far did these reflect local characteristics?).

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Evidence from the NEWCOMERS research results

Actors and technologies

NEWCOMERS dialogues and surveys held with CSC members and stakeholders brought out the importance of trust in building and maintaining energy communities; the actors therefore have an important role to play in building this trust (Hansen *et al.*, 2020). In some communities, efforts were made to reach out to local people to encourage them to join; in one community, though, which aimed to provide impartial advice and information to potential purchasers of solar PV, it was seen as important not to act like salespeople, pushing a product, but to wait for members of the public to approach them. The purpose of a community thus affects the modes of action and the ways in which members organise to set up and develop their collective work.

The choice of technologies and functions for the CSCs were both associated with the actors involved and the ways in which they needed to organise. A community set up to provide electricity from a single wind turbine, for example, had simpler organisational requirements than one that needed to coordinate many investors in solar PV, homeowners willing to 'host' PV panels on their roofs, maintenance and education workers, and local authorities. Other CSCs were focused primarily on social welfare or on testing out new technology. All had processes of self-organisation that reflected their aims, the social makeup of the locality, the resources available and the skills that emerged as necessary during the 'learning by doing' that took place in each community.

Knowledge and skills

The knowledge and skills required for a CEC will depend on its purpose. For example, a community set up to test a new type of technological solution, such as blockchain-enabled peer-to-peer electricity trading, is likely to require high-level technical skills in order to design and operate the ICT. For that reason, a high-tech local CEC is more likely to be organised top-down, harnessing residents' willingness to form new contractual relationships with the organiser, rather than through citizen self-organisation (see also Section 3.1.2 on virtual action).

Bringing together the necessary knowledge and skills is a crucial part of self-organisation for all local CECs. Some knowledge and skills may be needed for one-off or occasional actions - for example, the ability to draw up a founding legal document for the community or repair a faulty inverter - and may be supplied from within the community or brought in from elsewhere. But the alliances formed by the CSCs show a need to be able to rely on stable sources of specialist knowledge and skills. For example, apartment owners in the GEN-I Jesenice community relied on substantial support from a subsidiary of their electricity supplier. This took the form of design, financial planning, insurance, equipment maintenance and general assistance with management and coordination. The community members were also helped by an institution providing soft loans and by the housing association responsible for managing the whole apartment block. By contrast, the large Zuiderlicht community in Amsterdam was set up by energy practitioners who were able to undertake much of the project development and contract negotiations themselves. However, they still relied on the expertise of commercial PV installers and other parties, including an energy supplier that traded with the community's renewable energy generation.

Business models

A business model perspective was generally useful but not always entirely adequate to describe and analyse what happened in a CSC. For example, a CSC may create value in non-monetary forms, so that it is more useful to talk in terms of value than revenue streams, and to understand self-organisation in terms of value creation overall. We noted from early stakeholder dialogues that an organisation set up primarily to address a problem or issue (e.g. fuel poverty, climate change) is usually community-driven ('bottom-up'). An example of this is the 'solar village' in Dalby, Sweden. This is a housing association

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that operates based on 'a sharing way of living' and has assembled actors and technologies for collective benefit. The business arrangements are straightforward: one operates between the solar village and a cooperatively-owned wind farm, while a second allows for further investment in renewable energy generation. Both produce economic value for the community, but it is not profit oriented and does not have 'customers'.

By contrast, a community set up to test a perceived technical solution (e.g. blockchain) and/or one involving advanced ICT, may still rely on some self-organisation but is more likely to be led by a third-party organisation that enrols local citizens, rather than the citizens calling on the third-party organisation for expert assistance. The SoEN project in Italy, where new technology is being mobilised to manage energy services in housing for disadvantaged residents and to charge them via a 'social algorithm', shows an interesting combination of social and technical goals and relies on ICT expertise. Its business model consists of substantial upfront funding, given the experimental nature of the project, although it aims to recoup the initial investment via payments for electricity in the long run.

Conclusion

Place-based energy communities can be considered to perform 'configurational work': they need to organise people and technologies, and establish structured ways of learning-by-doing and bringing necessary skills and knowledge into the community in order to perform specific tasks. Each local/ place-based community will have its own distinctive features in terms of social, physical, regulatory and governance context, and the people and resources it can mobilise. Each will have a business model that reflects these distinctive features. However, among the place-based NEWCOMERS business models, we found that there were also several features that they shared with one another, such as a need for smart metering or for regulatory support for demand response. Such shared requirements and characteristics may mean that self-organisation in CECs will become easier over time, if the conditions (physical and regulatory infrastructure) for CECs grow more favourable. We might also expect newly-emerging energy communities to be increasingly able to draw on the experience, knowledge and skills that are being developed by the 'early actors', including their ability to negotiate administrative, financial, technical and legal processes.

3.1.2 Proposition on virtual action

Explanation of the proposition

New developments in digitalization and online social networks are having major impacts on communication patterns between people and their behaviour in relation to energy use (Horner *et al.*, 2016; Barnes, 2021). This has also affected the energy sector as there is widespread use of social networks by customers and commercial organisations alike, along with a rapid increase in the use of sensors, advanced metering and other ICT applications to manage and pay for energy services. Both developments make possible the formation of 'virtual communities' through which energy services can be provided and communicated, but the latter - the use of ICT for system management and billing - calls for specialised technical knowledge.

This led us to the formulation of the following proposition:

> *Viable virtual communities are likely to be created, usually in a top-down manner, to deliver benefits to individual participants and to energy systems*

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Evidence from the NEWCOMERS research results

Our evidence comes from three sources: one of our CSCs, that is an established 'virtual community'; an experimental virtual community that was planned and set up as part of the NEWCOMERS project; and a survey of citizens in nine European countries to assess their views on energy transitions and willingness to take part in demand response.

As we have only one CSC to draw upon, we need to be cautious in generalising about virtual energy communities. However, the sonnenCommunity - our case study - demonstrates that virtual energy communities, coordinated top-down, can bring benefits to individual participants and to electricity system operators. It has connected privately-owned generation and storage units (mostly solar PV and batteries) on a national scale through cloud-based software that allows central control, in the form of a virtual power plant. Comparison to the other CECs studied within the project, suggests the virtual community established by sonnen, geographically-dispersed, and reliant upon the utilization of advanced digital technologies could only have been created in a top-down manner (Barnes and Hansen, 2021).

The appeal of this arrangement lies partly in its offer of a form of self-sufficiency, in which individual members provide for their needs via their own equipment. There is also a community or sharing dimension that is widely valued, in that members are also relying on excess generation and storage provided by others in the virtual community.

The virtual model in our case study, based on hardware ownership or leasing plus a distinctive tariff, was proving itself adaptable to a range of customer circumstances and to market developments - for example, a leasing scheme for electric vehicles whose batteries would form part of the overall virtual community of storage assets. It also made it possible for the value of aggregated 'virtual community' activities to extend across electricity market value chains - beyond their local distribution networks - so that, for example, participants can contribute to peak demand reduction for the grid as a whole and be rewarded for doing so.

During our field trial of creating a new virtual energy community in Slovenia analysed in Andor et al. (2021, 2022a), we found that a majority of community members viewed their membership in our newly created virtual energy community as a positive experience and felt a sense of solidarity and connection to their community members. But it also became apparent that the community members barely communicated with each other during the study period and that the membership in the community hardly contributed to a reduction of *overall* energy consumption. Yet, towards the end of the study period, three months after the community was set in place, the first effects of the community on *peak* demand reduction became visible. Thus, it could be that a virtual energy community needs a longer time horizon to get its members engaged.

Virtual energy communities were also a topic in the international citizen survey of 13,500 people in nine European countries (Andor *et al.*, 2022a), conducted as part of the project. According to the results from a hypothetical discrete choice experiment embedded in this survey, participants from most countries do not mind being part of virtual communities, even without direct, personal contact to members. Exceptions are the UK and Poland, where participants seem to prefer meeting with real persons. If community meetings allow direct contact to members, then results are the same for all countries and show that it does not play a role whether such meetings are held locally or virtually. As only 4% of respondents were actually members of an energy community, and only 16% were aware of any communities, the fact that only 15% were unwilling to join any type of energy community and that most were open to the possibility of joining a virtual community is quite encouraging: there seems to be a recognition that such communities could offer benefits to individuals. The survey did however show a strong desire to be involved in decision-making processes: this would be an important consideration in setting up a top-down virtual community.

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Conclusion

In NEWCOMERS, we were able to analyse a virtual community that offered benefits to electricity system operators and to individual members; set up a new virtual community and survey citizens around Europe on their views about different types of CECs.

Given the level of technical sophistication and knowledge of electricity markets required, it is not surprising that the established case-study virtual community was set up 'top down' to develop a viable business model and to recruit and coordinate many members, scattered around Germany, in order to develop the services on offer. The experience with the experimental virtual community illustrated some of the issues that need to be addressed when establishing productive relationships for members and for system operators: this takes time but there is some evidence that such a community can be engaged in a form of demand response (lowering peak-time usage) within a few months.

The NEWCOMERS citizen survey was based on stated and self-reported revealed preferences and attitudes. Its findings across nine countries are useful in demonstrating high levels of interest in energy transitions - primarily for reasons of addressing climate change and providing affordable, secure energy services; also in indicating that a high proportion of citizens are willing in principle to join virtual communities provided they have some say in decision-making.

