Taylor & Francis
Taylor & Francis Group

Sustainability: Science, Practice and Policy

ISSN: 1548-7733 (Online) Journal homepage: www.tandfonline.com/journals/tsus20

What does it take to study learning in transitions? A case of citizen energy in Finland

Satu Lähteenoja, Sampsa Hyysalo, Jani Lukkarinen, Tatu Marttila, Heli Saarikoski, Maija Faehnle & Lasse Peltonen

To cite this article: Satu Lähteenoja, Sampsa Hyysalo, Jani Lukkarinen, Tatu Marttila, Heli Saarikoski, Maija Faehnle & Lasse Peltonen (2022) What does it take to study learning in transitions? A case of citizen energy in Finland, Sustainability: Science, Practice and Policy, 18:1, 651-664, DOI: 10.1080/15487733.2022.2109316

To link to this article: https://doi.org/10.1080/15487733.2022.2109316

© 2022 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group

Published online: 13 Oct 2022.

Submit your article to this journal

Article views: 1595

View related articles

View Crossmark data

Citing articles: 3 View citing articles

Full Terms & Conditions of access and use can be found at
https://www.tandfonline.com/action/journalInformation?journalCode=tsus20

SUSTAINABILITY: SCIENCE, PRACTICE AND POLICY
2022, VOL. 18, NO. 1, 651–664
https://doi.org/10.1080/15487733.2022.2109316

Taylor & Francis
Taylor & Francis Group

RESEARCH ARTICLE

OPEN ACCESS Check for updates

What does it take to study learning in transitions? A case of citizen energy in Finland

Satu Lähteenoja[a], Sampsa Hyysalo[a], Jani Lukkarinen[b], Tatu Marttila[a], Heli Saarikoski[b], Maija Faehnle[b] and Lasse Peltonen[c]

[a]Department of Design, Aalto University School of Arts, Design, and Architecture, Espoo, Finland; [b]Finnish Environment Institute (SYKE), Helsinki, Finland; [c]Department of Historical and Geographical Studies, University of Eastern Finland (UEF), Joensuu, Finland

ABSTRACT

Learning is commonly presented as one of the key premises of transitions governance. Empirical literature on learning in a sustainability transition context often remains on a generic level, without an in-depth analysis of what is learned and by whom. In this article, we address the study of learning in transition-related multi-party processes. We analyze a transition arena specifically designed to support the participants' learning and the possibilities to study it. Its focus was on urban citizen energy, increasing renewable energy production via solar panels, heat pumps, and other on-site solutions in detached apartment buildings. We investigate the process through the learning levels (learning loops) framework within which we were able to examine if and what kind of learning can be inferred to have happened and show what kind of data and analysis such inferences minimally require. Our results demonstrate that all participants reported learning from the arena process. This learning was predominantly first-order learning within participants' already pro-transition orientation. Half of the participants also reported some second-order learning, changing one's interpretative framing about citizen energy. Overall, the multi-party envisioning process supported participants' ongoing transformation efforts more than it resulted in transformative learning. Our results provide a basis for further development of a learning-sensitive approach enabling identification and consideration of methodological challenges involved in inferring learning in transitions research.

ARTICLE HISTORY
Received 8 December 2021
Accepted 29 July 2022

KEYWORDS
Sustainability; learning; transition; citizen energy; co-design; transition arena

Introduction

The transition toward environmental and social sustainability requires fundamental changes in wide-reaching socio-technical systems such as energy, mobility, and food systems, as well as how these systems are governed (Cohen 2019). Although nations have started implementing the Paris Climate Agreement, the proposed actions are insufficient, and there is an urgent need to accelerate transition processes (Masson-Delmotte et al. 2021; Köhler et al. 2019). Transition management is one of the approaches aiming to create new ways to govern transitions (Geels 2002; Schot and Geels 2008).

Learning is commonly presented as one of the key premises of transitions governance (e.g., Loorbach 2010; Kemp and Rotmans 2009; Van Poeck, Östman, and Block 2020; Dóci, Rohracher, and Kordas 2022). Diverse actors are required for environmentally sound change in socio-technical systems, and it has been asserted that they need to learn away from their existing regime-aligned perceptions and routine ways of working and to learn about more sustainable alternatives and the changes required to make these spread more widely (Loorbach 2010; Geels 2002; Frantzeskaki and Rok 2018; Voß, Smith, and Grin 2009).

However, empirical literature on learning in a sustainability transition context remains generic, without an in-depth analysis of what is actually learned and by whom (cf. Dóci, Rohracher, and Kordas 2022). As a recent editorial to a special issue on learning in sustainability transitions concluded, "sustainability transition researchers often refer to learning without conceptualizing or studying the concept in-depth. More generally, conceptual papers are lacking while empirical studies often remain implicit regarding who learns about what and why—learning is just assumed to take place" (van Mierlo et al. 2020, 253). It is thus time for transition scholars to start talking about and researching learning in transitions in a more serious and principled

CONTACT Satu Lähteenoja satu.lahteenoja@aalto.fi Department of Design, Aalto University School of Arts, Design, and Architecture, Espoo, Finland

© 2022 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group
This is an Open Access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/4.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

manner (van Mierlo et al. 2020; van Mierlo and Beers 2020; Van Poeck, Östman, and Block 2020).

The relevance of being able to provide evidence for and to conceptualize the learning that occurs (or does not occur) should not be belittled. If learning can be evidenced as a key (let alone as *the*) process driving transition-related deliberation, experiments, and policy, then the arrangements to further transitions should be specifically built to foster learning and specifically the types of learning processes that make a difference. If it turns out that many change-related phenomena that are loosely referred to as "learning" are also, and even primarily, something else—networking, interacting, influencing, following suit, imposing social pressure (and so on)—then the arrangements in transition-support processes would be best set up to primarily support these other phenomena and learning as an aside.

