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Citizen energy lost in sustainability transitions: Knowledge co-production in a complex governance context

Jani P. Lukkarinen [a,*], Miikka Salo [b], Maija Faehnle [a], Heli Saarikoski [a], Sampsa Hyysalo [c], Karoliina Auvinen [a], Satu Lähteenoja [c], Tatu Marttila [c]

[a] Finnish Environment Institute, Finland
[b] University of Jyväskylä, Finland
[c] Aalto University, Finland

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ABSTRACT

Countries are moving towards renewable energy systems, which creates new requirements and pressures for the established energy policy frameworks. One emerging issue is citizen energy production in community level that has been given a central role also in recent policy reforms in the EU. However, one understudied topic is how the decision-making and action in the existing and potential citizen energy communities connects to broader energy governance. In this paper, we focus on one such type of actor, housing companies in Finland, in which mobilising collective energy action has become a policy priority. We build empirically and methodologically on a facilitated knowledge co-production process utilising mid-range transition arena method to understand the main challenges in engaging citizen energy action in the Finnish policy context. The process was organised with central government authorities, and it involved a diverse mix of stakeholders from housing companies, business, knowledge production and different levels of administration. The analysis shows how different types of knowledge from system knowledge to target knowledge and transformative knowledge are generated in transition arena process, and how the shared production of knowledge increases on each step, which is necessary for drawing systemic lessons in sustainability transitions context. Therefore, we learn that the enhanced role of citizen energy communities requires active and simultaneous coordination of multiple policy pathways, illustrated as digital information, policy coordination, energy service and neighbourhood collaboration pathways. We also conclude that the traditional roles given to citizen energy agency become transformed and require more nuanced conceptualisation.

1. Introduction

Energy transitions towards low-carbon energy systems are needed in order to reach climate change mitigation targets, which can be achieved by following centralised and dispersed trajectories [1]. It is a matter of policy making to enable different development pathways and their societal embedding. Traditionally, in centralised energy systems, citizens have been positioned as consumers of energy, but this passive role is widened by the concept of energy citizenship, which emphasises the rights and responsibilities of citizens in the energy system [2]. Distributed low-carbon energy technologies such as solar panels and heat pumps can be deployed in houses, allowing people to become prosumers, meaning proactive consumers that possess assets for local energy generation, conversion and/or storage capable of also producing energy [3,4]. The energy citizenship literature presents citizens as central actors who can contribute to increasing energy security [5], addressing different types of injustices [6], boosting sustainable innovations and market developments [7], and also halting the placement of harmful fossil energy projects in their localities through protesting and stalling [8]. Citizen energy is a contested concept, with multiple complementary definitions that constantly evolve in the literature [9].

In the European Union, the Clean Energy Package with revised directives has created a framework for the member states to provide stronger legislative support for citizen engagement in community-level energy actions [10,11]. These regulatory reforms are geared towards transforming the operational conditions for active, efficient and inclusive citizen-led energy communities to emerge in diverse contexts [12–14]. More specifically, the market access rules and the information

* Corresponding author.
E-mail address: jani.lukkarinen@syke.fi (J.P. Lukkarinen).

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supporting the distributed energy producers have been improved [10]. The legitimacy of the EU policies on renewable energy, energy efficiency and market reforms is considered to be improved by enabling citizen energy action at the community level [15].

Finland has laws for phasing out coal in energy production by 2024 and achieving carbon neutrality by 2035 [16]. Together with the EU policies, these targets have created favourable conditions for more explicit policies to support distributed renewable energy production by energy communities. Earlier, this was an overlooked area in the Finnish national energy governance, which traditionally had tight connections with heavy industry, allowing dominance by corporatist interests favouring centralised energy production [17–20].

Along with the EU policy reform enabling citizen energy action, especially housing companies were identified in Finland as being in need of policy actions to remove regulatory barriers. The Smart Grids working group introduced by the Finnish government evaluated the technical and regulatory challenges for community energy production [21]. In Finland, jointly owned housing companies - equivalent to housing co-operatives, condominiums and homeowner associations in other countries - are an important segment of housing administration [22], as about half of the Finnish population of 5.5 million, consisting mostly of low-to-mid income class people, live in more than 90,000 housing companies. Therefore, the housing companies are important as potential energy communities in the changing governance of urban energy systems [23]. However, housing companies have proved to be a difficult segment for market-based emergence of novel low-carbon energy solutions, services and practices [24–25]. Although new policies have focused on promoting energy actions by removing regulatory barriers for establishing energy communities and promoting building retrofits [19,26,27], energy service market actors have neglected their promotion to housing companies due to the complexities and challenges in, e.g., their decision-making.

The aim of our research is to better understand how citizen energy action, and novel energy communities in the case of housing companies, could be better enhanced with policy interventions in the ongoing energy transition [22], and to draw lessons from knowledge co-production. We made these inquiries in the transition arena [18,28] process that was carried out in spring 2020 in collaboration with two key ministries – the Ministry of Economics and Employment and the Ministry of the Environment – responsible for implementing the new renewable energy and energy efficiency policies in Finland. The policy coordination between these ministries on overlapping issues of energy production and the built environment has remained fragmented. The transition arena involved stakeholders with complementary practice-based understanding on e.g., housing company decision-making, technology development, energy system dynamics, urban governance, knowledge distribution and policy implementation. The main task of the arena was to identify enabling and constraining factors for increasing citizen energy communities in housing companies based on on-site low-carbon energy solutions, and to co-create transition pathways to inform policy making on how to advance such community energy projects.

To guide our analysis, we formulated the following research questions:

- What kinds of system, target and transformation knowledge are co-produced in the transition arena promoting citizen energy communities in housing companies?
- How do the citizen energy roles in transitions become defined in the knowledge co-production process?

By answering these questions, we aim to iterate how the ideas of energy citizenship are picked up, stretched and mutated in the policy-relevant dialogues on low-carbon energy transitions in the Finnish policy context. In this study, we focused on citizen energy roles in the collective envisioning of the sustainable energy transitions [29], and utilised the framework of target, system and transformation knowledge to systematise different steps from knowledge claims to collective framing of citizen energy actions [30].

