

# Analyzing grassroots innovations in community energy from a system thinking perspective

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## Abstract

Community energy cooperatives (CECs) have been recognized for setting up democratically governed and decentralized renewable energy systems through community engagements. CECs also take up a range of initiatives to support energy transition and climate actions.

However, in the last five years, due to the withdrawal of subsidies and Feed-in-Tariff (FIT) incentives in the UK, CECs have applied different grassroots innovations to remain economically viable and achieve their objectives.

This paper aims to study grassroots innovations in the UK's community energy sectors through a system thinking perspective and analyze underlying issues and mental models that guide CEC's action towards grassroots innovations. The paper also recommends creating a conducive environment for grassroots innovations within the UK's community energy sector.

**Keywords:** community energy, energy transition, ecosystem, grassroots innovations, intermediary, system thinking

## 1. Introduction

CECs, through citizen engagements, set up renewable energy systems and involve in a wide range of sustainable development initiatives. Community energy projects are democratically governed and permit citizens to control their energy sources. CECs play a significant role in the sustainable transition by offering decentralized renewable energy systems and consumer-focused energy services (Caramizaru & Uihlein, 2020). In their action to support sustainable development, CECs create grassroots innovation and perform local experimentation within their ecosystem (Smith et al., 2016). Overall, CECs focus on social, economic, and environmental benefits for local communities by generating localized energy, avoiding dependency on large utilities, and help retaining energy revenue within the community (Becker, Kunze, & Vancea, 2017; Huh, Yoon, & Chung, 2019).

However, CECs face multiple challenges to strive and remain economically viable. The absence of supportive policy, government subsidies, and high entry barriers to energy markets has limited the ability of CECs to scale up (Smith et al., 2016). Additionally, the centralized institutional arrangements and market-driven economy make project funding for CECs in the UK more difficult (Huh et al., 2019). The FIT incentive scheme provided the much-needed impetus to community energy projects in the 2010s, resulting in the UK's community energy sector growth. However, the number of community energy projects

started falling after April 2019 in the UK, when community energy projects were no longer eligible for the FIT scheme.

Under the government's unfavorable and top-down policy enactment, the intermediary organizations play an important role in supporting community energy development in the UK. Intermediary organizations are part of the CEC business ecosystem and empower niche CECs to unlock their true potential in the energy transition process (Bush et al., 2017). Intermediaries are represented by different actors, such as citizen groups, trusts, or non-profit organizations (Seyfang et al., 2014). Intermediaries are umbrella organizations who support CECs with development and administrative services at the local level (Community Energy England, 2018).

Because of market-oriented and unfavorable UK policies, the CECs collaborate with intermediaries who are part of community energy business ecosystems (Acharya & Cave, 2020). Notwithstanding the adversity the CECs face in the UK, the community groups are willing to collaborate and work with city councils and local authorities to address the climate emergency. The outlook of CECs remains positive in the UK without depending on government funds and grants, and they are willing to develop innovative solutions. Acharya and Cave (2020) highlighted that CECs apply entrepreneurial and innovative business practices such as (1) working in a shared ownership model, (2) exploring innovative funding schemes, and (3) creating innovative business models.

This paper aims to analyze grassroots innovations in the UK's Community energy sector from the perspective of system thinking (ST). Using a conceptual lens of ST, we aim to observe and discern patterns of grassroots innovations that CECs across the UK apply to overcome the challenges faced in the UK's energy transition pathway.

Section 1 briefly discussed the role and offerings of community energy and the challenges faced by CECs in the energy transition pathways. In section 2, we discuss the methodology used in this paper. In section 3, we discuss the grassroots innovations concept, its relevance in the community energy sector, elements of the innovation ecosystem, and their interactions. Section 4 discussed the ST approach and why it should be applied to study grassroots innovations in the community energy sector. In section 5, using the ST iceberg model, we observed patterns of grassroots innovations and discussed the underlying structure and mental model of the community energy sector in the UK. Section 6 highlighted emerging patterns of grassroots innovations, underlying issues, and mental models and made recommendations to create a conducive environment for grassroots innovations to thrive.