In this article, we analyze a transition-arena process that focuses on ways to increase renewable energy production via solar panels and heat pumps and other on-site solutions in urban areas (so-called citizen energy). The process was geared toward building a shared understanding of the action required to promote citizen energy among relevant actors. Hence, it is well-suited for studying learning in multi-party processes. This article elaborates what at least needs to be done to warrant researchers meaningfully talking about learning in such settings and what types of methodological challenges remain. We use the learning levels or "loops" framework (Bateson 2000 (1972); Argyris and Schön 1978) because it is probably the most referred to learning theory in the transitions literature (van Mierlo and Beers 2020; Van Poeck, Östman, and Block 2020). Consequently, our research question is the following: Using the learning-level framework, what types of learning can be inferred to have taken place in the transition-arena process?

To achieve this objective, we next discuss learning in transition research in more detail. In the third section, we outline how learning can be brought into explicit focus in transition-arena deliberation through research and practice-design choices. We outline how we structured a transition-arena process oriented toward evidence learning, what data became available, and what can be inferred from such data. In the fourth section, we outline the resulting data and discuss the findings of the study in the fifth section. We critically reflect on what we can infer about learning from the findings and what lessons this offers for the study of learning in transition arenas and transition research more broadly, including the further analytical and conceptual directions that could be taken.

Inferring learning in transition arenas

Knowledge co-production in transition arena processes

A transition arena is a facilitated knowledge co-production process designed to address complex systemic transition topics and to facilitate the creation of normative transition pathways that enhance desired development (Rotmans and Loorbach 2009). Knowledge co-production creates specific expectations and requirements for the actual process as well as for the selection of stakeholders. First, transition arenas are expected to create a "shared language" among the diverse actors about the systemic challenges and possible solutions (Loorbach and Rotmans 2010). Second, the co-production setting requires facilitated interaction between the stakeholders who can affect the future systems and those affected by them (Voß, Smith, and Grin 2009). Third, opening the "co-production spaces" offers a shared sense of purpose for the stakeholders with diverse backgrounds and potentially helps bridge science and policy (Frantzeskaki and Rok 2018). The co-produced knowledge is thus expected to be the glue that ties together normative sustainability claims about the future with mundane everyday actions, the designers of technologies with the users, and scientific framing with policy implementation.

The co-productive setting has also been assumed to affect how the stakeholders perceive their position in the transition-arena process and the dynamics of learning. The co-productive learning is often framed by the phrases such as "learning by doing" and "doing by learning' (see e.g., Kemp and Rotmans 2009), emphasizing the role of knowledge in reproducing the social order (Jasanoff 2004). However, whether and what learning exactly occurs in transition arenas has been far less studied (van Mierlo and Beers 2020; Van Poeck, Östman, and Block 2020). Behind the concern for loose references to learning lies a methodological issue. As Jean Lave has aptly remarked about learning in general (1993, 8): "That learning occurs is not problematic. What is learned is always complexly problematic." The learning, forgetting, and learning away processes are challenging to infer reliably from, for instance, notes and minutes made by facilitators and scribes in the heat of the workshop action or from participant interviews unless these are specifically tailored to study learning—which is seldom the case in transition-related knowledge co-production.

Learning in educational and laboratory studies – the problem of ecological validity

Difficulties in inferring learning may at first sound odd for scholars whose mainstay is something else

than learning. After all, traditional experimental psychology seldom features problems in inferring learning. Such research conducts its studies on matters and in settings where increasing competence can be known, that is, there is an approximately "right" answer or a clear possibility to discern whether an adequate response to the same encountered situation has occurred (which is a broad definition of *learning* held by many (Bateson 2000 (1972); Engeström 2000). Inferential problems are mostly related to what might have been the mechanisms of learning—has it rather occurred through changes in cognitive schemata, social imitation, or improved appropriation of cultural and social mediators of cognition (Bandura 1977; Vygotsky 1987; Cole 1996).

However, such settings close the context of learning in important respects (Cole 1996). First, the subjects of learning tend to be pre-selected to suit the study of learning and not, for instance, for their relevance to the unique social process at hand (e.g., pupils in a class or a cohort or selected subjects in a learning experiment rather than frontrunner actors in a transition). Second, the topics and tasks are typically pre-assigned and feature known answers. Third, the subjects are generally informed that they will be measured on the increase of their competence and hence perform accordingly. Such arrangements to study learning are useful in many settings. Alas, they have low "ecological validity" (Engeström 2000; Cole 1996) in real-life settings and matters such as transition arenas are open-ended, real-life, (inter)organizational, interdisciplinary, and involve complex and multi-layered topics and problems.

Inferring learning in complex multi-actor processes related to systems change

Potentially because of the above-noted low ecological validity of constrained learning arrangements on socio-technical change-related processes, very different registers on learning are typically deployed (for reviews, see van Mierlo and Beers 2020; Van Poeck, Östman, and Block 2020). The best known of such traditions are the "learning economy," "social learning," and various "learning by" conceptions which typically proceed to infer learning from changes in time-series data, changes in industry structures, or changes in experiments.

The better validity has unfortunately often come at the expense of inferential problems. Scott-Kemmis and Bell's (2010) critical re-analysis of the founding study on learning by doing in wartime-ship manufacturing by Arrow (1962) shows the tradeoffs aptly. The authors showed how Arrow rushed to conflate several other processes—changes to ship design, availability of different tools, reorganization of work shifts, organization and management of shipyards, changes in staffing, and so on—into learning by doing, as if all these changes were taking place because the personnel learned while doing. In fact, when adequately differentiated, learning by doing may eventually have accounted for a rather minor share of the efficiency improvements in the time-series analysis of wartime shipyards. The results are also consequential. Should one follow Arrow when seeking to improve manufacturing efficiency, one would trust that a next-to-automatic learning process will take care of the improvements. However, based on Scott-Kemmis and Bell's analysis, this conclusion would likely be deeply flawed. One would be very unlikely to see the sought improvements unless numerous other organizational changes were pursued instead or in tandem with learning by doing. Thus, using gross outcomes as evidence of learning is a daring thing to do; in fact, it is better seen as placing a lump-sum "learning label" onto those phenomena that the economist's (or the system analyst's) tools do not capture—the "learning curves" represent improvement curves but do not result from the alleged learning process (Hyysalo 2009). The same applies to many learning economy and social learning studies: they evoke learning as a central explanatory mechanism but seldom take on the burden of making evident who has learned what and how (or not) among all the changes (Hasu 2001; Miettinen 2002; Hyysalo 2009; van Mierlo and Beers 2020; Van Poeck, Östman, and Block 2020).