The article is structured into six sections. Next, we elaborate concepts of citizen energy action and community energy in the housing company context. In the third section, we outline our methodological considerations building on literature related to transition management and knowledge co-production. Section four outlines our results, while the final two sections discuss the implications and provide conclusions.

2. Energy citizenship and citizen energy action concepts in the literature

The concept of energy citizenship emphasises aspects of public awareness and responsibility for climate change, attention towards equity and justice, and potential for collective actions [9]. Mullally et al. identified voting, formal participation through established institutions and more direct discursive action as modes of performing energy citizenship in democratic systems [31]. Furthermore, the concept is connected to multiple definitions of energy democracy ranging from descriptive perspectives of decentralised bottom-up energy initiatives to normative perspectives of sharing control over energy policies and means of production in society to make better policy decisions [32]. Whereas the energy democracy discourse emphasises social movements and political action, another branch of literature focuses on citizen roles that are grounded in diverse aspects of mundane everyday practices, such as cooking, washing clothes and entertainment, carrying implications to temporalities and functioning of the energy system [33]. The notion of energy citizenship has been criticized to remain largely as an "empty container" that has not developed into a consistent and tangible concept with broader relevance [34].

Citizens have major roles in technological innovation, adaption, creation of new practices, intermediation and market creation, especially related to housing energy systems. These have strongly affected the technical and social development and mass-market uptake of low carbon technologies, such as heat-pumps, pellet burning systems, solar PV and solar heat [35–45]. Regardless of the diverse analytical and political connotations, the main questions concerning citizen energy often turn out to be material, contextual and practical [36,46].

For collective citizen energy action, energy community is a key concept that carries several important analytical dimensions but has gained a variety of meanings especially regarding what is ascribed as a community and what are considered as pursued objectives [9,p. 11]. First, there is a wide range of energy communities that can be distinguished as place-based or non-place-based as well as single-purpose or multiple purpose initiatives depending on their spatial form or technological approach [47]. For example, a shared neighbourhood-level electricity micro-generation based on solar-PV or wood pellet production would be a place-based single-purpose initiative. However, technology development and digital applications have led to the emergence of roles and forms of energy communities beyond traditional frameworks [48]. For example, energy internet and blockchain technologies enable imagining more radical and commons-based energy communities that challenge contemporary political structures and means of distributing resources [49]. Second, to accommodate this multiplicity, the emergence of community energies can be approached as a process (e.g., closed or open to new entrants) and outcome (e.g., private or shared collective) [50]. More broadly, community energy is a form of civil society organisation foregrounding cultural changes considered crucial for the sustainability transitions [51,pp. 10–11].

Finally, community energy developments are not solely about energy, as they include more varied discussions about the implications of being members of a community, including learning new daily routines and sharing responsibilities and risks related to technologies in everyday contexts [52]. In our analysis, citizen energy gains substance and form through a collective community-level agency that is much more nuanced than the roles of individual producer, consumer or prosumer.

Bauwens et al. concluded in their recent review of community energy that the literature has been shifting from process-based community definitions to place-based definitions, from political definitions to economic definitions and from transformative action to incremental action [9]. These changes coincide with a growing focus on smart energy systems that are changing the peer-to-peer dynamics and role of economic rationality in community energy action [53]. Housing companies can be considered as existing place-based communities that have an autonomy to make decisions regarding energy production, consumption and management. They are often materially connected to urban district heating and cooling networks and nationally managed energy grids. Therefore, there is a broader network of actors influencing their energy community action. Other factors influencing the operational space of housing companies are ownership models and geographical locations.

3. Methodology: co-production of knowledge for transitions

3.1. Transition arenas as knowledge co-production processes

Low-carbon energy transitions consist of multiple simultaneous and differentiating socio-technical pathways and imaginaries. Their societal embedding is urgently needed in order to reduce greenhouse gas emissions, which calls for action-oriented transdisciplinary research orientations [54]. New knowledge is needed to create a basis for wider understanding of the necessary societal transformation beyond incumbent techno-economic viewpoints. Co-production methodologies are needed to bring in different forms of administrative, scientific and practice-based knowledge. Based on wide empirical evidence, Chambers et al. recently identified six generic, mutually non-exclusive modes of co-production that specify the core objectives, namely researching solutions, empowering voices, brokering power, reframing power, navigating differences and reframing agency [55]. Furthermore, to ensure trans-disciplinarity of knowledge co-production processes, Norström et al. illustrated context-based, pluralistic, goal-oriented and interactive as four core principles which have to be considered in research design [56]. The primary aim of such transdisciplinary processes is to enhance the conditions for change in empirical contexts and between different actor perspectives [57]. These transdisciplinary knowledge co-production approaches provide researchers with reflexive tools to implement research interventions with increasing policy relevance, as their own positions are connected to knowledge co-production in social sciences and realms.

Transition arenas have emerged as a prominent approach for knowledge co-production in complex policy contexts [28]. The transition arena method - bringing together a diverse group of actors concerned with societal challenge to develop vision, future pathways and actions - is based on transition management methodology that has been gaining popularity as an approach to reflexively govern persistent systemic challenges [58,59]. The transition management framework provides a systematic and reflexive methodology for constructing transition pathways in different governance contexts that are characterised by diversity, uncertainty, heterogeneity of society and decreased role of government [28,60]. The underlying aim is to accelerate sustainability transitions through providing space for 'frontrunners' to inform, and challenge, policymaking of the ambition and variability of future pathways [61]. The transition arenas also have potential to coordinate incumbent regime actors' interests in relation to emerging challenges, pressures and innovations, while articulating and dealing with possible conflicts [18]. Essentially, the transition arena process brings the diverse "theories of change" of participating stakeholders into dialogue and helps in identifying links crossing systemic societal challenges and spatial contexts [62]. Hitherto, transition arenas have been established in diverse institutional and geographical contexts, such as providing sustainability visions for urban strategic planning, reframing the institutional structures of water governance and challenging national energy policy targets [18,28,63–66].