3.2 Cooperation and mutual adjustment

3.2.1 Proposition on cooperation and mutual adjustment

Explanation of the proposition

Like local action, cooperation and mutual adjustment is a central theme that Jordan *et al.* (2018) propose to investigate through the lens of polycentricity. More specifically, they suggest that individual units (CECs in our case) are likely to develop collaborations with one another spontaneously and adapt their actions accordingly. The assumption is that individual units will maximise their utility by mutually adjusting to more effective strategies, based on good practices and experiments undertaken by other units in the system.

In line with this, the following proposition was formulated to focus on in the NEWCOMERS project:

> *Energy communities are likely to develop collaborations with one another spontaneously, and engage in processes of adjusting to each other*

Evidence from the NEWCOMERS research results

The topic of cooperation and mutual adjustment between CECs has not been systematically investigated in the NEWCOMERS project. However, working with our CSCs, we came across several forms of cooperation between CECs ranging from ad hoc and loosely organised contacts to more formalised collaborations. With regard to the latter, several countries have umbrella organisations in place that support energy communities in practical matters, facilitate the exchange of experiences between energy communities, and lobby for them at the level of central government (Palm, 2021, see section 4.4.1 for further details). In addition, CECs are seeking cooperation at the regional or local level. In the Netherlands and the UK, for example, there are larger cities that promote cooperation between energy communities. To this end, they support the creation of platforms that offer professional assistance to energy communities (e.g. Energie van Rotterdam, NL, Energie van Utrecht, NL, or Bristol Energy Network, UK) and/or encourage the mutual exchange of experiences (Platform

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02025 in Amsterdam). This also happens at the regional level (e.g. Energie Samen Noord-Holland, NL or Community Energy South, UK).

In the UK, *Energy Local CIC* has been developing and promoting a new CEC business model/approach through a federated structure. *Energy Local CIC* employs a core team of practitioners who coordinate and manage continuous development of their model whilst facilitating its deployment in diverse local contexts by working with local community groups. These local groups act as initiators of new Energy Local Clubs, using their connections to identify local generators and consumers, set up the cooperative and manage its operation in the first year, at all points supported by Energy Local CIC.

Additionally, our research results provide an indication that being active in an energy community may stimulate people to engage in other sustainability initiatives in the area (Kamin *et al*., 2021). For example, there is some evidence that people who are active in energy communities may set up other area-focused initiatives as spin-off of their CEC membership. In some of these cases, the revenues from the CECs are being invested in other local sustainability projects, giving a broader impact to energy community activities.

Our CSCs also provided some evidence that energy communities are mutually adjusting to each other. An example is the copying of successful models by others. A Dutch case in point is the replication and development of externally financed projects based on the so-called *Postcoderoos* regulation, an idea developed within *Buurtmolen Herbaijum* and being applied in *Buurtmolen Tzum*. Another example is the approach of *Zuiderlicht* located in Amsterdam(NL) that aims to include all citizens in the energy transition by providing them the opportunity to participate in larger scale solar projects and even make a small profit. Their crowdfunding model has been replicated by CEC Westerlicht that is active in another part of the city of Amsterdam.

Conclusion

The NEWCOMERS research findings confirm that cooperation and mutual adjustment are relevant phenomena with respect to energy communities. However, it is also evident that a certain critical mass is needed to start off regional or city-based cooperation and mutual adjustment between CECs. Not surprisingly, there seems to be a correlation between density of CECs and the occurrence and intensity of contacts and cooperation with others. At the same time, the learning between two Dutch *Buurtmolens* suggests that a common actor between the two initiatives is required to transfer knowledge and practice. Hence, our research findings indicate that there is some support for the proposition that CECs are seeking cooperation and are mutually adjusting and that this helps to make the sector function more effectively and accelerate its development. However, it will deserve a more systematic research approach to unravel the choices that CECs make about whom to cooperate with, how they cooperate, what the focus is of cooperation, and what the impacts are.

3.3 Experimentation, innovation, and learning

According to Jordan *et al*. (2018: 16), experimentation is another key theme of PGT as testing of new types of collaborations and business models is likely to facilitate governance innovation and learning about what works. In the NEWCOMERS project, this theme has fulfilled a prominent role in several research activities, which led us to formulate two research propositions dealing respectively with experimentation and learning.

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3.3.1 Proposition on willingness and capacity to experiment

Explanation of the proposition

Jordan *et al.* (2018) have stressed that multiple governing units taking initiatives at the same time should be seen as a setting ideal for natural experimentation and thus a welcome opportunity for learning about what works best in different contexts. Focused on CECs, Bauwens (2017) has argued that such initiatives indeed foster the conditions for experimentation and creativity, and exhibit informational benefits by encouraging the use of local knowledge. Based on these considerations, the following proposition has been examined in the NEWCOMERS project:

> *Energy communities' willingness and capacity to experiment is likely to facilitate governance innovation and learning about what works*

Evidence from the NEWCOMERS research results

Our in-depth research in cooperation with the 10 CSCs (Hansen *et al.*, 2022) as well as a survey of the sector suggests a significant amount of experimentation with business model governance to develop and manage CEC energy activities (see Table 2). Whilst 'willingness' is perhaps tricky to measure, the extent of partnership working between community-orientated organisations, municipalities, start-ups and established energy suppliers suggests CECs are experimenting with and developing novel governance arrangements. Our research demonstrates that in many instances governance innovation is required to develop new energy activities. For example, sharing or trading power across the public grid often requires an established energy supplier to be involved to undertake all regulatory compliance issues (Barnes and Hansen, 2021).

Table 2. Examples of experiments undertaken by NEWCOMERS CSCs

Countries	Experiments in terms of governance arrangements
Germany	Connecting privately-owned generation and storage units (mostly solar PV and batteries) on a national scale through cloud-based software that allows central control through a virtual power plant
Italy	Mobilising a new technology to manage energy services in housing for disadvantaged residents and charging them via a 'social algorithm'
Netherlands	Forming alliances with owners of large roofs focused on installation of PV combined with educational activities about energy
Slovenia	Stimulating the reduction of electricity use in peak hours by promising a charitable donation to the members of a virtual community
Sweden	Promoting sustainable living and implementing electricity generation and energy saving measures on communal buildings by a housing corporation
United Kingdom	Setting up 'Energy Local clubs' that use smart devices with communication and data transfer technologies in order to reduce costs and increase local consumption of renewable energy

Conclusion

Our findings support the proposition: willingness and a capacity of CECs to experiment is leading to innovation in their governance. Our work with the CSCs has revealed multiple examples of innovative approaches that are undertaken in different settings. Such innovations may refer to new alliances of stakeholders, new business models, new organizational arrangements, and new offers to members. However, it is certainly not the case that all CECs are experimenting with new approaches. It is a common practice that CECs are copying successful governance arrangements and business models from other communities.

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3.3.2 Proposition on learning

Explanation of the proposition

To enable working with the concept of learning, a distinction was made between three types of learning, including cognitive, normative, and relational learning (Haug *et al.,* 2011). Cognitive learning is the acquisition of new knowledge and an improved structuring of existing knowledge, which is important in environmental governance for bringing advocacy and understanding feedback systems (Haug *et al.,* 2011; McFadgen, 2019). Normative learning results in changes of perspectives, goals, or priorities, important for the development of common interests and goals, resulting in political consensus and collective action (Haug *et al.,* 2011; Gerlak *et al.,* 2019). Relational learning results in changes in trust, ability to cooperate, and understanding of other stakeholders' ideas and values. This latter type of learning enables participants to consider alternative perspectives, improving cooperation and helping to increase acceptance of new innovative management approaches (Haug *et al.,* 2011; McFadgen, 2019).

For the testing purposes of the NEWCOMERS project, the following proposition has been formulated:

> *Energy communities are likely to provide opportunities for learning by their members at cognitive, normative and relational levels*

Evidence from the NEWCOMERS research results

Our NEWCOMERS research results have shown that CECs indeed offer several opportunities for learning for their members (Kamin *et al*., 2020; Medved *et al*., 2021). More specifically, CEC members are spontaneously learning through their everyday practices ('learning by doing') as well as through more organised activities, which accelerate the learning processes of CEC members (see Table 3).

Table 3. Tools and mechanisms used by CECs for mutual exchange of learnings and information (based on Kamin *et al*., 2020; Medved *et al*., 2021)

Tools and mechanisms	Role	Prevalent types of learning
Regular formal CEC meetings	Represent an important platform for CEC members	Cognitive, normative, relational
Informal community discussions (in place-based CECs)	Enable community members to meet and discuss in person on various unarranged occasions, where they can spontaneously share experiences, exchange knowledge, learn from each other, and share personal practices	Normative, relational
Working/interest groups	Facilitate learning and knowledge-sharing activities focused on organization and management of different CEC operations, and non-energy related communal matters	Cognitive, normative, relational

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Newsletters (and/or e-mails, mailing list groups)	Represent a frequent and effective tool for sharing information and discussing about important matters with members	Cognitive
Web page	Functions as a consultative portal where CEC members can gain indications and guidelines for clean energy practices and energy saving	Cognitive
Knowledge ambassadors, community leaders and promoters, etc.	Fulfil important roles in CEC learning processes and represent a point of reference for CEC members and other interested people	Normative, relational, cognitive
Special CEC events	Improve socialization, encourage empowerment processes within CECs, generate debate about important issues or instruct the members about specific technical features	Cognitive, relational, normative
Intranet platforms/ member portals / social media groups	Provide members with information about the functioning of the CEC	Cognitive, relational

Through organised and spontaneous learning processes, CEC members can acquire various technical and non-technical skills and knowledge. Examples of technical skills and knowledge gained in CECs are related to managing technology like solar panels, controlling the functioning of renewable energy installations, managing internet portals and specific energy related apps, controlling and managing energy consumption, etc. There are also several other non-technical skills and knowledge that members can gain from participating in CECs, like ability to comfortably communicate about energy issues and explain specific technological knowledge, improving networking ability, developing business and legal knowledge with respect to subsidy schemes, tax regulation systems, acquiring knowledge about human behaviour and dynamics in a community, as well as about the local territory and geographical and cultural specifics, etc.