The inferential problems regarding learning are not insurmountable, but they do require focused attention and data gathering. To demonstrate this, we designed a variation of a transition-arena process (see next section) to make inferences about learning as easy as possible. We do so by using the single- and double-loop learning concepts by Argyris and Schön (1978) because it is the most used learning register in transitions research (van Mierlo and Beers 2020; Van Poeck, Östman, and Block 2020). It is also deployed in such a wealth of practice and organizational settings that its basic theoretical constructs have a reasonable number of empirical applications. It is also a learning framework that has been used in both individual and organizational learning and thus features a potentially wide scope of application.

The basic constructs of the framework and our operationalization of it are the following. Argyris and Schön (1978) built on Bateson's (2000 (1972)) logical types of learning theory in which Bateson defined learning as an adequate response to a state encountered by an organism (originally human or animal but

Table 1. The learning-types framework terms and definitions.

Bateson 2000 (1972)	Argyris and Schön (1978)	Definition	Our usage
Zero-order learning	Zero learning	Zero-order learning occurs when the same response to a situation continues to be deployed.	Zero-order learning
Deutero- learning	Deutero-learning	Subtle side-effect learning about the contexts of learning.	Deutero- learning
First-order learning	Single-loop learning	An actor learning to purposefully adjust its response to the situation or to the variation within the situation within its existing frame.	First-order learning
Second-order learning	Double-loop learning	Learner questions the way he or she assesses the situation and/or the set of possible responses to it, thus extending the set of possible interpretations and the framing of responses to the situation.	Second-order learning
–	Third-loop deutero-learning	Reorganizing the ability to learn in the entity that learns.	Learning-related to third-order change
Third-order learning	(Third-loop deutero-learning overlaps partially)	Change in the composition of the system that generates ways to organize second-order learning.	

in later use also in organizations) and is the definition we also use here. Zero-order learning occurs when the same response to a situation continues to be deployed. In contrast, learning can be said to occur when the actor learns to purposefully adjust its response to the situation or to the variation within the situation. This is first-order learning, or "single loop" learning, insofar as the framing of the situation, values guiding the action, and so forth remain the same. Learning is typically enmeshed in subtle side-effect learning, deutero-learning, about interactions, interactants, contexts, and so on. Second-order learning or "double loop" learning occurs when the learner questions the way he or she assesses the situation and/or the set of possible responses to it, thus extending the set of possible interpretations and the framing of responses to the situation. Sub-processes in second-order learning include questioning existing framings, assessing the applicability of different frames in different situations, and learning away some assumptions about how to act or think in a situation (Bateson 2000 (1972); Argyris and Schön 1978). In Bateson's view, third-order learning is a rare occurrence and entails a change in the composition of the system that generates ways to organize second-order learning. Argyris and Schön (1978), however, proposed third-loop deutero-learning as a category regarding attempts to reorganize the ability to learn in the entity that learns (be it an individual or an organization). The third-loop deutero-learning has also been called transformational learning and has counterparts in environmental education (see e.g., Nicolaides and McCallum 2013) and has been referred to in sustainability transitions and transition-arena literatures (e.g., Dóci, Rohracher, and Kordas 2022), often with an assumption that deep pro-environmental change also requires thoroughgoing learning (e.g., Frantzeskaki, Loorbach, and Meadowcroft 2012; Johannessen et al. 2019). The assumed connection between thoroughgoing learning and pro-environmental change likely owes to common markers of third-loop deutero-learning, such as learning about how previous actions have created the conditions for the present problems and reconsideration of how individuals or organizations need to be different to create transformative change (Argyris and Schön 1978). Yet, these specific markers are not necessarily exclusive to triple-loop deutero-learning as they can result also from just second-order learning if the previous frame of action was not quite as contrary to present problems (see Dóci, Rohracher, and Kordas 2022). Importantly, if the learning is truly transformative or expansive to the system that learns, the learning is likely to require a years-long process that features different phases, trials for new actions, and continuous adjustments in different aspects of the learning system and its context(s) before the learning has become completed (Engeström 2015).

In summary, inferring learning in transition-steering processes may require more careful research designs than most transition scholars thought was necessary when they evoked learning in their writings. The often referred to levels of learning framework provides one approach within which we can examine if and what learning can be inferred to have happened and to show what kind of data and analysis such inferences minimally take. Because of the differences between Bateson's and Argyris and Schön's terminologies, we follow from here on the terminology introduced in Table 1.

Materials and methods

Approach: facilitated mid-range pathway creation

The Citizen Energy Arena case study (CE Arena) was a transition-arena process that addressed

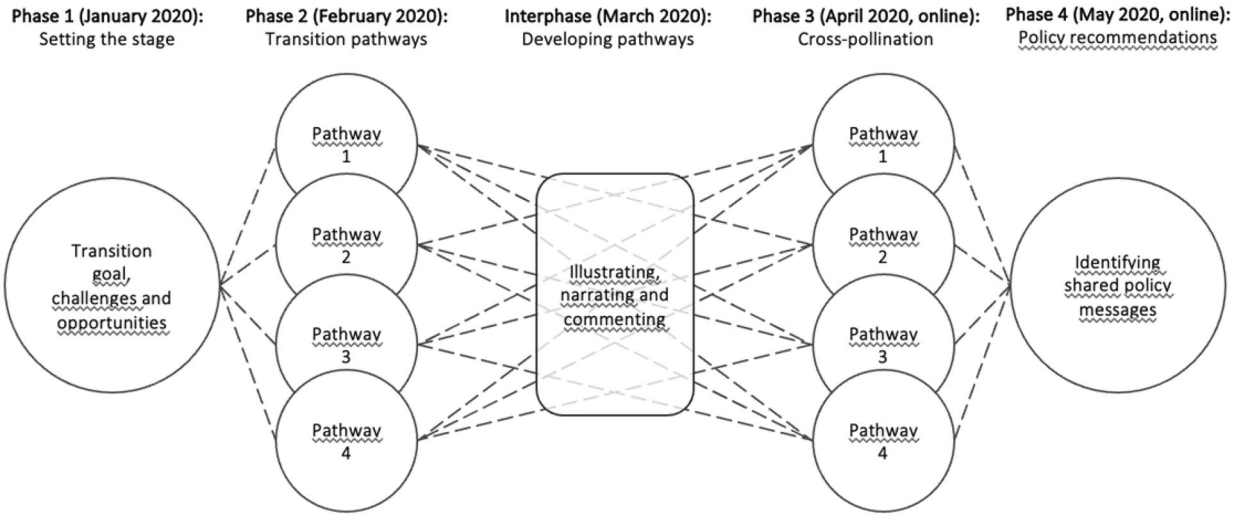

Figure 1. The stakeholder-interaction design of the Citizen Energy Arena.