Several shortcomings of transition management methodology have been pointed out. One challenge is whether the transition visions and pathways are legitimate and capture the 'discursive and 'agonistic' aspects of democracy that often become sanitised from transition lessons [60,67,68]. Further, a managerial approach and result-orientation might lead to disempowerment of stakeholders rather than mobilising the transformative action through creation of engaged communities [63]. Finally, transition management has been criticized for its disconnection from the official decision-making processes [60].

To address these shortcomings, we build on the midrange transition arena method, focusing on the 10–15-year time scale to ensure the policy relevance often missing from long-term 50–100-year future visions and enabling participants planning devices to participate in co-production of shared agenda, pathways and actions more directly [18], in connection with official policy processes [69,70]. In our transition arena setting the co-produced transition pathways were not technical "hard" scenarios of whole-system or regime transition [e.g. 1,71], but rather heuristic "soft" scenarios to balance different knowledge bases and viewpoints over the future developments. This methodological approach fitted well in the context of housing companies, where diverse stakeholders, including lay citizens, neighbourhood associations, housing sector professionals, energy companies, research institutes and public administrators, play different roles and have diverging views on future developments. Although the process opened an avenue to official decision-making, our approach placed more emphasis on different knowledge areas than on mobilising community action (a point which we return to in the discussion section).

3.2. Citizen energy arena process

The Finnish Citizen Energy Arena (CEA) was organised in early 2020 in collaboration with the Ministry of Environment and the Ministry of Economics and Employment. The Ministry of Environment is in charge of subsidies for renewable energy instalments in housing companies and implementation of long-term renovation strategy, while the Ministry of Economics and Employment is in charge of legislation concerning energy communities and micro-produced energy in electricity markets. In order to facilitate knowledge co-production across diverse areas of expertise and experience, we invited 17 participants including authorities from the above-mentioned ministries (3), municipal authorities involved in citizen energy experiments (3), employees from energy information services (2), front-running enterprises offering low-carbon solutions (2), large-scale energy enterprises (1), the Finnish transmission grid company (1), estate managing companies (2) and environmental non-governmental organisations (1) and activist citizens with experience in implementing energy projects in housing companies (2). These stakeholders were selected because of their personal engagement with the topic and their wide-ranging professional capabilities to engage in constructive dialogue. The citizen participants were important from a transdisciplinary perspective as they brought in practice-based experience on the reasons for users to adopt or reject on-site low-carbon energy solutions. The total number of participants was limited in order to enable more efficient working in small groups. Ten researchers (including authors of this study) acted as process facilitators providing supportive and complementary insights into the discussion but avoiding direct influence on the outcomes. However, to support informed engagement with complex real-world developments, information memos were provided for the participants at the beginning of the process, including information on emission reduction gaps, energy markets, existing policies and examples of housing company energy actions and pilots. As the focus was on informing ongoing policy processes and solving persistent challenges generally affecting the housing companies, the orientation of the transition arena was in this way more institutional rather than technical.

Building on transition management literature [28,71], the transition arena process was divided into three subsequent phases (see Fig. 1, also

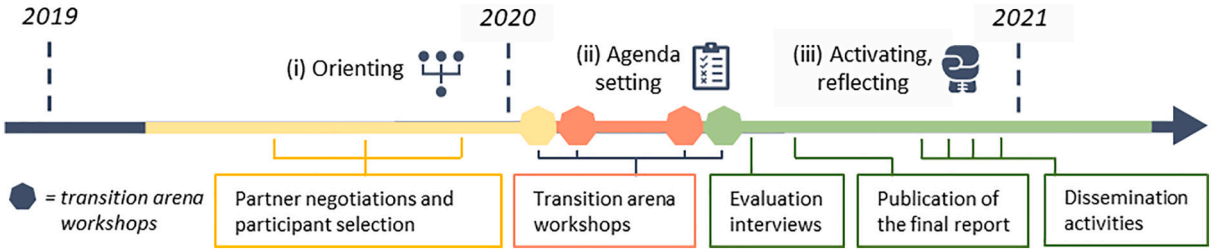

Fig. 1. Main phases of the CEA process, timing of transition arena workshops and related activities.

Appendix 1 for details of the workshop design). The orienting phase (June 2019 till January 2020) included establishing the transition arena facilitation team, brokering the dialogue between the two ministries, gathering relevant background knowledge and recruiting the relevant participants. The agenda setting phase (January till May 2020) was the main element in the process, focusing on setting a transition goal for the year 2035 based on Finland's carbon neutrality target, co-creating transition pathways to identify key policy actions and crossbreeding the prioritised actions. This phase consisted of four workshop sessions operationalised in iterative whole-arena sessions and predefined small group settings with complementary viewpoints among the members. The main element was co-creation of four transition pathways, that took two full workshops and was shifted to an online format in the middle because of the Covid-19 pandemic. The policy lessons were published as a shared output of the arena process in order to advance citizen energy policies. Finally, activating and reflecting phases (beginning in May 2020) were conducted in parallel by engaging different actors, in policy, in practice and in science communities, in discussions on the main outcomes, and by conducting evaluation interviews with participants regarding the content and facilitation of the process. The dissemination was organised in pre-existing networks, such as regional development collectives, an energy fair for key stakeholders, direct consultation with ministry representatives, an education event for regional energy advisers, research seminars for interested scholars as well as blog posts and popular articles for a wider audience.

3.3. Research data and analytical framework

Throughout the process, several types of data were collected (see Table 1). The main datasets included recordings of the transition arena meetings and post-arena interviews with 12 of the 17 participants (see Appendix 2 for the interview guide). These data sets capture the content of participants' knowledge claims, while specifically designed templates and material arrangements (magnet board to support building transition pathways and actions, see Fig. 2) were also utilised in the process to support co-production of systemic knowledge. The supporting datasets (project meeting notes and dissemination events) help to position claims in the wider societal context, where the knowledge co-production process was embedded through the preparation and mobilisation actions.

Table 1
Details of the research data.

Data source	Level of analysis	Function	Details
Participant interviews (12)	Transcribed and coded	Main data source	4 public authorities, 4 business, 2 civil society and 2 city actors
Preparation meetings	notes, not coded	Supportive	9 meetings focusing on framing, collaboration, process design and stakeholder selection
Dissemination events	notes, not coded	Supportive	6 events where the results were distributed to different policy, practitioner, and science audiences

Fig. 2. A photo caption of transition pathway co-creation work.