As part of the international citizen survey (Andor *et al.*, 2022b), we asked the participants about how well they felt informed about energy issues, energy consumption as well as being energy efficient. In a self-assessment, members of energy communities stated to be on average better informed on these topics than non-members did. However, this seemed not to be supported by their level of actual knowledge on energy related topics that was tested in the same survey. To get a first impression of whether members of energy communities are more energy literate than other citizens, we conducted an energy literacy quiz and compared the answers between the two groups. As a caveat, it should be noted that such a comparison cannot reveal whether any differences in energy literacy are due to learning within the energy community or to pre-existing knowledge differences. Such an investigation would require longitudinal studies. Nevertheless, comparing the answers of energy community members and non-members to the quiz questions, no clear picture emerges. While energy community members performed better on some questions, non-members performed better on others. Thus, there is no systematic difference detectable in the international survey.

Conclusion

The NEWCOMERS research findings confirm that CECs represent real "knowledge banks". As suggested by the proposition, they offer several opportunities for learning not only for their members,

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but also for interested others. Membership in CECs enriches and upgrades members' existing views, knowledge and skills, that affect their ways of life in relation to energy consumption but also to other matters related to sustainable living. However, our international citizen survey shows that members of CECs may perhaps feel more knowledgeable about energy issues but that this is not reflected in terms of their actual knowledge at the cognitive level.

3.4 Accountability and trust

3.4.1 Proposition on the importance of trust

Explanation of the proposition

Jordan *et al.* (2018: 18) suggest that "trust is likely to build up more quickly when units can self-organise, thus creating collective ambitions". This is considered particularly true at the local scale as in this case actors have the opportunity to interact face-to-face. To further strengthen mutual trust, the authors underline the importance of direct participation, information sharing, and having appropriate monitoring and evaluation systems in place.

Ostrom (2010) argued that levels of trust directly contribute to levels of cooperation, which in effect result in net benefits. These benefits may lead to new forms of learning and the adaption of altered norms, which can positively affect levels of trust, creating a feedback loop. This process is outlined in Figure 1.

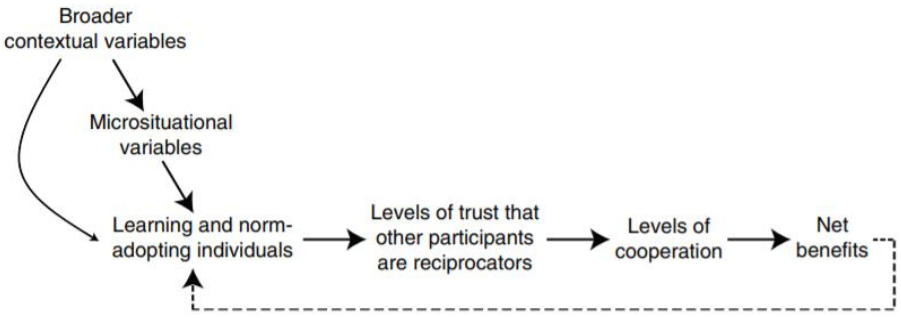

FIGURE 5. MICROSITUATIONAL AND BROADER CONTEXTS OF SOCIAL DILEMMAS AFFECT LEVELS OF TRUST AND COOPERATION

Source: Poteete, Janssen, and Ostrom 2010: 227.

Figure 1. Trust in a polycentric understanding (Poteete, Janssen, and Ostrom, 2010: 227)

With respect to CECs, such community-based trust is considered to represent a crucial dimension for their development and an indispensable attribute for cooperative behaviour within communities (Walker *et al.* (2007). Gui and MacGill (2018) have argued that the social capital developed through the cooperation processes within CECs can enforce trust between community members.

Inspired by this, the following proposition was formulated to investigate in the NEWCOMERS project:

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Trust is likely to build up more quickly when energy communities can self-organise, thus increasing collective ambitions

Evidence from the NEWCOMERS research results

Within the NEWCOMERS CSCs, it was possible to acknowledge a high level of community-based trust through the member surveys (Kamin *et al.*, 2020; Medved *et al.*, 2021). The distribution of participation and involvement of community members is generally perceived as rather equally allocated within the community (e.g. fair division of roles regarding the CEC every-day activities), despite different levels of involvement in CEC matters. The research results show that community-based trust represents a unifying factor within CECs and is maintained by transparency of actions and information sharing among members (Kamin *et al.*, 2020; Medved *et al.*, 2021). The NEWCOMERS CSCs are in general organised in a way, which allows members to rely on each other and have trust that they are all contributing to the community. This is an expression of a rather high collective empowerment of the community members, that could eventually lead to more ambitious future (collective) goals.

Community-based trust seems to be more accentuated in place-based than virtual CECs (Kamin *et al.*, 2020). The community members of virtual clean energy communities more often do not consider the virtual energy community as a "true community", therefore subjects of fairness and good behaviour of community members do not represent an issue for them. However, this contrasts with the findings by Andor et al. (2022) in the Slovenian CSC that a majority of community members viewed their membership in the newly created virtual energy community as a positive experience and felt a sense of solidarity and connection to their community members that further increased over time see (see Section 3.1.2).

Conclusion

In line with the proposition, community-based trust represents a unifying factor in CECs which empowers community members and consequently increases their collective ambitions. Community members are generally trusting towards other CEC members, mainly because of the transparent sharing of information among them. Moreover, trust is generated through perceptions of equal distribution of tasks among CEC members, and equal and fair division of roles in their CEC. In place-based CECs (where self-organisation is more frequent), community-trust develops more quickly and is stronger in comparison to virtual CECs.

3.4.2 Proposition on rules to safeguard accountability

Explanation of the proposition

Apart from 'community trust' (see Section 3.4.1), two other trust dimensions are also relevant for the functioning of energy communities, including integrity-based trust and competence-based trust. The latter indicates whether community leaders, members, and other partners involved in a joint energy related project have the capability and experiences to follow through on commitments and to provide reliable information (Berry, 2020).

Building on this distinction between different dimensions of trust, the following proposition was formulated:

Trust requires people that are acknowledged to be trustworthy, and rules to safeguard community members if there are breaches of trust (people not behaving in a trustworthy way).

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Evidence from the NEWCOMERS research results

A high level of integrity-based trust was acknowledged within the CSCs, with community members perceiving honesty and openness as essential components and identifying great trustworthiness between community members (Kamin *et al*., 2020). For example, there were no complaints about other members for not fulfilling their tasks or other non-collaborative behaviour.

Furthermore, it could be identified in our CSCs that members strongly rely on their energy community leaders to handle crucial issues on behalf of the community ('competence-based trust'). Community leaders are perceived as crucial to upholding the functioning of the community. Mostly they enjoy high trust from community members and are entrusted with all important tasks for strategic and daily management of CSCs. Community members highlighted that they had confidence in the expertise of the leaders, who they see as capable of running the community and pushing it forward.

Apart from community leaders, energy providers and network operators also receive significant trust from CSC members. In general, members are satisfied (with) and trust energy providers' knowledge and expertise, which is reflected through their core practitioners' capabilities of developing energy community business models and resolving technical complications.

The role of trust for the success of an energy community is further emphasised by participants' responses given during the international citizen survey (Andor *et al*., 2022b). A vast majority of the respondents (79.20%) "agree" or "strongly agree" with the statement that "trust is a crucial factor in a community initiative", while only a combined 2.56% either "disagree" or "strongly disagree". Similarly, 60.29% of the participants either "agree" or "strongly agree" with the statement that "it is essential that members of an energy community are like minded (for example, with respect to environmental, political and cultural topics)".

Conclusion

This proposition about trustworthiness is being supported with respect to the leaders of our CSCs that are playing a central role in terms of the overall functioning of their respective communities. The majority of members across the studied CECs strongly trust in and rely on their leaders to handle important issues on behalf of the community as they are considered to possess the adequate capabilities, skills and competences to operate and administer the energy community. At the same time, these leaders represent a point of reference and source of information for all main aspects (technical, legal, organisational, financial, management, etc.) of the community. Hence, based on the NEWCOMERS evidence, it can be concluded that especially community leaders, and to a minor extent energy providers and network operators, are seen as the main actors who could safeguard community members if "breaches of trust" emerge.

3.5 Institutional frameworks

3.5.1 Proposition on overarching rules

Explanation of the proposition

Jordan *et al.* (2018: 19) propose that "local initiatives are likely to work best when they are bound by a set of overarching rules that enshrine the goals to be achieved and/or allow conflicts to be resolved." In addition, they consider rules important as they can serve to protect the diversity of local action.