decentralized renewable energy production (citizen energy) in urban owner-occupied blocks of flats and row and terraced housing in Finland (see discussion below for more details). The CE Arena was hosted by two ministries (Ministry of the Environment andMinistry of Economic Affairs and Employment) in cooperation with two research projects ("SET – Smart Energy Transition: Realizing its Potential for Sustainable Growth for Finland's Second Century" and "CORE – Collaborative Remedies for Fragmented Societies – Facilitating the Collaborative Turn in Environmental Decision-making") that were in charge of the design, facilitation, and documentation of the process.

The method of designing and facilitating the CE Arena was built on the previous mid-range pathway-creation processes and tools presented in Hyysalo, Marttila, et al. (2019) and Hyysalo, Lukkarinen, et al. (2019). The CE Arena involved 16 stakeholders with diverse expertise in citizen-energy transitions: authorities at the Ministry of the Environment and the Ministry of Economic Affairs and Employment of Finland (in total two participants from this stakeholder group), municipal authorities involved in municipal citizen-energy experiments (three participants), employees in companies providing energy-information services (two participants), front-running enterprises that develop new services (two participants), large-scale energy enterprises (one participant), Finnish electrical grid company (one participant), real estatemanagement companies (two participants), environmental non-governmental organization (one participant), and activist citizens with experience in implementing citizen-energy projects (two participants).When selecting the participants, we as organizers of the transition arena also considered a balanced distribution of gender and age. The aim was to cover a broad range of expertise, including knowledge of relevant legislative processes, recent research, novel technical solutions, and practice-based experience involving the reasons for users to adopt or reject onsite renewable energy solutions.

The CE Arena participants worked together in four half-day workshops from January until May 2020. Before the first workshop and between the workshops, the participants also commented on draft versions of the working documents. The participants were divided into four groups and each group created a pathway to increase renewable energy production eightfold in Finnish housing companies in 15 years (by 2035). The design of the stakeholder interaction is described in Figure 1.

The CE Arena had a special research design to support the learning of the participants, as well as the possibilities to study it. The design elements included:

1. The same energy-production target for each pathway-formation sub-group allowed comparison between different participants and groups. In the first phase, the participants agreed on a common citizen energy-production target for 2035, namely to achieve an eightfold increase in decentralized on-site renewable energy production in Finland to four terawatt-hours (TWh) in a year. The target was agreed on after a brief presentation of the current situation and promising pilots and small-group discussions on the challenges and opportunities.
2. A particular focus was given to group formulation and facilitation in Phase 2. The parallel working groups only had 3–5 participants per group, which allowed considerable time for interaction and exchange of ideas. The groups were heterogeneous with participants with different perspectives and even conflicting interests in the topic.

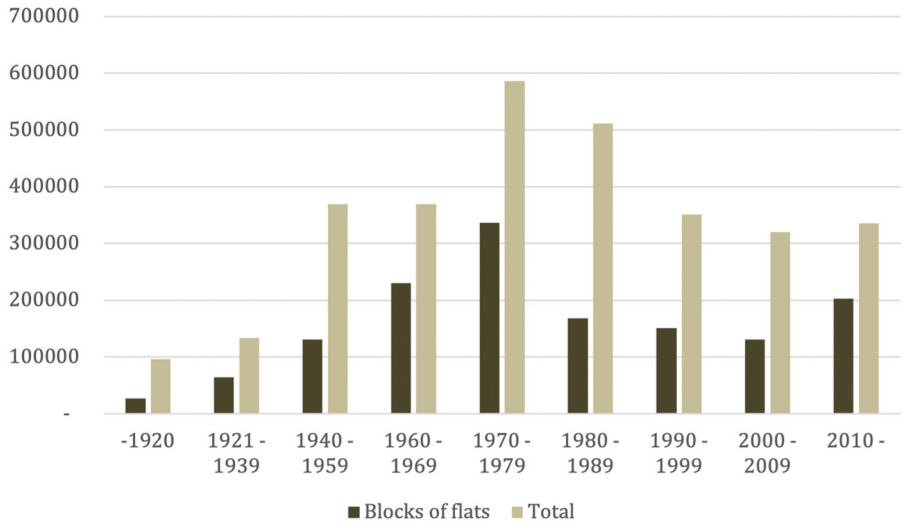

Figure 2. The age share of the Finnish building stock. Source: Statistics Finland (2021).

3. An explicit learning focus was then built into the final third phase of the arena in which the participants visited the parallel pathways constructed by other groups and were directly asked to reflect and report on what they agreed with and what they disagreed with, what was novel to them, and what pathway features they would want to adopt to their own pathway.

Research material: interviews and analysis framework

To study learning among the participants, we interviewed them on an individual basis a month after the last arena meeting and before publishing the final results. The timing of the interviews was set so that they would have time to reflect on their participation experience while still having a relatively fresh memory of the events and not yet colored by the final report. With respect to the research question, the interviews aimed to elicit the participants' perceptions of the process and to detect the impacts of the arena work on a personal level (new ideas, learning, changes in perception). We also inquired about their plans for further steps and concrete actions based on the CE Arena results (see the Appendix for an interview guide).

In total, we interviewed 13 of the 16 participants. Three participants could not schedule a meeting during the timeframe available, most claiming COVID-19-inflicted burdens and being too busy for reflection. The semi-structured interviews lasted 1–2 hours and they were conducted by video calls by three of the authors in June 2020. The questions were sent to the participants before the interviews and the recordings were transcribed and coded with thematic coding techniques using the Atlas.ti tool. This data-collection process was supplemented with participant observation made through facilitators' notes and reflections on the workshops.