The analysis was conducted by the first three authors as an iterative process. The qualitative content analysis of workshop discussions and produced textual materials enabled a systematic way of identifying contextually meaningful perspectives on citizen energy roles by focusing on repeated and contrasting statements [72,73]. First, the analysis focused on how the participants positioned different actor groups in relation to the challenge of advancing citizen energy action in housing companies at the beginning of the arena process. Second, the analysis moved to co-production of societal targets through transition pathway building. Finally, the process of outlining policy lessons and the outcome report was analysed. The three steps in the analysis process also approximately reflect how the different knowledge types – system knowledge, target knowledge and transformative knowledge – were emphasised in the process.

Noboa, Upham and Heinrichs suggest that transdisciplinary science-policy interactions in transition arenas cover three types of knowledge - system, target and transformative knowledge [64, also 30,74]. System knowledge covers the empirical aspects of contemporary systems, focusing on the drivers, barriers and uncertainties of change. Target knowledge deals with the purposive aspects with a view to diverse actor perspectives and interests as well as systemic constraints. Transformative knowledge can be derived from the target knowledge by prescribing strategies for stakeholders to engage in transformative action. We have summarised these aspects as an analytical framework for structuring the results (Fig. 3).

4. Results: opening the transition arena

4.1. System knowledge: positioning housing companies in energy system change

The first phase in the Citizen Energy Arena focused on defining the most important drivers and barriers of transitions as well as defining a shared target for the co-creation of transition pathways. The majority of the stakeholders shared a diagnosis of the change that it is important to

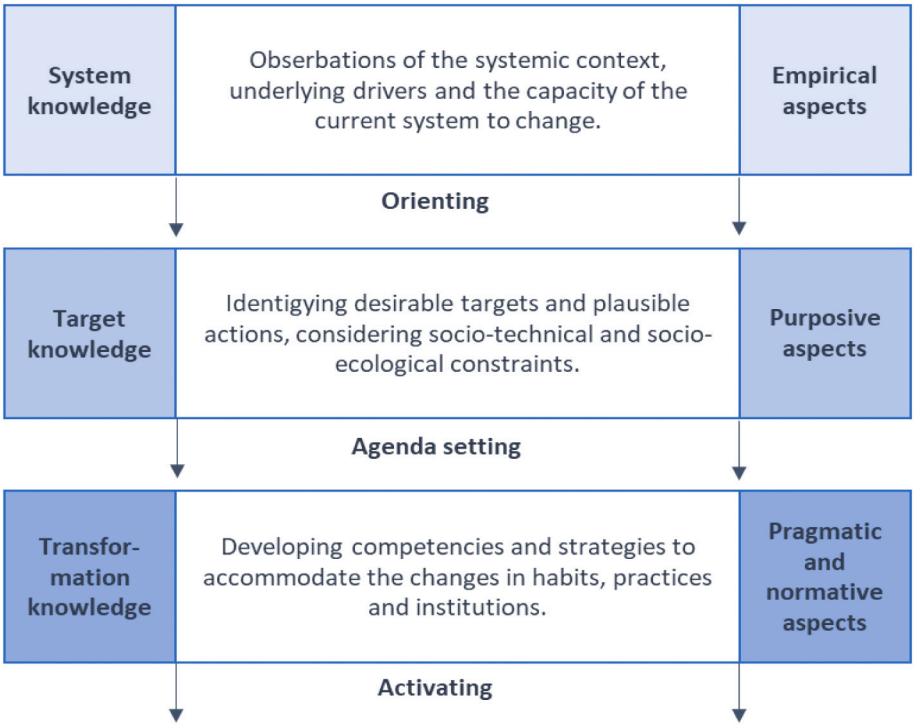

Fig. 3. Analytical framework [64,74].

drive the energy system away from fossil fuels towards low-carbon energy production, which makes energy action in housing companies significant.

In the arena, the participants were tasked to define the roles and responsibilities of business, civil society and public authority actors in the low-carbon energy transition. We combined their main arguments

Table 2
Stakeholder roles in energy transition according to participant statements in the Citizen Energy Arena.

	Business positioning	Civic positioning	Public positioning
Business views	• **Transition will proceed with development of diverse service offerings to meet consumer needs.** • Existing energy system provides a good basis for efficient (incremental) economic and climate actions. • Functioning energy service market needs qualified technology providers, installers, etc. • Transition won't happen without transactions: "money needs to change hands or the climate targets are unattainable."	• Homo economicus: Citizens (as individuals and housing company residents) are consumers that need to act rationally. • Climate change attitudes not visible in purchasing decisions. • Citizens have unfounded expectations towards economic benefits of energy actions and flexibility measures. • Citizen communities' dysfunctional decision-making is an unnecessary market barrier. • From the energy system perspective, there is no need for citizen-produced energy.	• Suspicion towards regulatory measures (that may cause market disturbances). • The role of public authorities is to remove existing bureaucratic barriers, especially in relation to the varying licensing and permitting practices of municipalities. • Public budget decisions can ease acquisition of energy services and technologies (which will pay itself back in taxes, while scaling up the market).
Civil society views	• Doubts regarding energy producers' interest in collaborating with energy citizens and communities. • Independent and autonomous energy actions are not actively considered as part of the energy system by incumbents.	• **Change emerges from citizen action (and becomes the moral justification of policy and market actions).** • Energy independence brings new responsibilities and requires novel capabilities from citizens. • Collaboration between the housing companies and on the local level is more generally seen as a key pathway for change.	• Public actors are responsible for advancing the sustainability transition. • Government (both national and local) must provide sufficient conditions for the development of citizen energy action, as e.g., individual housing companies have limited power.
Public authority views	• Large energy companies are considered brakemen of change that actively hinder change especially at the urban level. • Energy service companies must provide better solutions especially for demand response, sector integration, deep building retrofits, etc.	• Citizens are guardians of their local surroundings (buildings, neighbourhoods, cities). • "Too many chefs spoil the broth" of citizen energy decisions, which makes collective action a tall order. • Energy actions in citizens' vicinity increase the general legitimacy of carbon neutral policies.	• **Public authority is responsible for the functioning of the energy system and stability of the policies.** • Strong framework legislation is a necessary condition for the energy transitions.