## 2. Materials and Method

The paper is based on a literature review of the community energy sector articles published within the last five years. The literature review helped us summarize the key challenges and barriers faced by CECs under the present policy landscape. The study was confined to secondary sources of information from peer-reviewed papers, publications, and reports on the UK's community energy sector and intermediary organizations. First, the paper discusses the GI concept and its relevance in community energy, key activities, and the ecosystem. Second, the ST approach and its applicability in sustainability, then we used the ST iceberg model to analyze the emergence of GIs in the community energy sector.

### 3. Grassroots Innovation

#### 3.1 Concept

Grassroots Innovations (GI) emerge from networked activities for bottom-up solutions to support sustainable development. Therefore, GI is a collective and social value creation process driven by social links of local communities and their interactions aimed at building capacity and empowering other actors who are part of this network (Feola & Nunes, 2014; Seyfang & Smith, 2007). Seyfang et al.(2014) suggested GIs have a noticeable difference from market-based innovations (a) their driving force is a social and environmental need rather than rent-seeking, (b) their context is civil society rather than the market economy, (c) they support local and collective value creation rather than profit-seeking, (d) display diverse organizational forms like cooperatives, voluntary and community initiatives, rather than firms and (e) their resource base is voluntary input, grant funding, etc. rather than business loans and commercial income.

Grassroots innovations emerge when existing systems and practices fail to address the community's needs. GI arises through systematic experimentation or trial and error as part of an effort to create a bottom-up solution (Gupta, 2013). According to Feola and Nunes (2014), local contextual factors and matters related to geographical roots play an essential role in the success of GI. Although GIs arise from a local situation and are driven by the interest and values of the local communities involved (Seyfang and Smith, 2007), however, GIs can be replicated across different regions with the help of a) networking, b) intermediary agents, and d) shared learning (Hossain, 2016). GIs have intrinsic and extrinsic benefits; niche practices, as part of the intrinsic benefit, can bring radical changes alternative to the mainstream regime. The extrinsic benefit is the diffusion of niche practices to the mainstream (Seyfang and Smith, 2007).

However, upscaling and diffusion of GIs face multiple barriers: lack of policy support, funding issues, and centralized institutional arrangements. Using a systemic literature review approach, Hossain (2016) observed that community energy, co-housing, agriculture, and organic food are dominant sectors where grassroots innovations are prevalent. This paper is anchored around GI activities in the UK's community energy sector.

#### 3.2 GIs in Community Energy

Community-led renewable energy projects emerged in the 1980s; however, only in the mid-1990s UK government recognize the importance of community activities in developing alternate energy sources. In the last three decades, the UK government has liberalized the energy sector by creating new markets and allowing a space for community energy groups to contribute through experimentation and capitalize on available opportunities in the sector (Braunholtz-Speight, 2018).

According to Seyfang et al. (2014), CECs act as grassroots innovation niches involving multiple technologies, social institutions, and business models. CECs cover a range of sustainable activities, including energy generation and conservation projects, upgrading home insulations, and supporting behavior change for a low carbon lifestyle. CECs, as a niche, bring in new ways of doing things to survive and grow that include exploring

alternative financing mechanisms, creating new institutional arrangements, and promoting change in the social and cultural practices for technology use (Braunholtz-Speight, 2018). CECs, as part of grassroots innovations, use diverse organizational forms, technology, skills, and infrastructures to challenge dominant incumbent regimes (Smith, 2016).

### 3.3 Activities Involved

Post FIT withdrawal in April 2019, CECs in the UK are involved in business model innovation activities to survive unfavorable policy contexts (Nolden et al., 2020). In contrast to traditional cooperative-based structures, CECs apply entrepreneurial and innovative practices to explore new business models. CECs' new business models include (a) large commercial scale solar farms; (b) power purchase agreements, and (c) energy-related services to secure new revenue streams; CECs use (a) collaboration and partnership, (b) new financing models, and (c) innovation and shared knowledge to support new business models (Acharya, 2020). In their actions, CECs demonstrate agility and resilience in the wake of frequent policy changes and changing economics; CECs collaborate with intermediaries to overcome market barriers and improve their business economics in a post-subsidy free environment (Nolden et al., 2020).