Building on the literature reviewed above, our analytical framework focuses on the types and levels of learning that the interviewees reported. The types of learning arose from the interview material and include learning on the content, on the viewpoints of the others, and on the process, as examples. For analyzing the levels of learning, we use the learning-levels framework described in the earlier section of this article. To support the analysis, we asked the participants for possible matters that fostered and hindered learning and the authors discussed these explanations as a group.

Citizen energy in housing companies as a context

The CE Arena focused on the potential of increasing decentralized renewable energy production in owner-occupied housing companies in Finland. There is variance in the legal, terminological, and practical aspects of multi-owned housing across national contexts, but the Finnish housing-company model is akin to housing cooperatives, condominiums, and/or homeowner associations found in other countries (Matschoss et al. 2013; Lujanen 2010; Weatherall, McCarthy, and Bright 2018). In Finland, more than half of the population lives in residences that are part of a total of 90,000 owner-occupied housing companies where decision-making power and access to apartments are divided based on ownership share. The majority of the buildings were built in the 1960s and 1970s (see Figure 2). Many of them need extensive renovations in the short-term future and this is an enabling condition for significant energy-efficiency improvements and investments in decentralized energy-production

technologies such as solar panels and heat pumps. At the CE Arena, the situation was framed as a possibility for housing companies to emerge as energy communities with a more active role in energy policy.

The critical role of housing companies has also been noted on the national policy level, where a new energy-assistance system was introduced with extensive publicity in early 2020. Also, the European Union (EU) long-term renovation plan for 2050, mandated by the Energy-Efficiency Directive, was finalized parallel to the CE Arena. It aims at sustained coordination of the policy interventions in the building stock and its instruments are connected to the transitioning energy policy where the phase-out of coal by 2029 will create urgent demand for dispersed energy production and reimagining the governance of heat networks. Distributed energy production—especially heat-pump solutions—has gained popularity in detached building stock, but a similar development has yet to take place among the housing companies (Murto et al. 2019; Hyysalo 2021). The main reasons are connected to the particularities of housing companies, the complexity of assessing what are the suited solutions, and the underdeveloped markets and intermediation processes (Murto et al. 2019; Hyysalo et al. 2022). Each building has unique material characteristics, and each housing company has its own social dynamics that affect how they may or may not proceed with energy projects. Moreover, the range of actors connected to housing companies is wide and heterogeneous, which calls for the facilitation of actor roles and knowledge exchange among the stakeholders. On one hand, the CE Arena facilitated exchange between the diverse actors who were only partially aware of others' options. On the other hand, the arena expanded the stakeholder group by inviting active residents and innovative small companies to discuss alternative ways of engaging housing companies with energy topics.

Results

Zero-order learning among the participants

The overwhelming majority of the many actions and interactions that took place during the arena process did not involve learning that participants would have recognized and reported to researchers. In the learning-levels framework, most action and interaction featured zero-order learning, which is to be expected. At the same time, the reported learning has with very high likelihood been enmeshed in subtle side-effect learning, that is, deutero-learning, about the interactions, interactants, arena processes, material tools, and so on, but the interview data we rely on does not allow us to discern it further than what was noticed and reported by the participants (Bateson 2000 (1972); Argyris and Schön 1978).

Table 2. The types of first-order learning reported by the participants.

First-order learning reported	Number of participants
Reported learning about the views of others within one existing frame	12/13
Reported learning about the system of citizen energy as a whole	4/13
Reported learning on specific topics related to citizen energy	7/13
Reported learning that changed their existing perceptions	10/13
Reported further concrete plans based on learning	6/13
Reported ideas on which policy processes the results should feed into	4/13
Reported ideas on how the impact of the transition arena could be improved	9/13
Reported learning on how to co-create pathways together	6/13
Reported useful experiences in collaboration with people representing conflicting interests	3/13

First-order learning among the participants

All 13 interviewees reported learning from the arena process. The participants reported three types of learning which can be considered first-order learning (Bateson 2000 (1972); Argyris and Schön 1978): (1) learning about the content of citizen energy from one's existing point of view, (2) learning about the viewpoints of other participants from one's unaltered viewpoint, and (3) learning about the arena process (see Table 2).

A majority of the participants reported content-related learning. For example, several respondents learned about the need and mechanisms to support decision-making processes in the housing companies related to investments on renewable energy. Furthermore, almost half of the participants pointed out the importance of collaboration between housing companies in the same neighborhood in order to increase citizen energy in urban areas. Several respondents pointed out that, in particular, the implementation stories of the front-running citizen activists served as an eye-opener, illustrating the concrete reasons why boards of housing companies are not keen on adopting new energy solutions. However, the responses predominantly resided within the framings and lines of actions which the participants already had. One interviewee noted that,

> When it was discussed from many viewpoints, for example, the issue of enhancing the decision-making capacity of housing companies—it was really concretized there. I maybe hadn't thought about that so much, and I ended up thinking about

it. It was a concrete outcome, and we—us and this project—should put effort into that.

Learning new content about citizen energy did not depend on the participant's background. The respondents who could not specify content-related learning included one citizen, one municipal representative, the representative of one large company, and the representatives of two public authorities (Table 1, line 4). A few interviewees answered that they learned a lot about the content during the arena process, but they could not be more specific or give examples. This outcome might have been due to feeling that they did not have the same level of expertise as the others. Furthermore, being able to link the new content directly to one's work seemed to support first-order learning:

> But were there benefits? Absolutely, there were very good viewpoints, and it was really interesting, and it was really educational just because all the actors were so different and, indeed, really competent people. It was useful as such for me … I still don't feel competent in any respect to comment, at least not publicly, on energy legislation or other legislative issues; I still don't know it well enough. But indirectly I still got some insights.

The participants also reported learning from the viewpoints of others and the ability to understand alternative perspectives was, for many interviewees, the main reason and motivation to join the arena work. However, it seems that this type of learning alone did not always lead to ideas for concrete next-step actions:

> Well, maybe I learned that it is worth discussing and deliberating widely, that you always get new valuable perspectives and people have partly surprising and new views that you don't imagine when you just sit at your desk wondering what this might mean.