Each row combines the main arguments of the arena participants sorted by their backgrounds, while the columns specify how the main actors were positioned regarding systemic barriers and roles in policy change.
Bolded arguments are the strongest reflections that were recurring most often in the participant statements – thus considered here as self-reflections of the specific actor category regarding the energy transition.

and sorted them according to the arena participants' backgrounds (see Table 2). The arena participants had heterogeneous compositions, but meaningful similarities on positioning stakeholders in the energy system change appeared. Participants offered varying prognoses on how the change will take place and – more importantly – on the role of citizens in the transition.

We analysed the statements as system knowledge. The arena participants with a business background consisted of incumbent energy companies, novel energy service companies and advocacy associations serving different interests. They shared the idea that the current energy system operates quite efficiently to achieve carbon neutrality targets. In their view, the existing regime rules provided a backbone for considering new civic initiatives and community energy developments, from economic and climate change perspectives. Thus, dispersed energy production in housing companies was not of paramount importance but rather an effect that will be achieved by developing the energy service markets. Thus, civic stakeholders needed to act – both individually and collectively – as rational market actors. This was reflected by recurring claims of complex and slow decision-making processes in housing companies as a market barrier. Furthermore, these participants had an ambivalent attitude towards public interventions, as new regulatory measures were considered important in easing out the energy service markets, whereas public policies were generally viewed as possible market disturbances.

The arena participants with a civil society background had a starkly different system framing compared to the business participants. Civic action was generally considered as the initiator of energy transitions. Therefore, the housing companies' residents were viewed as potential drivers of change. Also, the capabilities and responsibilities of the residents were emphasised as forward-looking actors engaging in cooperation between the housing companies towards the energy service providers. Own energy production and energy independence from the dominance of large companies was considered as having an intrinsic value. Although the development of novel services and business models was viewed positively, the primacy of markets as a driving force of change was questioned. The public authorities were positioned with responsibility to set ambitious future policy targets and policies, and to provide the space for civic action to emerge.

The public authorities as an arena participant group were more heterogeneous than the other two groups. The majority of the public authorities emphasised their position as safeguards of predictable, secure and equal functioning of the energy system. For example, provision of information and development of permitting and certificate principles were necessary aspects of this moderating role. Some authorities also stated that strong framework legislation is a necessary condition for the transition, although not the prime mover. However, especially the large energy companies were viewed as brakemen of change because of little concrete support for distributed energy actions in the energy grids they govern. Moreover, the public authorities showed little optimism regarding the civil society actors, who were viewed mainly as guardians of their immediate surroundings. The capacity of citizens at the level of housing companies or neighbourhoods was questioned, although citizen energy actions were considered to provide legitimacy for long-term policy measures.

4.2. Target knowledge: co-producing transition pathways

In the second phase of CEA, we moved the orientation towards building transition pathways. The contrasting positions of participants became amplified when a shared transition goal for the year 2035 was decided. As facilitators, we suggested setting a specific citizen energy production target to help the evaluation and quantification of different actions. This was supported by the citizen actors and energy service companies, suggesting an 8-fold increase over the 15-year time frame leading to an estimated 4TWh energy production in the housing companies (one third of housing companies' total energy consumption at the end of the timeframe). However, participants from cities and incumbent energy companies challenged this as a trivial target focusing on inefficient climate actions, and suggested an alternative target of half of the housing companies engaging in energy retrofits in the time frame. The alternative target offered a complementary register by focusing on energy efficiency, demand response actions and project engagement. As a compromise, a dual target of 8-fold increase in housing company energy production and half of Finnish housing companies engaging in energy retrofits was established.

In the pathway work, participants were divided by the facilitating team into four small groups with complementary expertise in each group and avoiding allocation of e.g. two civil servants or citizen activists to the same group. They were tasked to elaborate the most effective actions to trigger change in housing companies. Each group had approximately similar compositions and operated with the same baseline facts to identify concrete actions needed in the spheres of e.g., policy, technology, economic incentives, knowledge generation, land-use and citizen action [for details, see 66]. Although there were several conjunctions across the transition pathways, the groups emphasised contrasting aspects as the main motors of change. These emphases were further considered by the participants and designated in the illustrative pathway names: 1) Digital Information pathway, 2) Policy coordination pathway, 3) Energy service pathway and 4) Neighbourhood collaboration pathway. As the names were given retroactively, the hermeneutic policy pathways also signalled several other types of policy actions, e.g., related to immediate action in the housing companies. To unpack the diversity of suggested actions, we identified four cross-cutting aspects of target knowledge of knowledge provisioning, market development, regulation and citizen action that span through all pathways, although with different emphases (Table 3).

First, the pathways emphasised the centrality of organised and accessible energy knowledge as a trigger of the transitions. It was recognized in the transition arena that large amounts of data existed on energy solutions, environmental and economic impacts, and good and bad experiences of project implementation, but that it was distributed across multiple actors and was difficult to access. Each pathway group noted that no actor was responsible for curating and verifying this data, integrating solutions or providing tailored support at local project implementations. However, the groups were split on whether the main emphasis should be on managing knowledge (Digital information and Energy service pathways) or mobilising locally tangible project support (Policy coordination and Neighbourhood collaboration pathways). Furthermore, the definition of energy knowledge differs greatly between the pathways, as some actors emphasised the role of transferable and automated data, others publicly managed and selected information, and yet others the importance of contextually specific pragmatic advice. The different aspects of knowledge further cumulated in other areas of the transition pathways.

Second, development of markets around citizen energy and especially novel services in the interface between the built environment and the energy system were emphasised. The markets were not considered as neutral, but as a target for active policy reforms and market creation actions. In essence, different types of policy and systemic orientations were required for multiple markets. The Digital information pathway included the increasing demand for information and data in the interface between citizen energy producers, network operators and customers. This was considered to lead potentially to energy data markets, where citizens could directly operate under the emerging platform economy. The Energy service pathway focused on the need to upgrade the service and technical skills of the current system operators in order to create space for more customer-oriented services, while the Neighbourhood collaboration pathway group focused especially on destabilising incumbent energy companies through reforming the energy and grid regulations, such as opening the district heating grids to citizens. Only the Policy coordination pathway group did not explicitly set targets for market creation, as service markets were considered a natural

Table 3
Characteristics of the main aspects of target knowledge in the four transition pathways.