Compared to other European countries, the CECs in the UK are entrepreneurially inclined. CECs in the UK operate in hybrid organizational structures such as CBS (Community Benefit Societies) and CIC (Community Interest Company); such a hybrid structure provides agility and resilience to explore new business opportunities. Community Energy England (2018) reported CBS is the most dominant form of organization structure used by 47% of CECs, while just 19% CECs were bona fide cooperatives. CBS secures private funds by issuing membership shares to investors instead of relying on public funds and grants; the CBS model focuses on benefiting a wider community rather than its members (van Veelen, 2017). To overcome the limitation of the bona fide cooperative structure, in 2014, the UK's Financial Conduct Authority (FCA) mandated that all new CECs follow a CBS model (Community Energy England, 2018).

The CBS model helps CECs promote entrepreneurship in a democratic way where members are given voting right in the decision-making process. On the other hand, the CIC-based organizations are social and environmental mission-driven, aim to serve wider communities, and can reinvest their profits in new geographic locations; at the same time, their assets remain locked (Hiteva & Sovacool, 2017).

Under the UK's market-driven policy landscape, access to easy project financing and the higher cost of raising capital are significant barriers to community energy growth (Community Energy England, 2018). Community Energy England reported that in 2018, out of 69 stalled projects, 15 projects were delayed due to inaccessibility to low-cost project financing (Community Energy England, 2019). However, in the last 2-3 years, CECs have started exploring innovative financing schemes. CECs in the UK collaborate with social enterprise banks such as Triodos bank to explore crowdfunding platforms based on innovative financial schemes to attract small and retail investors for project funding and, in return, provide tax-free interests to investors (Acharya & Lisa, 2020).

### 3.4 Ecosystem

An innovation ecosystem consists of actors, activities, artifacts, institutions, and their relations that collaborate, complement, and co-evolve to create shared value rather than competing or substituting each other (Granstrand & Holgersson, 2020). The sustainability-related ecosystem comprises people, organizations, policies, and processes working towards a joint mission of improving sustainability (Chan, 2018). Sustainable innovation ecosystems are citizen-centric, promoting citizen engagements and allowing grassroots participation in decision-making (Taratori et al., 2021). In the wake of rapidly changing energy sector policies, the CECs in the UK continue to innovate through new technologies, business models, and partnerships. CECs, along with intermediaries and key sector stakeholders like local authorities, industry organizations, commercial developers, and energy experts, work as an innovation ecosystem to ensure CECs can contribute with maximum value to the ongoing energy transition (Community Energy, 2020). In 2019, 47 CECs collaborated with technology providers to explore low-carbon transport projects; around 90% focused on electric vehicle projects, including community transport, and charging infrastructure (Community Energy, 2020). CECs are exploring innovative business models in energy-related services such as demand-side response, local energy supply, and peer-to-peer (P2P) trading with a variety of partners, including Distribution Network Operators (DNOs), technology start-ups, universities, local authorities (Community Energy, 2019).