> As I said at the beginning, the expectations were not high, and the method was … I had no idea what it would be. So, in my view it did lead to a couple of really wonderful group work situations. It somehow worked. I think it was a positive surprise and I believe that in this way it is possible to get people who work very differently and have different interests to work together toward a collective goal.

That CE participants reported significant first-order learning was also premised in that they were already knowledgeable of the ongoing energy transition in Finland and had mostly aligned their own actions accordingly, even if its implications for the housing companies as potential citizen-energy producers were only starting to be elaborated in the CE arena.

> So, in a way, the result of the arena work more kind of strengthened the fact that what we are now doing is approximately taking us in the right direction. And of course, it is possible to use this, maybe, as a reason for developing the activity further. So, that type of information I feel I have got here. But just those, in a way, new insights that some would, or we would together, have noticed—that some aspect has been left untouched—they are maybe what was missing, but in another way, it can of course be a pleasant result—it is always a pleasant result when someone comes and states that 'What you are doing is right. Just keep going.'

Table 3. The types of second-order learning reported by the participants.

Second-order learning reported	Number of participants
Reported learning that changed their existing perceptions	6/13
Reported further concrete plans based on learning	5/13
Reported ideas on which policy processes the results should feed into	2/13
Reported learning new ways to interact through the arena process	5/13

Second-order learning among the participants

Half of the respondents reported learning that can be considered second-order learning (see Table 3; notice that these same themes also featured first-order learning as reported in Table 2, lines 4, 5 and 6). Many of these changes in the framing of participants' positions were related to their understanding of housing companies. The most important lesson for the respondents seemed to be that the housing companies do not have as good a basis for making decisions on renewable energy investments as the participants had thought. This led the energy companies to consider rethinking the quality of the services available for housing companies, a public authority to consider the challenge when planning future funding, and a city representative to think about how to support the local neighborhoods in new ways and to put them at the center of the climate work.

According to this analysis, learning about the content of citizen energy was closely related to the reported second-order learning. All six participants who reported concrete plans based on what they had learned also indicated that they learned about the content.

> In a way, maybe the biggest thing I realized here was that the best or an important way to support citizen-energy transitions is just to support the collaboration of the local community in the neighborhood.

> Maybe because housing companies and especially as the solar energy credit calculation goes forward in the legislation, we need to look at what kind of advice activities we should fund next year to housing companies especially.

Three participants pointed out that the method enabled constructive dialogue with an actor with whom they have conflicting interests, thus potentially facilitating the shaping of the energy transition. The interviewees reflected that they are often put into confrontational situations in public discussions, and they were delighted that this was not the case in this arena. Instead, the respondnets were able to listen to each other and to work together toward a common goal. This was also positively recognized and mentioned by other participants.

> I think, for me, the biggest thing was maybe to see that the method was such that it enabled us to work in such a group and constructively vocalize one's thoughts so that the others can hear them also. It was, somehow the group worked well. This method was, in my view, interestingly good.

Half of the participants also reported learning from the arena process itself. They felt the process was valuable and something new compared with the stakeholder processes they had been involved in previously. Several interviewees found it helpful to co-design future paths and also considered it a useful method for other topics. Learning about the process and the viewpoints of the others were linked: most of those who learned about the process also learned about the views of others.

> At the start, I was puzzled as to why such a large group is promoting this method, but I think this way to act started to work right away, so I noted that I got a bit excited about that. Well, this is actually a really good way to make different people think about things.

> So, the way to work inspired even me, this kind of grey civil servant official, to maybe do a bit more vivid thinking.

Learning related to third-order change among the participants

Our interviewees did not report transformative learning beyond their second-order learning, that is, learning related to third-order learning (triple-loop deutero-learning) (Argyris and Schön 1978). Even when participants discussed the arena process from the point of view of organizing learning, this took place as second-order learning about their existing framings with respect to workshops rather than as a transformative shift in the way in which they were "learning about learning."

> And about the process as such, I found the process interesting. I have been doing this kind of facilitation and leading workshops and other strategy work, so I was also interested in seeing that side. With a colleague of mine with whom we have led these, I sent, among others, photos of the boards where it was possible to move the arrows. I think that was a good idea. It makes it concrete when you can move the elements with your hands and write onto the magnetic notes. So, somehow it was, for me, a new element there.

In addition to analyzing what the participants reported to have learned, it is worth considering what they did not mention. None of the interviewees said, for example, that they would be proud of the results. Instead, many respondents criticized the outcomes by, for example, saying that there was nothing really new or nothing that they did not know already. There are at least two possible reasons for these statements. First, the interviews were conducted before we published the final report and the full scope and complete details of the results were not fully visible to the participants beyond their own sub-group. Second, the main objective of the arena method is not to create totally new ideas but to bring together existing knowledge about the topic, pilots, and examples and to find linkages between existing ideas in order to create transition pathways (Hyysalo, Marttila, et al. 2019).

> Well, also new insights were raised there but then I somehow would have expected something even more new to emerge. So, in a way, if some topic was emphasized too much or if an important theme was left aside, in relation to my expectations, the end results were in the end surprisingly familiar.

These considerations match the relatively higher amount of first-order learning in contrast to second-order learning let alone learning related to third-order change among the participants. As noted above, this was to be expected because most of the respondents held high levels of expertise about citizen energy in housing companies and were also aware of the other relevant stakeholders in the area from earlier encounters. A higher incidence of first-order learning is also, in terms of learning, something to be expected. While participants may have wanted to gain new ideas and perspectives, the second-order step of questioning and unlearning one's previous framing in light of the new perspectives is "costly" as it requires reorganizing one's existing models and perceptions, and thus it is seldom done unless there is a need to go through the burden of it. "Transformative" learning related to third-order change is even more difficult and even potentially perilous as it requires a thoroughgoing reorganization of the entity that engages in the learning (Bateson 2000 (1972)).