	Knowledge provisioning	Market development	Regulatory change	Citizen action
Digital information pathway	Concentrated public effort is needed in mapping, managing, and coordinating existing energy knowledge under single authority.	(+) Emerging service markets provide the backbone of the transition pathway that also requires development of information markets in the platform economy.	New strategic targets are needed to ensure favourable conditions of citizen energy both nationally and transnationally.	(−) Citizens are in dire need of curated energy knowledge to advance energy investments, renovations, and deep retrofits in the housing companies.
Policy coordination pathway	Dedicated energy experts will collect and organise knowledge and provide locally tailored counselling.	(−) Scaling of energy solutions in housing companies will follow market logic after the markets have been established on public interventions.	(+) Dedicated national strategy with clear targets and instrument mix for citizen energy as well as regional and local implementation is central for the transition pathway.	(−) Citizens will actively engage in the activities proposed by public actors, e.g., knowledge support for decision-making and locally facilitated networks.
Energy service pathway	(+) One-stop-shop for reliable and unbiased information and training for citizens constitutes the transition pathway.	Customer oriented and flexible energy services are needed to enable change in housing companies and generate wider societal interest in citizen energy action.	(−) Coordination between ministries is needed to overcome patchy regulation and information support.	Enhanced energy knowledge helps housing company residents' engagement in energy decision-making, speed-up processes and remove local bottlenecks.
Neighbourhood collaboration pathway	More accessible energy knowledge and training services are required to consolidate demand for energy efficient solutions.	Currently monopolised heating markets need to be opened to create incentive for integrated solutions and citizen power to local energy systems.	Regulation obliges housing companies to set sustainable energy targets and integrates energy into service contracting models.	(+) Networked co-learning and emergence of community energy solutions at the neighbourhood scale establish the citizen energy transition pathway.
Examples	*Public energy counselling to mobilise energy knowledge for housing company action.*	*Digital energy services to challenge traditional role of energy in housing companies.*	*Long-term targets for municipalities forcing the change in energy planning practices towards housing companies.*	*Community interaction* e.g., *neighbourhood groups as a source of collective energy action in housing companies.*

(+) = Central theme of the transition pathway; (−) = aspect was touched only indirectly in the pathway process.
The central themes were identified by the facilitating team in dialogue with the group members. The indirect topics were identified afterwards by analysing the workshop recordings and communication materials.

outcome of policy reforms and enhanced targets at different policy levels. In essence, the three groups focused on different elements related to citizen energy action: the actual energy activities (data and information), capabilities to participate in the energy markets (services) and structuring conditions of markets (infrastructure).

Third, regulation was viewed as necessary in establishing a predictable policy framework and more effective implementation to enable and coordinate the citizen energy actions. The Digital information and Policy coordination pathway groups identified a need to set dedicated targets for the share of citizen-produced energy at the national level, which would align with transnational (EU-level) targets and would stimulate action more locally. The pathways map out an emerging policy mix including explicit phase-out policies (such as oil-heating bans for buildings), favourable taxation policies (e.g., for renewable energy technologies in buildings) and reforms to the energy tariff system to support dispersed production. However, the Policy Coordination pathway group promoted actions towards policy implementation in the municipal scale, including standardised renewable energy permitting principles and removal of regulatory barriers for distributed heating energy markets. The Neighbourhood collaboration pathway group emphasised the importance of local policy implementation, especially in requesting housing companies to develop sustainable energy targets, and included energy actions as a central element in housing company maintenance and service contracts.

Finally, the four pathway groups also discussed citizen action in housing companies in their local contexts. In the Digital information pathway group, citizen action was restricted to the role of customers in developing service markets, and in the Policy coordination pathway group, citizen action was restricted to setting targets for policy actions. However, the Energy service pathway group considered proactivity of citizens as a prerequisite for transitions that stems from public interest in solving environmental issues, such as climate change. If the current bottlenecks in the regulatory system and information provision were solved, motivated and informed citizens in housing companies were assumed to create the need for new solutions and services. The Neighbourhood collaboration pathway group approached citizen action from a wider angle of neighbourhood and suburban scales, where collaboration between active citizens in housing companies would lead to shared learning and emergence of modular energy solutions in the suburban scale. In essence, the technologies utilised in (collectives of) housing companies could establish novel institutional forms and become disruptive towards the central role of large energy companies.

4.3. Transformative knowledge: translating citizen energy knowledge into energy actions

In the context of transformative knowledge, we focused on changes in the positioning of citizens in the ongoing policy developments. In the CEA, transformative knowledge became a focal point towards the end of the process, when the focus shifted to collectively considering the main actions stemming from the four transition pathways. The four pathway groups had listed a total of 35 immediate actions – half of which emerged in more than one pathway. Three actions were brought up in all pathways: public coordination and curating of energy retrofit information, reform in education policies, and incentives for market-based service development. In this final stage, all the actions were prioritised, with each participant having a similar vote, and "assigned" to bundles of most relevant societal stakeholders in order to reinforce dissemination activities.

As noted by Hirch Hadorn and colleagues, the co-produced transformative knowledge can be understood in terms of *existing habits*, *practices*, and *institutional objectives* [74]. We refer to the existing habits as a sphere of everyday action, practices as a sphere of connections where rules regarding use and sharing of knowledge and administration are negotiated, and institutional objectives as a sphere of developing shared long-term understanding of the direction of change, all being connected to socio-technical aspects of systemic change. Moreover, in the CEA process, the final stage of setting shared actions was central in mobilising transformative knowledge. Therefore, the three areas of transformative knowledge are described in terms of collective messages (see Table 4).

Firstly, the transformation in existing habits was considered by the CEA participants mainly in terms of shifting persistent energy consumption patterns and housing company decision-making routines by

Table 4
Overview of transformative knowledge identified in the CEA policy actions.