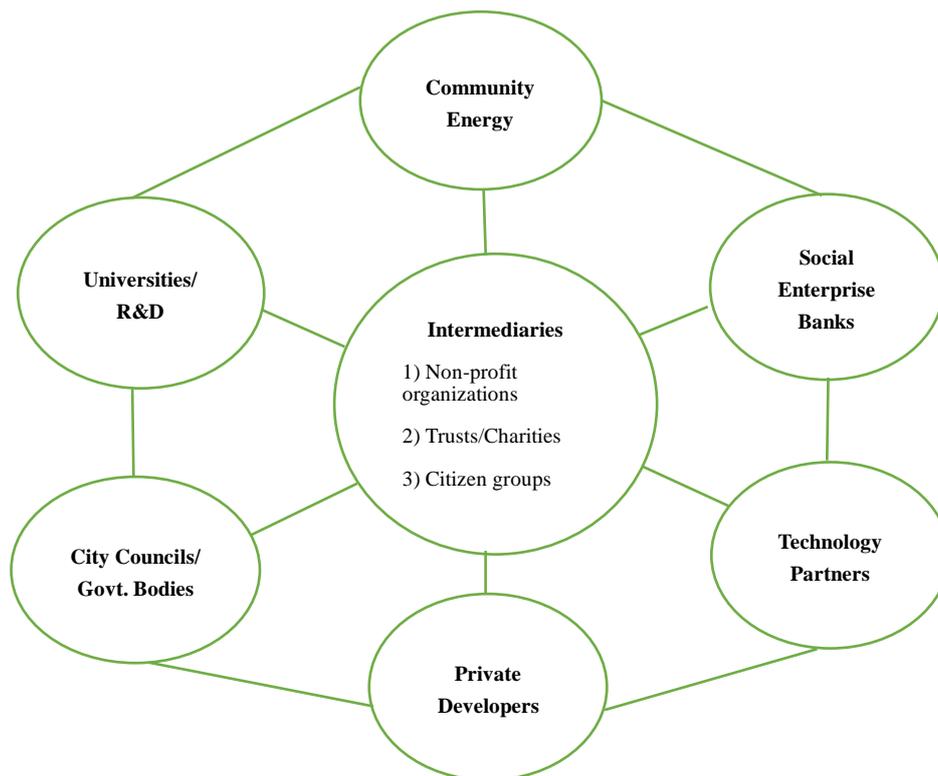


Figure-1 (Grassroots Innovation Ecosystem in community energy sector)

Intermediary actors take center stage within the ecosystem and play a key role in facilitating and brokering complex business models on behalf of CECs. In their action to brokering and managing partnerships, these intermediary actors provide legal, commercial, financial, and

technical assistance to set up community projects driven by complex revenue models (Nolden et al.,2020). Intermediary organizations manage shared knowledge and grassroots information effectively. As part of strategic niche management, intermediaries consolidate the learnings flowing ‘up’ from the grassroots level and repackage it into ‘downward’ transferrable knowledge to help new projects (Seyfang et al., 2014). in this way, they aggregate learning and resources to help replicate projects in new locations and influence policymakers to adopt niche ideas and practices. In the post-subsidy environment, intermediaries improve economic viability and create localized energy markets by reducing/sharing risks, enabling CECs to benefit in these localized energy markets (Nolden et al.,2020).

#### 4. System Thinking approach

ST is a strategic tool used to study archetypes of organizations or human groups by observing their behaviors over time under the influence of underlying structures. ST involves observing events to identify patterns of behaviors that, in turn, help us surface underlying structures responsible for changed behaviors. By understanding and correcting those not supportive structural issues, we can create long-term solutions to complex problems (Goodman, 1997). According to Arnold and Wade (2015), the ST is an analytic skill used to improve the system capability by identifying and predicting their behaviors and carrying out modifications within the system to improve performance. ST approach is applied to a critical and recurring problem with known history (Goodman, 1997).