Discussion

Our study indicates that learning is indeed central to transition-arena processes. While many other social dynamics are undoubtedly at play, the

respondents reported learning as a major benefit of their participation and did so in identifiable ways. In other words, they went beyond an unarticulated expression that they must have learned something or changed somehow. This concreteness in the reported learning is key evidence for its actual occurrence—in contrast to participants just espousing that learning had occurred, which is notoriously common parlance in future and change-oriented social action such as transition arenas (cf. Lave 1993; Miettinen 2002, 2013).

Moreover, the recognition of learning and elaboration about what was being learned owed to participants background expertise and prior perspectives with respect to the topic of citizen energy. Some interviewees had difficulties specifying what they had learned. It seems that the more elaborated the participants' existing framings for action and thinking were, the easier it was for them to recognize and articulate what they had learned. Participants who saw direct links to the discussed topics in their work also tended to report more learning than counterparts whose work was not inherently related. Relevance is furthermore linked to considered capability to make changes in one's work. Accordingly, business representatives reported more learning than civil servants whose job descriptions seldom include direct action.

Regarding the types of learning that occurred, first-order learning was by far the most common. Regarding citizen energy, first-order learning concerned its position in the energy system, specific citizen-energy topics, and concrete plans identifying the policy processes that should be influenced. Many respondents considered learning about the viewpoints of others, and about the arena method itself, to be essential. The designers and facilitators of the CE Arena process aimed to offer a platform for co-design that could support collaborative content development. This feature seemed to create value for the participants, including value in terms of learning. The respondents regarded our facilitation methods—such as having to agree on a common target, co-designing the pathways until 2035 in small groups, and cross-checking the pathways created by other small groups (cf. Hyysalo, Marttila, et al. 2019)—as important ways to enable learning. This finding supports the notion that transdisciplinary research on climate change-related issues has moved beyond the problem identification and diagnosis state to pragmatic learning on transformations (Fazey et al. 2018). However, the diverging knowledge-bases, stakeholder interests, and forms of co-productive knowledge production create challenges for transdisciplinary science to move from ambiguous outputs toward more tangible and contextually relevant outcomes (Caniglia et al. 2021; Chambers et al. 2021). Regarding the arena process, participants reported having learned how to build pathways collaboratively and to interact with stakeholders who had conflicting views (see the results section for examples). Many also reported ideas on how the impact of the arena process could be improved, for example, by having more quantitative data available supporting the pathway creation.

Half the participants reported some second-order learning, mostly related to their framing of housing companies' capacities to act on energy renovations and, with respect to the arena methodology, making them reassess how interaction and knowledge production could be organized. The lesser prevalence of second-order learning, and particularly learning related to third-order change in contrast to the plentiful and wide-ranging first-order learning, is noteworthy and demonstrates that thinking and action regarding the sustainability transitions are well underway among the frontrunner stakeholders—they are no longer "awakening" to the need or possibilities of doing things in new ways but have adopted change-oriented framings which they clarified, broadened, and sharpened in the arena process.

On one hand, it may also take considerable time for second-order learning to come to fruition and thus only becomes articulated later (and thus would not be evident in our interviews conducted one month after the last arena workshop). This is still more the case with learning related to third-order change (Argyris and Schön 1978). On the other hand, follow-up interviews some months later could have easily become detached from the arena experience, prompting the respondents to misrepresent intricate processes such as learning. However, more research would be needed to better understand the factors that lead to second-order learning, its prevalence, and its actual importance in transition-related settings.

Our study indicates both limitations and new research directions on learning in transitions. We used reflective interviews after a transition-arena design that explicitly featured comparisons of outcomes and cross-group sharing by multidisciplinary small groups. This methodology allowed participants to point out both the occurrence and nonoccurrence of learning. However, this research design left unattended learning that participants failed to recognize or forgot to report a month later and, just as well, changes in participant orientations that become visible only after the passage of some time. To capture interactive and in-situ learning, our original approach (changed because of COVID-19) featured video recording of the cross small-group sharing sessions. We could have analyzed the resultant

transcripts for group learning and interaction dynamics and potentially used them to stimulate recall sessions afterwards and to gain participant reflections. We could have further examined these recordings to identify the material and social mediation of learning in transition arenas, albeit with considerable effort. The lighter touch data-gathering that we did—such as including questions on learning in feedback questionnaires that participants filled out after each arena session or comparing the steps that the small groups made between transition paths—provided only rather scattered data for us that alone would not have been sufficient to make inferences about leraning. This reflection is worthy of attention by other transitions scholars interested in studying learning as it indicates one is unlikely to be able to adequately study it from usual documentation procedures such as transition arenas. The longer-term learning effects are yet more difficult to isolate, as follow-up interviews conducted several months or years later would tend to blur any one event with many others that occurred during the intervening time (Hyysalo, Lukkarinen, et al. 2019).

Conclusion

In this article, we have sought to elaborate on what researchers need to consider when talking about learning in transition-related multi-party processes. Rather than a recipe for success, our results provide a foundation for a learning-sensitive approach that enables identification and consideration of methodological challenges. This study was motivated by recent reviews showing that the rhetorical centrality of learning in the transitions literature is paired with a conspicuous lack of studies that provide sufficient evidence for learning (van Mierlo and Beers 2020; Van Poeck, Östman, and Block 2020; cf. Hyysalo 2009; Scott-Kemmis and Bell 2010; Miettinen 2002, 2013). Our work demonstrates that transitions research can create research designs that focus more explicitly on learning, both in terms of seeking to support it among participants and making it possible to verify if learning has indeed occurred—and if it has, what has been learned and what kind of learning it is.

This study thus underscores that individual learning in transitions is a complex but worthy topic of study. It contests common assumptions in many transition studies such as the supposition that social learning takes place among participants from diverse backgrounds once they become engaged in arenas designed to enable transformative change (van Mierlo and Beers 2020; Van Poeck, Östman, and Block 2020). What is being learned and by whom varies considerably, and higher-level learning cannot be easily "codified" as linear knowledge transfer (Dóci, Rohracher, and Kordas 2022). Similarly, the common assumption that an arena aiming for transformative change would, and perhaps should, result in transformative learning remains unwarranted (cf. van Mierlo and Beers 2020; Van Poeck, Östman, and Block 2020). Our results indicate that first-order learning may be far more important for the participants, many of whom are already busy working toward sustainable change.