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Accordingly, the following proposition was formulated with respect to CECs:

> *Energy communities are likely to work best when they are bound by a set of overarching rules that enshrine the goals to be achieved, define or shape processes for achieving them, allow for conflict resolution and set penalties for actions that compromise the effective working of the community.*

Evidence from the NEWCOMERS research results

Nearly all CSCs were developed in the absence of common rules guiding their development. The only exception to this might be the CECs developed under the Dutch *Postcoderoos* Regulation which was specifically designed for and only open to participation by cooperative enterprises. This legislation has been very effective at fostering renewable energy projects. However, this is an exception rather than the norm across the countries studied. Few other countries have created specific or broad policies in support of CECs. The UK launched a Community Energy Strategy in 2014 but quietly dropped it a few years later.

The EU's Clean Energy Package (CEP) and its associated rules on citizen and renewable energy communities has the potential to set the goals to be achieved by CECs but has only recently been transposed by Member States or is still in the process of being transposed. For the NEWCOMERS project, the resulting national laws and regulations came too late to determine whether initiatives 'work best' under clear legislation. Our case study in Slovenia (GEN-I Jesenice) was enabled by national legislation (it would not have been possible in its current form before the legislation was passed), whilst in Italy, one of our case studies (SO_EN social housing) expects to be enabled by the national legislation on CECs that is currently being developed. Furthermore, at this stage, it remains unclear if overarching rules will allow conflicts to be resolved in the formation of CECs.

Conclusion

The NEWCOMERS research results tentatively suggest there is limited evidence for this proposition as in the countries studied CECs have developed without any clear overarching rules providing definitions and setting goals to be achieved. The transposition and implementation of the EU's CEP is a clear step towards the creation of overarching rules for CECs at the European level, which will allow for furthering analysis of this proposition in the future.

3.5.2 Proposition on hindering and facilitating factors

Explanation of the proposition

As briefly explained in Section 2.1, technical systems interact with their environment and are subject to varied influences external to the technology, such as *social, economic, political, cultural, geographical and historical* conditions. As a consequence, sociotechnical styles are time and spatially delimited and this is why energy systems evolve differently in countries. In the NEWCOMERS project, these conditions, have been investigated with a focus on their impact on energy communities. Barriers and enablers were identified for energy communities to emerge in relation to sociotechnical styles.

Based on these considerations, the following proposition has been investigated in the NEWCOMERS project:

> *Energy communities are hindered or facilitated by local social, economic, political, cultural and geographical factors that collectively amount to local 'sociotechnical styles'.*

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Evidence from the NEWCOMERS research results

In relation to socio-economic conditions, we focused on urban and rural aspects, education, trust, and GDP and households' economy in relation to electricity prices. The four NEWCOMERS countries with the most CECs (Germany, the United Kingdom, the Netherlands, Sweden) are also the ones with higher levels of urbanisation. This contradicts earlier research but can also be a reflection of the fact that many of the CECs in the NEWCOMERS countries have invested in PVs, which according to Lowitzsch *et al.* (2020) suit both urban and rural CECs.

There is no obvious way to study the influence of education on CECs at a national level. We decided to test if the level of tertiary education (college and university level) in a country had any correlation to the number of CECs. The comparison indicates that there is no clear relationship between a country's number of CECs and its share of inhabitants with higher education.

In earlier research on CECs, trust is a factor often mentioned, coming with different meanings and in different contexts (see for example Section 3.4.1 about the importance of trust in the community context). In WP3, we studied trust in the political or legal system and if it seems to have any significance for the emergence of CECs. The results indicate that the Netherlands and Sweden have high levels of trust in institutions, which might indicate a good base for creating CECs. For Slovenia and Italy, trust appears to be more of a barrier hindering the future development of CECs.

Furthermore, we checked if GDP influences the number of CECs. In the world ranking, all six NEWCOMERS countries are included in the top 36 countries with highest GDP per capita. However, Italy and Slovenia have relatively lower GDPs and also fewer CECs compared with the other NEWCOMERS countries. In similar terms, the level of average disposable income has been identified earlier as a key factor that explains the different levels of CECs between Italy and Germany (Magnani and Osti, 2016). There were however no indications that the electricity price influenced the numbers of CECs (Palm, 2021).

With respect to technical systems, or more specifically energy systems, the countries' electricity generation mix, related emissions, and the electricity grid have been studied. For the NEWCOMERS countries, there were no clear relationships between the countries' electricity generation mix and energy-related emissions and the number of CECs. In relation to the electricity grid, Germany has many DSOs and also many CECs, but otherwise, there are no obvious patterns or correlations between the number of DSOs and the number of CECs in a country (Palm, 2021).

In relation to institutions, the main focus was on national policies and regulations facilitating CECs. These differ from the overarching rules in Section 3.5.1 in the sense that the latter especially focus on the definitions of CECs and the way they are structured in terms of governance. Our research showed that all NEWCOMERS countries had some CEC relevant renewable subsidies in place. Germany for example subsidises biofuels and has a cooperative law facilitating new renewable CECs to emerge. Italy has support schemes for renewable energy electricity and tax exemption for renewables. The Netherlands aims at 50% local ownership in wind and solar projects by 2030 through the development of thirty regional energy strategies. The country earlier had a tax deduction scheme in place that aimed to stimulate local ownership of renewable energy projects (*Postcoderoos* Regulation). Slovenia has a support scheme for renewables and combined heat and power. Sweden has a tradable green certificate system and a program supporting local and regional infrastructure investments. Wales and Scotland within the UK have targets for levels of community energy.

Furthermore, Feed-in-Tariff (FiT) schemes have been widely used to give a push to CECs in order to enable renewables to be competitive with fossil energy (Palm, 2021). Several of the NEWCOMERS countries (DE, NL, SI) have such FiT schemes in place to encourage renewable energy production. Italy has had a FiT scheme in place and is since 2020 experimenting with a specific FiT for renewable energy

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communities where the tariff will be used to reward the renewable power plants that participate (Palm, 2021).

Earlier research often emphasised the need for policymakers at all levels to support CECs to emerge and that lack of political support and lack of access to politicians and policymakers are barriers for CECs to develop (Brummer, 2018). Among our six NEWCOMERS countries, the UK was early with its strategy for CECs and consequently the UK has many CECs in place.

The structure of the electricity market has in earlier research been proven important for the emergence of CECs. A main barrier for bottom-up initiatives such as CECs is a centralised design and regulation of existing energy systems (Brummer, 2018; Koirala et al., 2018; Kooij *et al*., 2018; Warbroek *et al*., 2018). Kooij *et al*. (2018) found in their study that a decentralised organised energy infrastructure within an SME economy was enabling the emergence of CECs. However, all NEWCOMERS countries are dominated by a few large energy companies. A liberalised market with domestic competition has been identified as more beneficial for CECs than a closed energy market where rules and resources are tailored to large players.

A final enabling factor for the emergence and operation of CECs is support by umbrella organizations. In the United Kingdom, the Netherlands and Germany, CECs are part of larger cooperative organisations that represent common interests and function as intermediaries between CECs and governments at all levels. Importantly, they help putting CECs issues on the political agenda. Furthermore, almost all studies highlight the extreme dependence of CECs on volunteer labour. To ease this burden for volunteers, umbrella organisations can fulfil an important role by creating networks, hence providing a possibility for learning between CECs, and platforms for sharing of best practices. Similar organisations are lacking in Italy, Slovenia and Sweden.

Conclusion

The evidence collected in the NEWCOMERS project strongly supports the research proposition that social, economic, political, cultural, geographical and historical factors play a decisive role in the emergence and operation of CECs. Relevant socio-economic barriers identified for CECs were lack of institutional trust and low average disposable income. Institutional barriers identified were the existence of a centralised energy system, where large scale solutions dominate, together with high grid connection costs. Lack of tailor-made policies for CECs can also inhibit their development, together with bureaucracy and administration. Barriers in relation to technical systems were not so apparent in our six NEWCOMERS countries.

Socio-economic enablers identified were access to financial support as well as trust. An enabler related to technical systems was the existence of many DSOs. Institutional enablers identified were CEC-related policies and regulations, FiT schemes, CO_2 taxation, and incentives and subsidies exclusively developed for CECs. The existence of umbrella organisations has been identified as an enabler together with other intermediaries. They can be a platform for networking and learning and also provide support in the contacts with politicians.

3.6 Value creation and distribution

3.6.1 Proposition on value creation for members and local communities

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Explanation of the proposition

Jordan *et al.* (2015) argue that an improved understanding of co-benefits generated from a polycentric system is important for overcoming public acceptability concerns and may help provide a strong political case for innovation. Other scholars have also linked polycentrism as beneficial for public value creation, where co-benefits can be generated for local communities and society (e.g. Bryson *et al.,* 2016). However, accounting for these co-benefits is still in its early stages (Wierling *et al.*, 2018).

Against this background, the following proposition was developed for the NEWCOMERS project:

Energy communities are likely to generate value for their members and local communities

Evidence from the NEWCOMERS research results

Evidence from across the NEWCOMERS project suggests CECs deliver a wide range of values to members and local communities (see Kamin *et al.*, 2020; Medved *et al.*, 2021; Hansen et al., 2022). The types of value that CECs deliver to their **members** include functional values like reducing energy costs and delivering renewable power to members and environmental value, such as reducing carbon dioxide emissions. Beyond these types of value, CECs also deliver cognitive, social and affective value to members. For instance, participation in CECs opens up new opportunities to engage in energy systems, in decarbonisation efforts and with existing or new communities of place or interest. Engagement in CECs can result in development of new skills and knowledge.