Existing habits	Novel technical and service offerings create market-based push for transforming everyday energy habits by applying e.g., energy micro-generation, storages, flexibility and local trade that further the wider energy system transitions.
Practices	*Administrative practises* related to incentivising energy projects and locally governing building sector energy action require reconsideration; *Knowledge practises* of tailored energy advice for different stakeholder groups and energy counselling enable active use of energy data in energy decision-making and everyday action.
Institutional objectives	Objectives for developing feasible policy mix for citizen energy actions as well as developing general awareness and trust are central in creating informed and interested publics.

introducing novel market-based interventions. The permanence of habits was used by participants as a central justification for specifying technological developments and market offerings, such as holistic service concepts and deep retrofits, that would be simple enough to overcome the inertia due to lacking energy literacy in the housing company context. Furthermore, especially the business actors emphasised integrating new technological offerings of electricity micro-generation, energy storages, flexibility automation and trade into everyday actions of citizens inhabiting housing companies. The management of active energy demand was thus viewed as a potentially novel citizen energy habit in the future energy system.

Secondly, the participants viewed the transformation in practices as an area where the most visible change is required. However, the practices can have different forms depending on what area of the energy system is under scrutiny. On the one hand, especially the citizen and civic actors called for changes in the *existing knowledge practices* by discussing solutions such as one-stop-shops of energy information, step-by-step guidelines for different project contexts and digitalized energy monitoring applications platforms. All of these were considered as necessary means of overcoming the persistent challenges of managing existing energy knowledge in housing companies, and therefore making citizen energy action visible. On the other hand, the market actors were more concerned about *administrative practices* related to incentive structures and regulations. For example, the lack of concrete support for housing companies in the planning stages of projects in the current system was considered to be leading to piecemeal energy solutions. Furthermore, the local regulatory practices, such as town plans and building inspection, were considered ill-equipped to deal with housing company energy action and too discontinuous to provide long-term support. Overall, the public policy interventions became a central area of transforming citizen energy practices.

Finally, the participant perspectives towards transforming institutional objectives focused on explicit policy reforms and improvement of awareness. The civic actors noted that a well-defined policy mix covering national, regional and municipal levels would be required to institutionalise the support for citizen energy action. This could take place either as an extension to the government's official climate and energy strategy or as a dedicated citizen energy strategy. Importantly, the strategies were connected to reforming building and energy taxation geared towards maintaining systemic lock-ins around centralised energy production. Many participants also pointed towards the issue of mistrust regarding economic and environmental claims for dispersed energy production, as the public discussion is dominated by private economic interests. To counter this dynamic, raising of public awareness to create an informed and interested public was presented as an institutional object, with an arbitrary 80 % share of the national population suggested as an objective for engaged citizens.

4.4. Closing the transition arena: citizen roles in energy transitions

The main objective of the CEA process was specifying citizen energy action as part of energy communities, more specifically in housing companies. In our analysis of transition arena dialogues among participants, we identified several types of roles for citizens in the energy transition process. In the ex-post evaluation (see Appendix 2), the participants expressed their views on how citizen energy actions and energy communities could be increased, which provided a context and several cues on diverse citizen roles in energy transition.

Firstly, the citizens were framed as *customers*, *implementers* or *partners* in the emerging energy technology and service markets. Citizens were considered to have power to apply diverse capabilities at the level of everyday decision-making, socio-material constellations of buildings, and energy markets. However, they were assigned a less important role in influencing the directionality of energy transitions, that was assumed to follow market-based trajectories. Secondly, in the perspective of broader energy transitions, citizens were framed as *hindrances* requiring caretaking and explicit guidance to follow the policy templates. Therefore, the novel knowledge practices were proposed to decrease the active resistance of misinformed members of the public by providing timely and contextually tailored messages promoting the "correct choices". Thirdly, citizens were also framed as *protagonists* of transformative targets. This role could take the form of *active forerunners*, or *critical evaluators* of actions – or merely of *passive tokens* and *mascots* of the decisions set on other forums. These different roles and meanings given to citizens demonstrate the fragmented role of citizen energy action, requiring multiple complementing policy pathways in order to be captured properly.

The concrete task of CEA was to open the Gordian knot of inactivity of citizens of the housing companies in energy transitions. The diverse identified citizen energy roles emphasise the complexity of low-carbon energy transitions – which carry weight towards designated policy actions. The energy citizens' roles were reflected as units of collective action, with the focus on housing companies located in cohabited buildings and in neighbourhoods, rather than as idealised liberal individuals responsible for their own energy consumption and investment decisions. The focus was on the roles of individual citizens enabling collective action points towards action enabled by civic motivation that requires consideration, which is often missed in transition and policy discourses.

5. Discussion

The focus of our paper has been on citizen energy community action in the policy-relevant context of housing companies in Finland. The case reveals two layers of complexity in governing emerging energy community action. On the one hand, mobilising energy action *in* the communities faces dysfunctional decision-making structures, persistent everyday habits and very diverse socio-economic contexts. Overcoming these challenges requires new types of arrangements that involve reconfiguring administrative and market operations. On the other hand, mobilising energy action *around* the communities is currently characterised by mixed incentives, problematic administrative practices and lukewarm targets. Thus, more active orchestration across the old positions especially in the urban energy systems can be considered a necessity for engaging citizen energy communities in sustainability transitions. The four co-produced policy pathways provided starting points for these systemic considerations.

Our approach was to analyse transition arena knowledge co-production process in terms of understanding knowledge types and conflicting views present in the process of building shared transition targets, pathways and actions for future policy making. Moreover, we identified emergent citizen energy roles appearing during the illustrated systemic change. Housing companies give rise to a difficult context for energy communities, as the misaligned incentives and complex governance structures push co-owners towards resistant, passive and protagonist citizen energy roles. Before concluding the paper with a policy-oriented note, we want to raise three discussion points: first,

conceptually on citizen energy agency; second, epistemically on co-produced knowledge; and finally, methodologically on utilisation of transition pathways in their different interpretations.