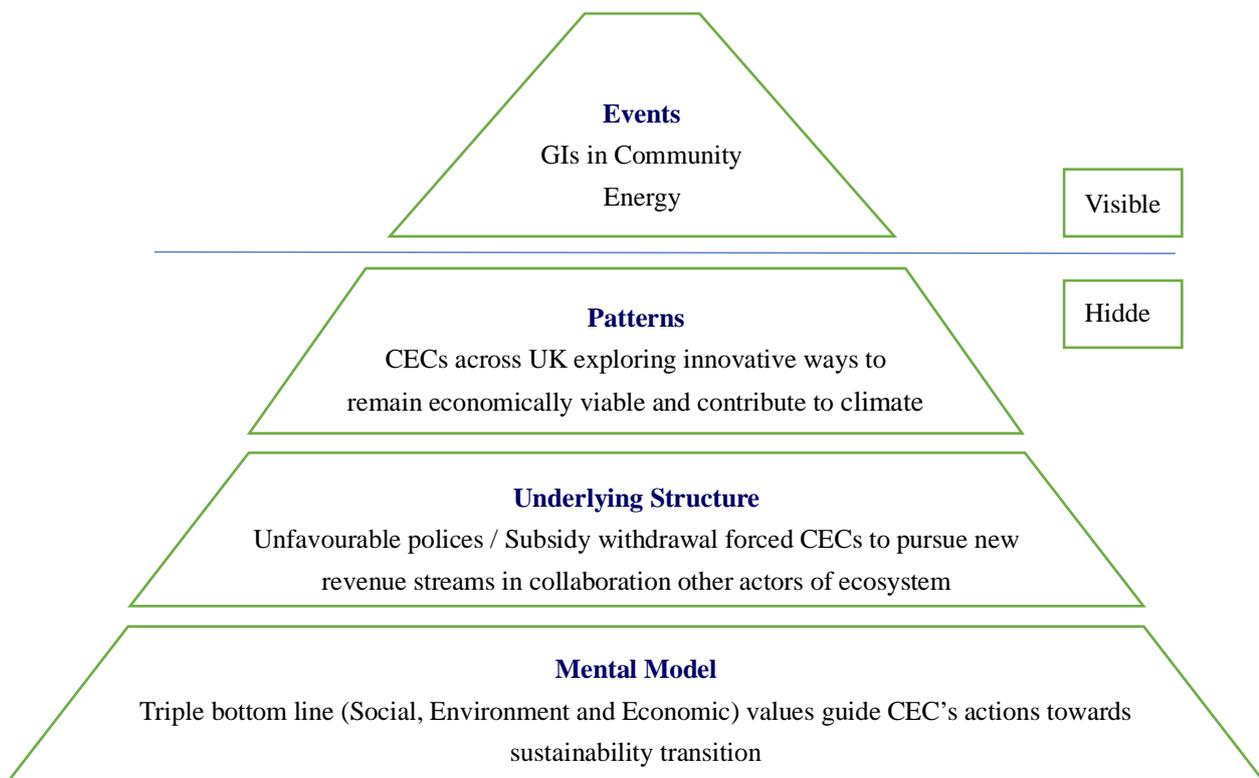


Figure-2 (System thinking iceberg model for community energy sector)

Proponents of ST have highlighted limitations in conventional or myopic thinking, which is based on reductionism, and argued it is ineffective in solving complex problems. According to Reynolds and Holwell (2020), conventional thinking has the following limitations- a) ignores interconnections between variables, b) does not understand how a situation arises, and c) focuses on outcome rather than the process required to resolve the issue. In contrast to reductionist or myopic thinking, which considers humans are separate from nature and need to control it for survival, ST posits humans evolved from nature and are inextricably linked to it (Seibert, 2018). According to Reynolds et al. (2017), ST provides a space for experimentation and innovations through conversation and cooperation required for sustainable development goals. Therefore, ST is the ideal problem-solving tool for sustainability. ST looks into the future, thinks beyond the present, values collectiveness between humans and non-humans, and scans deeper below the surface to understand underlying things (Seibert, 2018).

## 5. Discussion

This paper discerns emerging patterns and analyzes underlying issues and mental model leading to grassroots innovations in the UK's community energy sector using the ST iceberg model (Figure-2). By identifying and discussing underlying issues, this paper also makes recommendations for necessary corrections to support the community energy sector's growth across the UK and enable them to play an effective role in sustainability transition and climate action. According to UK Government's net-zero strategy (2021), 424 active CECs across the UK have the potential to contribute to a net-zero future if appropriately supported; the CECs can generate 5,270 MW, support 8,700 jobs and add £1.8 billion to the economy each year. Like other EU countries such as Germany, Denmark, and the Netherlands, in the wake of the climate emergency, the UK also witnessed an increased interest in community movement intending to set up local energy systems and provide energy justice through locally embedded innovative and entrepreneurial practices.