Similar financial, cognitive, social and affective types of value cascade out of CECs to their **wider communities**, where they are based in localities (Barnes et al., 2021). Depending on the activities undertaken, CECs can educate wider communities of place, about climate change, energy system decarbonisation and possible means of participation. Local schools and buildings which host CEC generation assets are often used as a focal point for this engagement activity. CECs can retain money within local economies by using local services and trades to install and maintain energy assets, whilst creating new value chains that directly link customers to generators, cutting out middlemen and in many cases giving members the opportunity to own generation assets.

In this sense, CECs act as autonomous units with distributed decision-making over how they operate (with some added interaction with selected others), which are developing a range of innovative approaches that deliver multiple types of value to members, local communities and also broader society. The NEWCOMERS research suggests that CECs deliver types of values that go beyond functional, financial and environmental values. Whether any particular CEC does so depends on the actors involved. How actors' primary motivations are translated in accordance with local context conditions (such as the availability of existing energy assets, levels of community cohesion and organisation, etc.) impacts the types of energy activities they seek to undertake with or without the help of other professional energy system actors. This supports the proposition presented.

Comparing respondents that are energy community members as opposed to non-members, we observed some differences in opinions among the two groups (Andor *et al.*, 2022b). When asked about the importance of the energy communities' benefit of reducing household electricity costs and fossil fuel consumption, the distribution is similar among members and non-members. Yet, opinions do differ when respondents are questioned about the importance of some other aspects. In particular, energy community members perceive financial revenues, i.e., earning money, as a more important benefit of CECs than non-members. The same applies to the social aspects of such communities, the aim to address climate change, using CECs as investment opportunities, engaging in new technologies, contributing to a fairer energy transition, as well as fostering a more secure and independent energy provision. Members of CECs see all of these as more important than non-members. The data does, however, not allow determining the causal direction of this relationship. Being a member could change one's perception about the benefits that CECs provide, but it is just as, if not more, plausible that

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people who perceive such benefits as important are more likely to start and join energy communities in the first place.

During our field trial of creating a new virtual energy community in Slovenia, we were able to draw causal conclusions about potential value creation by this energy community due to the experimental design. Interestingly, we found that, compared to non-members, the energy community members did reduce their peak hour electricity use (Andor *et al.* 2022a). This was achieved in the context of a "load-shifting challenge" in which the study participants were asked to reduce their electricity consumption between 5pm and 9pm. As an incentive, a charitable donation was made by the project team on behalf of the study participants, if a substantial reduction was achieved. The ability of electricity consumers and CECs to shift electricity consumption away from peak demand hours is beneficial to the continued success of the energy system's transition to renewable energy and therefore represents a societal benefit. As a caveat, however, it should be noted that membership in the newly created CEC had no direct effect on participants' energy conservation efforts. Yet, on the other hand, the CEC in our study was a pure virtual energy savings community without any other special technical equipment, such as own power generation facilities or electricity storage. Since many CECs incorporate such technologies, their potential for load shifting could be even larger.

Conclusion

Based on the NEWCOMERS research results, it can be concluded that the proposition is supported with respect to the actual delivery of multiple values to members of CECs and their local communities. The proposition is supported in the sense that CECs as autonomous units with distributed decision-making over how they operate (through interaction with selected others) are developing a range of innovative approaches that deliver multiple types of value to members and local communities. The research results also suggest that CECs deliver types of values that go beyond functional, financial and environmental values. Whether any particular CEC does so depends on the actors involved. How actors' primary motivations are translated in accordance with local context conditions (such as the availability of existing energy assets, levels of community cohesion and organisation, etc.) impacts the types of energy activities they seek to undertake with or without the help of other professional energy system actors.

3.6.2 Proposition on value creation for wider society and energy systems

Explanation of the proposition

E. Ostrom (2010) hypothesised that in a polycentric system of governance, actors would come up with their own innovative solutions to generate public value or benefits, such as improved human health, cheaper energy prices and improvements to air quality. Based on her hypothesis, the following proposition has been investigated in the NEWCOMERS project:

> *Energy communities are likely to generate value for broader society and especially renewable energy systems*

Evidence from the NEWCOMERS research results

Value for wider society and energy systems

The same functional, social and environmental values as identified under the previous proposition (see Section 3.6.1) may have tangible impacts at the scale of wider society and particularly governments across multiple scales. At this broader societal scale, the benefits of CECs include the democratisation of energy systems, through facilitating ownership of energy generation assets to new members and

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segments of society as well as by creating a means for citizens to become active stakeholders in energy systems (Kamin *et al*., 2021; Hansen et al., 2022). Linked to this, CECs have the potential, depending on the way they are configured, to contribute to procedural and distributive justice. They can create new ways for people, including the old and energy illiterate, to participate in energy system transformation, whilst reducing energy bills, thereby lowering energy poverty. Beyond this, CECs are perceived to hold value as practical implementation of the green transitions that governments across all scales are advocating for.

The proposition is partially supported where it concerns the functional value CECs currently provide to energy systems. Given how existing research (e.g. Brown *et al*., 2019) suggests that to succeed CECs will need to deliver bi-directional benefits that are synergistic to both CECs and energy systems, this is worrying. Analysis of the direct, functional benefits delivered to energy systems by our case studies suggests they primarily increase renewable generation capacity and, proportionally, decrease the carbon intensity of electricity grids (Hansen and Barnes, 2021). In only a limited number of instances did our CECs go beyond the generation and consumption of renewable power to actively foster demand side flexibility or deliver services to grid operators that help maintain reliable electricity systems. Where services were delivered to grids, CECs had to develop increasingly sophisticated business arrangements involving a range of ICT enabled and remotely controlled technologies, with domestic batteries being a central piece of kit, to be able to deliver value to energy systems, with no input from members. Despite the sophistication of these actor-technology relationships, we find the primary reason CECs do not deliver more value to energy systems is rooted in the rules, regulations and markets guiding energy system operation. In short, there are currently few incentives or opportunities for CECs (or any other energy system actor) to contribute system services (Hansen and Barnes, 2021). Consequently, we argue that the extent or existence of polycentric systems of governance does not alter the capacity of CECs to deliver system services at present.

Conversely, we found that CECs currently provide a range of indirect benefits to energy systems that are poorly recognised, supported or rewarded by policymakers or grid operators at present (Hansen et al., 2022). This includes reducing energy demand and fostering demand-side flexibility through how CECs are designed and operated. Often the practical consequence of seeking independence from existing actors or systems and motivated to achieve greater self-sufficiency, CECs are creating new sociotechnical configurations that reduce demand and facilitate greater, flexible use of locally-generated renewable-based energy that has inherent value to operating energy systems. These benefits go largely unrecognised and rewarded in current markets, markets that only recognise the delivery of system benefits where they are delivered by market contracts. Moreover, such markets, rules and regulations do not facilitate the creation of CECs limiting their potential.

In tandem, the capacity of CECs to deliver (direct or indirect) benefits to energy systems is strongly curtailed by the broader context conditions in which CECs operate. The capacity of CECs to deliver multiple benefits to energy systems is neither constrained nor facilitated by the existence of polycentric governance arrangements but largely shaped by the highly regulated market that CECs operate within.

In the international citizen survey (Andor *et al*., 2022b), we systematically investigated citizens' perceptions about the values that are created by CECs. Here we present an excerpt from these results:

- Amongst the respondents who are aware of energy communities, 85.28% believe that energy communities play an important role for the transition towards a sustainable energy system.
- The two benefits of energy communities that are perceived as most important are the reduction of household electricity costs (88%) and the reduction of fossil fuel consumption (81%) (Andor et al. 2022a).
- Further positive aspects of energy communities that find endorsement in the citizen survey are, in that order, energy security, making the energy transition fairer, independence from large energy providers, engagement with new technologies, being part of a movement that addresses

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climate change, investing and earning money as well as doing things together with other community members.

Conclusion

We find partial support for the proposition. Our work suggests CECs generate a range of values that cascade out to wider society, including government. It also suggests CECs deliver value to energy systems, most notably the generation and consumption of renewable power. Further analysis of the direct, functional benefits delivered to energy systems by our CSCs suggests that in only a limited number of instances did our CECs actively foster demand side flexibility or deliver services to grid operators that help maintain reliable electricity systems. More crucial to the present analysis, we found the delivery of services to energy systems was a consequence of relatively immature market rules and mechanisms to incentivize system services, whilst the extent of polycentricity within the governance systems CECs operate in has little bearing.

3.7 Diffusion and upscaling

Explanation of the proposition

Scaling and diffusion are two important terms relevant to the growth and expansion of local scale innovation, among these CECs. Scaling, according to van Doren et al. (2018), can be conceived along two axis. Horizontal scaling entails a quantitative expansion (e.g., members communicating information to further potential members, or the growth and replication of elements of business models) and vertical scaling entails a form of institutional change (e.g., the development of supportive policies).

Diffusion on the other hand can be understood as the unhindered movement of an idea or innovation, particularly by using processes of learning, transfer and adoption (Jordan & Huitema, 2014). The nuances and similarities of these definitions are key to understanding what aspects of CECs scale and how this is applicable to PGT. In the operational sense, to better understand this question we explored to what extent the knowledge and skill needs of CSCs were met. We foresaw an explicit role for intermediaries – both by mediating learnings (horizontal pathway) and by translating experiences to higher-levels of decision-making (vertical pathway) (van der Grijp et al., 2019).