Our first contribution is conceptual and focused on the diverging definitions of citizen energy action. The conceptualisations of citizen energy action build on different emphases with theoretical, jurisdictional and pragmatic connotations [9,12–14,32] that are often connected to normative claims for citizen action in the energy system. Moreover, the complexity is often increased by variations in geospatial, material and organizational aspects of energy communities [34,36,46] that lead to locally situated analysis. In our analysis, we attempted to distance ourselves from the normative and situated approaches in order to evaluate the diverse positive and negative roles which citizen energy action gains in the sustainability transitions. Here, citizens are not necessarily the main protagonists or mere pawns of transition agendas, but have different active and passive qualities that need to be taken into more focused consideration.

Moreover, these reflections coincide with the research and policy focus extending from local communities towards smart and digital technologies enabling energy actions and networked communities [9,53]. The research combining the perspectives of place-based communities, such as the housing companies, and digitally mediated communities will be a necessary strand in understanding the diversity of citizen engagement in the low-carbon energy transitions.

Our second contribution is epistemic and is connected to empirically bridging the knowledge co-production literature and energy transitions studies. Here, the case of the policy-oriented transition arena process distinguishes a pathway from system knowledge through target knowledge to transformative knowledge [54–57,64]. In the transition management process, this also relates to raising the level of collective knowledge, as the individual views of systemic dynamics are navigated, negotiated and merged to form shared transition pathways and transformative actions. However, this collective nature does not presuppose a full coherence of views but rather a range of convergence that can motivate stakeholders with different positions to act. The future research on co-produced knowledge types should pay closer attention to mobilisation of these policy actions and evaluate more closely the entrepreneurial work of the engaged participants.

Our third contribution is methodological and relates to the utilisation of transition management approaches for energy transitions. The co-production of four illustrative midrange transition pathways captured the range of actions from top-down policy goals and bottom-up decision making with situated stakeholders. Despite the frictions in the knowledge bases, the combined mix of actions provides a heuristic pathway for connecting housing companies to the energy transitions [48,60,70]. The suggested policy-mix, therefore, combines centralised and decentralised solutions rather than actions relying on one side of the spectrum [1]. However, coupling the deep stakeholder interaction on policy pathways to broader sociotechnical pathways is an area that requires further research emphasis [see also 71]. As noted by Rogge et al. [1], the future zero-carbon energy transitions can take a highly centralised or widely dispersed trajectory depending on technological designs set in motion in the current phase of energy system transition. These are policy considerations that profoundly impact citizen energy roles in sustainability transitions and thus require transparent societal dialogues.

Finally, there are two limitations in the research. First, the wider societal impact of the transition arena intervention remains partially unknown. The corona pandemic caused challenges in reaching out to the key stakeholders, and the wider impact of lessons will emerge with a delay in the agenda setting for next policy programmes. Second, it is worth pointing out that our own role as transition arena workshop facilitators limited our academic neutrality. However, this is a necessity, when engaging with more action-oriented knowledge co-production to reframe power and agency, as noted by Chambers et al. [55].

6. Conclusions

In this paper, we have provided an analysis of the process of transformative knowledge co-production in the complex energy governance context around housing companies in Finland. The ambitious climate neutrality targets together with ongoing energy transitions away from fossil fuel combustion have set prominent but ambiguous expectations for citizen energy action. There are two policy-relevant conclusions which we want to emphasise. On the one hand, setting normative targets for citizen energy action is a problematic task, as citizen energy communities gain different meanings depending on whether their role is understood in terms of increasing participation in energy systems or optimising operation of the system. Therefore, bridging of the agendas supporting prosumerism and system optimisation is highly recommended in order to support different forms of citizen energy action – a position amplified by the energy crisis. On the other hand, the co-created illustrative transition pathways show that there are multiple interlinked policy developments that need to be considered while coordinating citizen energy action in practice. To avoid further policy fragmentation, the areas of information support, market steering, policy coordination and planning need to be considered jointly. Currently, the turbulent times are making the different roles of citizen energy agency visible, emphasising the need for a nuanced understanding of policy pathways.

Declaration of competing interest

Authors declare no conflict of interest.

Data availability

Data will be made available on request.

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Appendix 1. Workshop structure

Workshop 1 (13.1.2020, in person)
- *Main tasks*: Identification of transition challenges, opportunities and targets
- *Operating mode*: Three rounds of small group dialogues followed by shared iteration of the main messages

Workshop 2 (6.2.2020, in person)
- *Main tasks*: Building transition pathways to meet the transition target of 8-fold increase in housing company energy production by 2035
- *Operating mode*: Four small groups that utilised the mid-range transition pathway design protocol

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(*continued*)

Workshop 3 (16.4., 20.4., 22.4., online)
- *Main tasks*: Finalising the pathways and commenting the main actions of other pathways
- *Operating mode*: Online meetings run separately for each of the four pathway groups

Workshop 4 (5.5., online)
- *Main tasks*: Prioritising the policy actions most central in the four pathways, discussion on central actors and reflection of the workshop process
- *Operating mode*: Jointly online dialogue complemented with voting on Mentimeter platform

In addition to the workshop interaction, an online platform was opened for commenting the results between the workshops

Appendix 2. Evaluation interview protocol

Topic 1: Transition arena

1. How did you experience the transition arena work? What benefits and what problems were in the process? Did the Citizen Energy Arena target setting meet your expectations? Was there enough time to set the joined target?
2. Were all the relevant actors present?
3. Did some topic gain too much focus? Was some relevant topic not considered?
4. Did you notice competing interests in the process? How did this impact the results?

Topic 2: Learning

5. What kinds of practically relevant things during the arena work (if any)? Do you have plans regarding this?
6. Did you gain new ideas with the arena participations contribution (for example on business, policy or practical action)?
7. Do you consider we encountered issues we do not know enough about? How could such challenges and knowledge needs be best solved after the process?

Topic 3: Transition and policy

8. How could the transition arena's recommendations be promoted in society?
9. Which stakeholders should be the most engaged in the transitioning work after the arena?
10. Which policy processes need to be influenced directly?
11. How can the impact of the arena be enhanced?

Topic 4: General

12. Would you like to summarise in few sentences your own take on how citizen energy action needs to be advanced over the next five years?
13. Did other pathway groups suggest actions or developments that you do consider feasible or worthwhile?
14. Do you have any other comments or greetings?

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