In the last five years, CECs have been moving away from subsidy and FIT-based business models to innovative business models entrepreneurially inclined and driven by shared knowledge. Large scale solar farms in partnership with private developers to increase the volume of operation and Power Purchase Agreements (PPA) with local authorities to have a long-term revenue stream are among new business models being practiced by CECs across the UK (Nolden et al., 2020). Faced with upscaling barriers and the high cost of capital funds, CECs reorient themselves in innovative institutional arrangements. The new organizational forms such as split structures and networks of organizations are evident in UK's community energy sector. In this split structure, community groups own local assets, while the asset manager, usually a CIC organization, takes up governance and energy generation (Community Energy England, 2018). Another innovative organizational form in the UK represents a network of organizations consisting of several community groups; these help communities set up their energy cooperatives, arrange capital funds, and provide business support services (Caramizaru & Uihlein, 2020). These institutional arrangements help CECs distribute their risks and remain profitable (Caramizaru & Uihlein, 2020). Such hybrid institutional forms have emerged as a preferred choice in the UK (Hewitt et al., 2019).

Emerging GI patterns across the UK are shown in table 1.

Table 1 (Emerging patterns across the UK)

<b>Grassroots Innovation- Patterns</b>
<p><b>New Organization forms</b></p> <ol style="list-style-type: none"> <li>1. Split structure (anchor asset owned by communities / asset manager a CIC organization)</li> <li>2. Networked organizations (community groups connected)</li> <li>3. Shared ownerships (community groups and private developers)</li> </ol>
<p><b>New Business Models</b></p> <ol style="list-style-type: none"> <li>1. Commercial scale solar farms in partnership with private developers</li> <li>2. PPA contracts at pre-agreed tariff with local authorities / schools</li> <li>3. Local energy clubs to aggregate local renewable energy within communities</li> <li>4. EV charging infrastructure</li> <li>5. Shared low carbon transportation within communities</li> </ol>
<p><b>New Ways to Raise Capital</b></p> <ol style="list-style-type: none"> <li>1. Exploring crowdfunding platforms</li> <li>2. Collaborating with banks to attract small investors in community projects</li> </ol>

European countries saw the onset of the community energy movement in the 1990s; however, its growth remains asymmetric among different European countries, mainly due to country-specific policies and energy market configuration (Hewitt et al., 2019). Around 3500 energy communities are active across Europe, most of them located in Germany (1700), Denmark (700), Netherlands (500), and the UK (400+) (Caramizaru & Uihlein, 2020). Germany and Denmark have decentralized and support-oriented policies for community energy sectors to develop a coordinated energy market for community groups. In Contrast, the UK, and the Netherlands, driven by neo-liberal ideas, develop market-driven policies and expect community groups to be innovative and enterprising to survive in the competitive market (Creamer et al., 2018). Denmark and Germany have decentralized institutional arrangements and involve community groups in policy making as part of bottom policy support compared to the UK, which considers top-down policymaking. The centralized institutional arrangements and competitive energy markets are the main barriers to the UK's community energy sector growth (Simcock, Willis & Capener, 2016).

With a focus on energy transition targets, the UK used market-driven instruments such as Renewable Obligations (RO) and Contract for Difference (CfD) to develop large-scale renewable energy systems. Such instruments were beneficial to big energy companies having larger generation capacity and higher risk appetite (Strachan et al., 2015). In contrast, market-driven policy instruments are not beneficial to community groups. CECs do not high capital funds and usually have a lower generation capacity (below 5 MW) and lower risk appetite (Curtin et al., 2018). Another barrier is policy gaps due to the centralized and top-down policymaking in the UK. As part of grassroots initiatives toward energy transition, the local authorities and city councils take up bottom-up initiatives to fill in top-down policy gaps. As

local authorities are knowledgeable about local issues and available resources, therefore can effectively support bottom-up initiatives (Caramizaru & Uihlein, 2020). The underlying structure covering UK’s community energy sector’s challenges and barriers are shown in table 2.