Bearing this in mind, this section aims to reflect on the following proposition set out in the beginning of the NEWCOMERS project:

> *A transfer of knowledge and skills between and within energy communities and through intermediaries is likely to enhance the potential for upscaling, both in horizontal and vertical pathways.*

Scaling and diffusion are complex processes, which to date have not been explicitly addressed in PGT (Petrovics, 2022). Nevertheless, by focusing on multiple scales, multiple domains and the interlinkages of individual initiatives, PGT implicitly hints at the need for local-scale initiatives to coexist in multiple sites and for various actors to assume appropriate responsibilities distributed across various scales (Jordan et al. 2018). When zooming in on the specific case of CECs, the self-communicated barriers put forward by members are an informative starting point for what may be needed for a well performing polycentric governance system in the field of clean energy development and diffusion.

The main reason provided by individual respondents for not joining a CEC is that they were not aware of their existence (Andor *et al.*, 2022b). Other reasons included a lack of knowledge and skills as well as a lack of financial resources. These barriers raise the question as to how CEC models scale and how the necessary knowledge and skills and required policy framing can diffuse.

Evidence from the NEWCOMERS research results

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While searching for pointers on how to approach this problem, in the case of NEWCOMERS, observations for the project have produced the following baseline pathways of scaling/diffusion (Blasch *et al*., 2022):

- Diffusion via members sharing knowledge and experience with people external to the community;
- Replication of individual actors' business models as offered by companies that cooperate with CECs; and
- Diffusion via activities from umbrella organisations and other intermediaries, such as trainings and webinars, inspirational events (e.g. the annual HIER opgewekt event in the Netherlands where the annual Local Energy Monitor is launched which creates large scale publicity).

Based on the results of the NEWCOMERS project a number of pre-requisites should also be in place to aid the above pathways. These include:

- Regulation and supportive policy playing an active role, such as financing facilities launched by umbrella organisations (e.g. MECISE by REScoop, a development fund (*Ontwikkelfonds*) by Energie Samen) or setting policy targets (e.g. 50% local ownership in NL), and
- Simple guidelines for CEC development being present, such as local government launching and/or supporting platforms in order to help kick starting new local CECs.

What shines through the empirics and in effect supports this proposition is the concept of learning. For CECs to scale, learning has to take place both within and between CECs. Energy Local is a CSC that has internalised this idea as part of their operational set-up, with headquarters taking on a central coordination role, which processes learnings from a growing number of formally independent Energy Local Clubs. This is needed firstly to internally develop the necessary knowledge and skills, and secondly to diffuse this across the movement of CECs. Another example is provided by CEC Tzum that learned directly from CEC Herbaijum.

Finally, related to overarching rules our empirics show that it is mostly supportive policies, simplified administrative processes, and reliable policy environments which help CECs emerge. This has been particularly the case with rules on self-consumption in Italy and Slovenia. The lack of rules in certain cases can however also be seen as inhibiting the growth and scaling of CECs. Overall, it is clear that rules are central to the efficient functioning of polycentric governance systems. These rules can be both internal to communities, resembling Ostrom's work on design principles but they can also be overarching to the whole polycentric governance system itself.

Conclusion

All-in-all it can be said that there is no silver bullet, which can deliver CECs at scale. However, pressure points do exist, which policy makers and energy community practitioners alike can focus on. A closer examination of NEWCOMERS CSCs, which do carry elements of scaling or diffusion has indicated that one should ask the question 'whose (business) model is being scaled?'. It is not simply the models of CECs, which scale but usually specific elements of them - primarily those connected to some form of financial interest embedded in market logic. This is for example the case of Greenchoice in the Netherlands, which is effectively scaling (replicating) their business model of collaborating with CECs. In a similar way, sonnen grows the sonnenCommunity in size by growing the number of its customers.

Overall, based on the empirical findings of the NEWCOMERS project, our proposition that the transfer of knowledge and skills may be necessary for the scaling of energy communities is being supported. Nevertheless, nuances have to be brought into whose business model scales and what types of prerequisites should be in place for scaling to take place. For this reason, we put forward the following adapted proposition when it comes to the scaling of energy communities:

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If regulation and supportive policy and simple guidelines for CEC development are in place, a transfer of knowledge and skills specific to the interest of commercial actors can be facilitated between energy communities towards their successful scaling.

4 DISCUSSION

This section discusses the research findings of Section 3 against the background of polycentric governance thinking (PGT) and insights from sociotechnical systems and social innovation research. Besides investigating their relevance to the emerging area of community energy, it also aims to provide thematic entry points for developing recommendations about how to further support the growth of CECs across Europe through supportive governance arrangements. Section 4.1 summarises the support we found for our set of 12 research propositions in the six NEWCOMERS countries. Section 4.2 provides a reflection on working with the research propositions.

4.1 Support for research propositions

Based on the NEWCOMERS research results, Table 4 provides indications of the level of support we found for the PGT propositions in our research. This tentative assessment is based on qualitative and quantitative analyses of CECs undertaken within empirical WPs. For the assessment, we used a qualification range for the level of support ranging from high to moderate, low and no support. A high level of support refers to evidence found in five or six NEWCOMERS countries and associated CSCs, whereas a moderate level points to evidence from three or four countries and a low level implies evidence in one or two countries only.

In conclusion, we found certain levels of support for the majority of research propositions (10 out of 12) in most countries studied (Germany, Italy, Slovenia, Sweden, the Netherlands and the United Kingdom). However, this was not the case for two propositions where we could not identify any support. For the one on virtual communities, the design of the project with its limited focus on such energy communities could be the reason, for the other one on overarching rules the early stage of implementation of the Clean Energy Package and related legislation in EU member states could be a major argument.

Table 4. Support for PGT propositions based on NEWCOMERS project results

NEWCOMERS themes and research propositions	Indicative level of support provided by NEWCOMERS evidence
Local and virtual action	
1-Place-based energy communities are likely to take off at a local level through processes of self-organisation by citizens	Low to moderate
2-Viable virtual communities are likely to be created, usually in a top-down manner, to deliver benefits to individual participants and to energy systems	None

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Cooperation and mutual adjustment	
3-Energy communities are likely to spontaneously develop collaborations with one another, and engage in processes of mutually adjusting to each other	Low to moderate
Experimentation, innovation and learning	
4-Energy communities' willingness and capacity to experiment is likely to facilitate governance innovation and learning about what works	Moderate to high
5-Energy communities are likely to provide opportunities for learning by their members at cognitive, normative and relational levels	Moderate to high
Trust and accountability	
6-Trust is likely to build up more quickly when energy communities can self-organise, thus increasing collective ambitions	Low to moderate
7-Trust requires people that are acknowledged to be trustworthy, and rules to safeguard community members if there are breaches of trust (people not behaving in a trustworthy way)	Moderate
Overarching rules	
8-Energy communities are likely to work best when they are bound by a set of overarching rules that enshrine the goals to be achieved, define or shape processes for achieving them, allow for conflict resolution and set penalties for actions that compromise the effective working of the community	None
9-Energy communities are hindered or facilitated by local social, economic, political, cultural and geographical factors that collectively amount to local 'sociotechnical styles'	Moderate to high
Value creation	
10-Energy communities are likely to generate value for their members and local communities	Moderate to high
11-Energy communities are likely to generate value for broader society and energy systems	Moderate to high
Upscaling	
12-Transfer of knowledge and skills between and within energy communities and through intermediaries is likely to enhance the potential for upscaling, in horizontal and vertical pathways	Low to moderate

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Our research results demonstrate that self-organisation is a highly relevant characteristic of CECs as they need to organise people and technologies, and establish structured ways of learning-by-doing and bringing necessary skills and knowledge into the community in order to perform specific tasks. Furthermore, our findings provide indications that processes of cooperation and mutual adjustment with respect to CECs are taking place in countries where there is already a higher level of self-organising activity. However, as our citizen survey showed, the level of awareness about CECs is still low in most countries (Andor *et al.*, 2022b) which could be the reason that initiatives to set up energy communities are not taking off everywhere as yet.

Furthermore, we found that value creation is a multidimensional concept in relation to CECs. Monetary and non-monetary value is being created by CECs not only for members and local communities, but also for wider society and energy systems. Although a business model perspective was generally useful, it was not always entirely adequate to describe and analyse what happened in our CECs. Consequently, we argue that self-organisation should be understood in terms of value creation in multiple ways.

According to our survey among CEC members, a high level of integrity-based trust could be acknowledged, with community members perceiving honesty and openness as essential components and identifying great trustworthiness between CEC members (Kamin *et al.*, 2020). Our member survey did not give any indication that there were any complaints about other members for not fulfilling their tasks properly or other non-collaborative behaviour. However, the internal management of CECs is a complex issue and members may not easily express their doubts in case of mismanagement. The citizen survey indeed provided evidence that people may have some concern about the conduct of others in the energy community context (Andor *et al.*, 2022b).

4.2 Working with research propositions

In terms of working with research propositions, we identified pros and cons. On the one hand it helped structuring the analysis by giving a simple and coherent framework of research priorities. On the other hand, we may have missed important issues because they were not included in our propositions. For example, the internal governance of energy communities was not studied in-depth whereas this can have major impact on the effective functioning of energy communities overall and the level of trust members and non-members may have in them.

With regard to the testing of propositions, Jordan *et al.*, (2018) emphasise that empirical studies in specific domains should be done with an open and critical eye and in a rigorous manner. We are hesitant in claiming to have achieved such a rigorous level of testing in the NEWCOMERS project. One of our conclusions is that it will take a much broader research effort to fully understand the processes within and between energy communities, as well as how they relate with other stakeholders. Our evidence about CECs has been limited to an in-depth study of 10 CSCs in six countries only. However, we believe that we made some relevant first steps by identifying topics that are interesting to delve in deeper and by experimenting with research approaches for tackling these issues.

With regard to the propositions themselves, we experienced during the execution of the project that there was some overlap between them and that some of them could benefit from a more precise formulation. This is an argument to keep critically reflecting on the research propositions and if there is sufficient reason to propose reformulation. For example, the proposition on upscaling has some overlap with other propositions but could also be considered as a higher level proposition. The propositions on trust could be perhaps made more concrete by explicitly focusing them on criteria of accountability, transparency, inclusiveness, and responsiveness.

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5 CONCLUSION

This deliverable aimed to assess the relevance of polycentric governance thinking (PGT) to the emergence and growth of clean energy communities (CECs) across Europe. By doing so, it meant to provide thematic entry points for developing recommendations about how to further support the growth of CECs across Europe through supportive governance arrangements. The assessment was made by testing a set of 12 research propositions, rooted in PGT and substantiated with insights from sociotechnical systems and social innovation research.

Our main conclusions are as follows:

- In several NEWCOMERS countries (DE, NL, SE, UK), there is a pattern emerging of polycentricity in action, with CECs playing a role in current renewable energy transitions. In other countries (IT, SI), it is too early to draw such a conclusion as the development of CECs is in an early stage and it is not possible to give a prognosis in which direction current developments are heading.
- PGT provides a useful lens to study energy communities. Inspired by this line of thinking, a narrative around self-organisation by citizens can be developed focusing on processes of value creation, experimentation and learning that may provide benefits to individuals as well as local communities, energy systems and society at large. Importantly, this narrative may also provide thematic entry points for designing effective policy interventions stimulating the emergence and operation of CECs in European countries.

Based on our research findings, we suggest the following thematic entry points for developing policy recommendations:

- Citizen awareness about the potential of CECs is key to their further development. To incentivize such higher awareness, communication campaigns should especially focus on the various benefits created by CECs at the level of individuals as well as local communities, energy systems, and society at large.
- Target setting can fulfil a role to make aspirational levels concrete. To stimulate self-organisation at local and virtual level, it would be helpful if stakeholders receive more guidance what to aim for, how and why.
- Experimentation with new technologies, new business models and new governance arrangements are important features of CECs. To support such experimentation, institutional settings should allow for a maximum diversity of CECs, combined with low levels of regulatory complexity and bureaucracy.
- Setting up and managing CECs requires many different types of knowledge and skills that citizens do not always have themselves. To encourage them to be active in CECs, they need to have more easy access to training and education. Umbrella organisations and service centers could fulfil important roles in this.

The actual policy recommendations will be formulated in D7.3 Policy recommendations.

6 REFERENCES

Andor, M.A., Blasch, J., Milev, I., Mlinarič, M., Niehues, D., Sommer, S., Tomberg, L., & Vermeer, B. (2021). Electricity consumption of members in a newly developed top-down energy

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 837752.

community. Deliverable 5.1 developed as part of the NEWCOMERS project, funded under EU H2020 grant agreement 837752.

Andor, M.A., Blasch, J., Milev, I., Mlinarič, M., Niehues, D., Smole, A., Sommer, S., Tomberg, L., & Vermeer, B. (2022a). Success of interventions to stimulate conservation behaviour and load shifting in new clean energy communities. Deliverable 5.2 developed as part of the NEWCOMERS project, funded under EU H2020 grant agreement 837752.

Andor, M.A., Blasch, J., Cordes, O., Hoenow, N. C., Karki, K., Koch, B. Y., Micke, K., Niehues, D., & Tomberg, L. (2022b). Report on cross-country citizen survey. Deliverable 6.3 developed as part of the NEWCOMERS project, funded under EU H2020 grant agreement 837752.

Barnes, J., Hansen, P., Kamin, T., Darby, S., & Tajnšek, I. (2021) Business models of new clean energy communities: a summary report on the international workshop of the NEWCOMERS project. Developed as part of the NEWCOMERS project, funded under EU H2020 grant agreement 837752,

Barnes, J., & Hansen, P. (2021). Governing energy communities: the role of actors and expertise in business model innovation. In: S. Löbbe, F. Sioshansi, & D. Robinson, Eds. Energy Communities: Customer-centered, market-driven, welfare-enhancing? Elsevier.

Berry, D. (2020). Designing innovative clean energy programs: Transforming organizational strategies for a low-carbon transition. Energy Research & Social Science 67, 101545.

Bevir, M. (2012). Governance: A very short introduction. UK: Oxford University Press.

Birkland, T.A. (2014). An introduction to the policy process: Theories, concepts and models of governing. Politics and International Relations, 3, 12-34.

Blasch, J., van der Grijp, N.M., Petrovics, D., Palm, J., Bocken, N., Darby, S.J., Barnes, J., Hansen, P., Kamin, T., Golob, U., Andor, M.A., Sommer, S., Nicita, A., Musolino, M., & Mlinarič, M. (2021). New clean energy communities in polycentric settings: Four avenues for future research. Energy Research & Social Science 82, 102276.

Blasch, J., van der Grijp, N., Petrovics, D., Palm, J., Darby, S., Barnes, J., Hansen, P., Kamin, T., Kogovšek, T., Medved, P., Andor, M.A., Sommer, S., Niehues, D., Nicita, A., Musolino, M., Tajnšek, I., Drevenšek, M., and Smole, A. (2022). Comparative analysis of country-level and case study results & identification of best practices. Deliverable D7.1 developed as part of the NEWCOMERS project, funded under EU H2020 grant agreement 837752.

Bauwens, T. (2017). Polycentric governance approaches for a low-carbon transition: The roles of community-based energy initiatives in enhancing the resilience of future energy systems. In: N. Labanca, (Ed.), Complex systems and social practices in energy transitions. Framing energy sustainability in the time of renewables. Springer. 119-145.

Brummer, V. (2018). Community energy – benefits and barriers: A comparative literature review of Community Energy in the UK, Germany and the USA, the benefits it provides for society and the barriers it faces. Renewable and Sustainable Energy Reviews 94, 187-196.

Gerlak, A., Heikkila, T., Smolinski, S.L., Armitage, D., Huitema, D. & Moore, B. (2019). It is time to learn about learning: where should the environment and natural resource governance go next? *Society and Natural Resources*, 32, 1056-1064.

Gui, E. M., & MacGill, I. (2018). Typology of Future Clean Energy Communities: An Exploratory Structure, Opportunities, and Challenges. *Energy Research & Social Science 35*, 94–107.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 837752.

Hansen, P., & Barnes, J. (2021). Distributed energy resources and energy communities: Exploring a systems engineering view of an emerging phenomenon. Working paper developed as part of the NEWCOMERS project, funded under EU H2020 grant agreement 837752.

Hansen, P., Barnes, J., & Darby, S. (2022). Final report on clean energy community business models: emergence, operation and prospects of European case studies. Deliverable D4.6 developed as part of the NEWCOMERS project, funded under EU H2020 grant agreement 837752

Haug, C., Huitema, D., & Wenzler, I. (2011). Learning through games? Evaluating the learning effect of a policy exercise on European climate policy. IVM (Institute for Environmental Studies).

Horner, N.C., Shehabi, A., & Azevedo, I.L. (2016). Known unknowns: indirect energy effects of information and communication technology. Environmental Research Letters 11 (10), 103001

Hughes, T.P. (1983). Networks of power: electrification in Western society, 1880-1930. Baltimore: Johns Hopkins University Press.

Huitema, D., Jordan, A., Munaretto, S., & Hildén, M. (2018). Policy experimentation: core concepts, political dynamics, governance and impacts. Policy Sciences, 51(2), 143-159.

Jordan, A., & Huitema, D. (2014). Policy innovation in a changing climate: Sources, patterns and effects. Global Environmental Change, 29, 387–394.

Jordan, A., Huitema, D., & Hildén, M. (2015). Emergence of polycentric climate governance and its future prospects. Nature Climate Change, 5(11), 977–982.

Jordan, A., Huitema, D., Schoenefeld, J., van Asselt, H., & Forster, J. (2018). Governing climate change polycentrically. In: A. Jordan, D. Huitema, H. van Asselt, & J. Forster (Eds.), *Governing Climate Change: Polycentricity in Action?* (pp. 3-26). Cambridge: Cambridge University Press.

Kamin, T., Golob, U., Medved, P., & Kogovšek, T. (2020) Benefits for community members in terms of increased access to clean, secure and affordable energy. Deliverable 6.1 developed as part of the NEWCOMERS project, funded under EU H2020 grant agreement 837752.

Koirala, B.P., Araghi, Y., Kroesen, M., Ghorbani, A., Hakvoort, R.A., & Herder, P.M. (2018). Trust, awareness, and independence: Insights from a socio-psychological factor analysis of citizen knowledge and participation in community energy systems. Energy Research and Social Science 38, 33-40.

Kooij, H.-J., Oteman, M., Veenman, S., Sperling, K., Magnusson, D., Palm, J., & Hvelplund, F. (2018). Between grassroots and treetops: Community power and institutional dependence in the renewable energy sector in Denmark, Sweden and the Netherlands. Energy Research & Social Science 37, 52-64.

Lowitzsch, J., Hoicka, C.E., & van Tulder, F.J. (2020). Renewable energy communities under the 2019 European Clean Energy Package – Governance model for the energy clusters of the future? Renewable and Sustainable Energy Reviews, 122.