Table-2 (Underlying Structure)

<b>Grassroots Innovation- Underlying Structure</b>
<p><b>Centralized &amp; top-down policy making</b></p> <ol style="list-style-type: none"> <li>1. Centralized institutional arrangements</li> <li>2. Policy gaps (incoherent policies for community energy)</li> <li>3. Withdrawal of subsidies / FIT incentives</li> </ol>
<p><b>Market driven policies</b></p> <ol style="list-style-type: none"> <li>1. High entry barrier to energy market due to market-based instruments</li> <li>2. Higher cost of raising capital</li> <li>3. Market failures due to negative externalities (Competing with fossil-based energy)</li> </ol>
<p><b>Shortage of skilled professionals</b></p> <ol style="list-style-type: none"> <li>1. Lack of business acumen</li> <li>2. No prior energy sector experience</li> </ol>

CECs are mission-led and locally focused, and the altruistic values of individual members drive community energy activities. In their offerings, CECs bring positive social changes to their local communities and create multiplying impacts by re-investing their profits back into society. CECs focus on providing cheap and sustainable energy to local communities and take up a wide range of initiatives to change citizen behaviors on energy use and climate actions. Researchers have used a sustainable entrepreneurship framework based on a triple bottom line approach to study community energy actions and motives. Acharya (2020) used the sustainable entrepreneurship framework to study UK’s community energy sector and found that CECs are mission-led not-for-profit organizations that aim to maximize social, environmental, and economic values through citizen engagement. Using the qualitative case study method, Acharya (2020) identified five themes that CECs use to maximize social, environmental, and economic values are (a) purpose-driven aim to multiply social impacts, (b) collaborative, (c) opportunity realizing, (d) growth-focused, and (e) innovative. In the UK, CECs set up community benefit funds and re-invested a portion of their profit back to local communities to bring about positive social changes by promoting low carbon technologies and energy efficiency practices (Community Energy England, 2018). Community benefit funds increase awareness of energy conservation and are used in energy efficiency upgrades for community buildings (Community Energy England, 2019). A mental model for CEC’s actions and behaviors driven by a triple bottom line approach of social, environmental, and economic value creation is shown in table 3.

Table-3 (Mental Model)

<b>Grassroots Innovation- Mental Model</b>	
<b>Social values</b>	<ol style="list-style-type: none"> <li>1. Provide democratically governed energy systems</li> <li>2. Setup community energy funds to multiplying social impacts</li> <li>3. Increase awareness on low-carbon lifestyle</li> <li>4. Address fuel poverty</li> </ol>
<b>Environmental values</b>	<ol style="list-style-type: none"> <li>1. Generate renewable energy</li> <li>2. Contribute to climate actions</li> <li>3. Work on energy conservation and energy efficiency</li> </ol>
<b>Economic values</b>	<ol style="list-style-type: none"> <li>1. Provide low-cost electricity and avoid grid dependency</li> <li>2. Retain energy revenue within the community</li> </ol>

## 6. Conclusion

This paper discerned emerging GIs patterns and analyzed underlying issues and mental model leading to GIs within the UK’s community energy sector. The paper highlighted emerging GI patterns across the UK, covering innovative and entrepreneurial activities such as new organizational forms, innovative business models, and new ways to raise low-cost capital. The paper discussed the importance of an innovation ecosystem where CECs, with the help of intermediary organizations, collaborate with other ecosystem actors, including universities, social enterprise banks, technology partners, private developers, and local authorities. The paper identifies underlying issues such as a) centralized and top-down policymaking, b) market-driven policies, and c) shortage of skilled professionals are the main barriers impacting the growth of CECs in the UK. By acknowledging the mental model for CEC’s actions based on a triple bottom line approach of social, environmental, and economic value creation, the paper makes three recommendations to create a more conducive environment for GIs to thrive and upscale. First, the UK government should adopt a decentralized approach to community energy policymaking. Second, policymakers should involve local authorities, intermediaries, and other ecosystem actors in decision-making to avoid incoherence and policy gaps. Third, use the community energy sector as a vehicle to connect with local communities as part of the long-term net-zero strategy.

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