Magnani, N., & Osti, G. (2016). Does civil society matter? Challenges and strategies of grassroots initiatives in Italy's energy transition. Energy Research & Social Science 13, 148-157.

McFadgen, B. (2019). Connecting policy change, experimentation, and entrepreneurs: advancing conceptual and empirical insights. Ecology and Society 24(1), 30.

Medved, P., Kogovšek, T., Berzelak, N., Golob, U., & Kamin, T. (2021) Potential of energy communities to increase energy literacy, attitudes, perceptions and support for the energy

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 837752.

transition among members and the general public. Deliverable 6.2 developed as part of the NEWCOMERS project, funded under EU H2020 grant agreement 837752.

Moroni, S., & Tricarico, L. (2018). Distributed energy production in a polycentric scenario: Policy reforms and community management. Journal of Environmental Planning and Management, 61(11), 1973–1993.

Ostrom, E. (2010). Polycentric systems for coping with collective action and global environmental change. Global Environmental Change 20, 550-557.

Palm, J. (2021). Energy communities in different national settings – barriers, enablers and best practices. Deliverable 3.3 developed as part of the NEWCOMERS project, funded under EU H2020 grant agreement 837752.

Petrovics, D., Huitema, D., & Jordan, A. (2022). Polycentric energy governance: Under what conditions do energy communities scale? Environmental Policy and Governance.

van Doren, D., Driessen, P. P. J., Runhaar, H., & Giezen, M. (2018). Scaling-up low-carbon urban initiatives: Towards a better understanding. Urban Studies, 55(1), 175–194.

van der Grijp, N.M., et al. (2019). Theoretical framework focusing on learning in polycentric settings. Deliverable 2.1 developed as part of the NEWCOMERS project, funded under EU H2020 grant agreement 837752.

Walker, G., Hunter, S., & Devine-Wright, P. (2007). Harnessing community energies:explaining and evaluating community-based localism in renewable energy policy in the UK. Global Environmental Politics 7(2): 64–82.

Warbroek, B., Hoppe, T., Coenen, F., & Bressers, H. (2018). The role of intermediaries in supporting local low-carbon energy initiatives. Sustainability, 10.

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Annex 1. NEWCOMERS research propositions and their operationalization in research questions

Local and virtual action

PGT theme	Proposition as formulated in literature	Proposition as formulated in D2.1	Research questions as formulated in D2.3
Local action	Governance initiatives are likely to take off at a local level through processes of self-organization (Jordan et al., 2018)	Place-based energy communities, are likely to take off at a local level through processes of self-organization by citizens.	To what extent do new clean energy communities emerge through local level processes of self-organization? (WP2) What themes emerge from the narratives of how each place-based community formed and developed? (WP4) What actors and technologies are necessary for the emergence and operation of new clean energy communities? (WP4) What distributed energy resources are available to the selected case study communities? (WP4) What responsibilities and obligations towards the electricity system/network do energy communities have now? How might responsibilities and obligations change in the future? (WP4)
Virtual action	(Energy) communities can be organized without being place-based and with a single- or multi-issue focus differentiating between scope of activities (Moroni et al., 2018)	Viable virtual communities are likely to be created, usually in a top-down manner, to deliver benefits to individual participants and to energy systems	What do participants in virtual energy communities gain from membership? (WP4) What objectives are virtual energy communities achieving, and for whom? (WP4) What objectives are difficult to achieve via virtual communities, and why? (WP4) What are the benefits and challenges associated with introducing smart technology

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			to community energy initiatives? (WP4)

Cooperation and mutual adjustment

PGT theme	Proposition as formulated in literature	Proposition as formulated in D2.1	Research questions as formulated in D2.3
Mutual adjustment	Constituent units are likely to spontaneously develop collaborations with one another producing more trusting interrelationships (Jordan et al., 2018)	Energy communities are likely to spontaneously develop collaborations with one another, and engage in processes of mutually adjusting to each other	Are there opportunities for place-based and virtual energy communities to cooperate, for example through federation? (WP2/4) Are place-based and virtual energy communities sometimes in competition for physical resources and members? (WP2/4)

Experimentation, innovation and learning

PGT theme	Proposition as formulated in literature	Proposition as formulated in D2.1	Research questions as formulated in D2.3
Experimen-tation	The willingness and capacity to experiment is likely to facilitate governance innovation and learning about what works (Jordan et al., 2018)	Energy communities' willingness and capacity to experiment is likely to facilitate governance innovation and learning about what works	What pricing structures stimulate generation/storage/load-shifting/conservation within energy communities? (WP5) Which instruments (price-based and/or non-price-based/ behavioral interventions) stimulate conservation and load-shifting behavior (within energy communities)? (WP5)
Innovation	Polycentricity offers potential to generate innovative business models through collaborative community-based governance (Marshall, 2009; Marshall, 2015)	Polycentricity is likely to lead to the emergence of new energy service business models used by energy communities in the	What new energy service business models are emerging in the field of low carbon energy? (WP2) What risks do communities take when they innovate in different ways? (WP4)

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		field of low carbon energy	What are the most (a) likely and (b) desirable alterations in market arrangements in order to open up the range of viable business models for energy communities? (WP4)
Learning		Energy communities are likely to provide opportunities for learning by their members at the cognitive, normative and relational levels	What are the potentials for learning between different polycentric settings? (WP3) What sort of formal knowledge and practical know-how do members need to run energy communities? (WP4) What knowledge and skills of the wider energy system are required for effective operation? (WP4) How much have CSCs learned from the experiments of others? (WP4) How do members interact and learn from one another? (WP4) What can be done to improve learning? (WP4)

Accountability and trust

PGT theme	Proposition as formulated in literature	Proposition as formulated in D2.1	Research questions as formulated in D2.3
Trust building	Trust is likely to build up more quickly when units can self-organise, thus increasing collective ambitions (Jordan et al., 2018)	Trust is likely to build up more quickly when energy communities can self-organise, thus increasing collective ambitions	What forms of trust are building up within energy communities? (WP6)
Forms of trust	--	Trust requires people that are acknowledged to be trustworthy, and rules to safeguard	What are the rules that establish accountability and trust for place-based and virtual energy communities? (WP4)

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		community members if there are breaches of trust (people not behaving in a trustworthy way)	How confident are community members in the rules for each community? (WP4) Does trust take different forms in place-based and virtual communities? (WP4)

Institutional frameworks

PGT theme	Proposition as formulated in literature	Proposition as formulated in D2.1	Research questions as formulated in D2.3
Overarching rules	Local initiatives are likely to work best when they are bound by a set of overarching rules that enshrine the goals to be achieved and/or allow conflicts to be resolved (Jordan et al., 2018)	Energy communities are likely to work best when they are bound by a set of overarching rules that enshrine the goals to be achieved, define or shape processes for achieving them, allow for conflict resolution and set penalties for actions that compromise the effective working of the community	How do national polycentric settings and multi-level patterns of governing influence the emergence of new forms of energy communities? (WP3) What policy and regulatory conditions promote the emergence and continuance of effective new clean energy communities, place-based and virtual? (WP4) What responsibilities and obligations towards the electricity system/network do energy communities have now? How might responsibilities and obligations change in the future? (WP4)

Value creation and distribution: propositions, research questions and focal areas

PGT theme	Proposition as formulated in literature	Proposition as formulated in D2.1	Research questions as formulated in D2.3
Value creation and distribution	In a polycentric system of governance, actors will come up with their own innovative solutions to generate	Energy communities are likely to generate value for their members	Does membership in an energy community have an impact on household electricity consumption patterns of members? (WP5)

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	values for local communities and society (Bryson *et al.*, 2016)		How do new forms of energy community meet their members (i.e. consumers' and citizens') needs for clean, secure and affordable energy in their everyday life settings (existing values and practices)? (WP6) Which values, namely self-oriented, other-oriented, extrinsic, intrinsic (for example functional, economical, emotional, social, ecological) related to the new forms of energy communities do members perceive in relation to the alternative energy service models? (WP6) What are the relative advantages of new clean energy communities for energy communities' members? (WP6)
		Energy communities are likely to generate value for local communities	--
		Energy communities are likely to generate value for energy systems	What are the energy outcomes and distributional outcomes from the different case study communities? (WP4) What pricing structures stimulate generation/storage/load-shifting/conservation within energy communities? (WP5) Which instruments (price-based and/or non-price-based/ behavioral interventions) are successful in stimulating conservation and load-shifting behavior

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			(within energy communities)? (WP5)

Diffusion and upscaling: propositions, research questions and focal areas

Theme	Proposition in literature	Proposition in NEWCOMERS	Research questions
Potential for upscaling / Transfer of knowledge, skills, and practices	Up-scaling can take form in horizontal and vertical pathways – the former describing spatial expansion and the later institutional embedding (van Doren et al., 2018). Understanding the interactions of actors within a system of polycentric governance may offer the means to identify why certain initiatives were successful.	Transfer of knowledge and skills between and within energy communities and through intermediaries is likely to enhance the potential for upscaling, both in horizontal and vertical pathways	How replicable/ scalable are the different CSCs likely to be? (WP4) To what extent are horizontal and vertical pathways to up-scaling of CSCs possible? (WP4) What knowledge and skills, needed by energy communities, are most easily transferable, and which are most challenging? (WP4,6) How specific are different types of knowledge and skills to particular places? (WP4,6)

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