An important facet in this regard may be the timing of the arena within the overall transition process. Energy transition in Finland is well on its way even as citizen energy in housing companies is as yet a nascent part of it. Had an arena on citizen energy in housing companies been convened 15 years ago when the overall energy transition was only starting, the participants' framings would likely have been less change-oriented and hence the learning in the arena could have been potentially geared less toward first-order learning and more toward second-order learning and learning related to third-order change.[1]

For future research on sustainability transitions, our learning-focused transition arena was based on a mid-range timeframe, and it exemplified how learning could be brought more to the forefront in transitions research. We purposefully chose a popular and very barebones framework of first-order learning, second-order learning, and learning related to third-order change to show that learning in transition arenas can be analyzed even when the process includes formal and informal interaction, elaboration of ideas among different groups of people, and voices from several perspectives, including conflicting and opposing views. At the same time, our findings underscore that, for instance, we should not assume that learning related to second- or third-order change should take place or be the main learning benefit (even when the organizers assume this to be the case). Weakly specified or implicit assumptions about learning, such as settings that seek to catalyze transformative change or that insist on transformative learning, simply cut too many corners.

As to the implications for building transition arenas that are conducive to learning, four issues stand out. First, the creation of well-working group dynamics by careful facilitation and selection of the participants enables a safe space for sharing ideas, which then supports learning about the viewpoints of other participants. Second, facilitated pathway creation, aimed at commonly agreed targets, enables learning about the content of the topic by providing common referents and externalizing participants' points of view. Third, having several sub-groups

work on the same topic and goal and with the objective of sharing their productions with others before finalizing their own pathways is an excellent way to encourage reflection and to gain a more comprehensive picture of the topic. Finally, given different orientations and levels of expertise, organizers can level the interactions in important ways by providing a background memo that recounts key facts, ongoing policy processes, and development projects for all participants.

Note

1. The differences that transition phases induce to arena work have been evident in outcomes and processes of a transition arena related to the UN 2030 Agenda implementation in Finland. In 2021, hosted by the Finnish Prime Minister's Office, six transition-arena pathways were developed for implementing the sustainable development goals (SDGs) in food, energy, natural resource use, health and well-being, economy, and education systems (Lähteenoja, Hyysalo, and Marttila 2022).

Ethics approval and consent to participate

We obtained the written consent of all interviewees to take part in the research. The data have been anonymized without distorting the scholarly meaning. The research protocol has been internally reviewed by the authors and fully adheres to the guidelines of ethical research by TENK, the Finnish board of scientific integrity and ethics.

Disclosure statement

No potential conflict of interest was reported by the authors.

Funding

This work was supported by the Strategic Research Council of Finland consortium 293405 "Smart Energy Transition: Realizing its Potential for Sustainable Growth for Finland's Second Century (SET)" and the Strategic Research Council of Finland consortium 313013/313014 "Collaborative Remedies for Fragmented Societies—Facilitating the Collaborative Turn in Environmental Decision-making (CORE)," Academy of Finland profiling funding Profi 6 336454 and Academy of Finland consortium Digitally Mediated Decarbon Communities in Energy Transition 348197.

ORCID

Satu Lähteenoja http://orcid.org/0000-0002-8852-7370
Sampsa Hyysalo http://orcid.org/0000-0003-0545-0011
Jani Lukkarinen http://orcid.org/0000-0001-6362-2470
Tatu Marttila http://orcid.org/0000-0001-9844-7318
Heli Saarikoski http://orcid.org/0000-0001-7256-9691
Maija Faehnle http://orcid.org/0000-0002-4206-8543
Lasse Peltonen http://orcid.org/0000-0003-2423-1420

References

Argyris, C., and D. Schön. 1978. *Organisational Learning: A Theory of Action Perspective*. Reading: Addison Wesley.

Arrow, K. 1962. "The Economic Implications of Learning by Doing." *The Review of Economic Studies* 29 (3): 155–173. doi:10.2307/2295952.

Bandura, A. 1977. *Social Learning Theory*. Englewood Cliffs, NJ: Prentice Hall.

Bateson, G. 2000 (1972). *Steps to an Ecology of Mind: Collected Essays in Anthropology, Psychiatry, Evolution, and Epistemology*, 2nd Edition. Chicago: University of Chicago Press.

Caniglia, G., C. Luederitz, T. von Writh, I. Fazey, B. Martín-López, K. Hondrila, A. König, et al. 2021. "A Pluralistic and Integrated Approach to Action-Oriented Knowledge for Sustainability." *Nature Sustainability* 4 (2): 93–100. doi:10.1038/s41893-020-00616-z.

Chambers, J., C. Wyborn, M. Ryan, R. Reid, M. Riechers, A. Serban, N. Bennett, et al. 2021. "Six Modes of Co-Production for Sustainability." *Nature Sustainability* 4 (11): 983–996. doi:10.1038/s41893-021-00755-x.

Cohen, M. 2019. "Introduction to the Special Section: Innovative Perspectives on Systems of Sustainable Consumption and Production." *Sustainability: Science, Practice and Policy* 15 (1): 104–110. doi:10.1080/15487733.2019.1703331.

Cole, M. 1996. *Cultural Psychology: A Once and Future Discipline*. Cambridge, MA: Harvard University Press.

Dóci, G., H. Rohracher, and O. Kordas. 2022. "Knowledge Management in Transition Management: The Ripples of Learning." *Sustainable Cities and Society* 78: 103621. doi:10.1016/j.scs.2021.103621.

Engeström Y. 2015. *Learning by Expanding*, Cambridge: Cambridge University Press.

Engeström, Y. 2000. "Activity Theory as a Framework for Analysing and Redesigning Work." *Ergonomics* 43 (7): 960–974.

Fazey, I., N. Schäpke, G. Caniglia, J. Patterson, J. Hultman, B. van Mierlo, F. Säwe, et al. 2018. "Ten Essentials for Action-Oriented and Second Order Energy Transitions, Transformations and Climate Change Research." *Energy Research & Social Science* 40: 54–70. doi:10.1016/j.erss.2017.11.026.

Frantzeskaki, N., D. Loorbach, and J. Meadowcroft. 2012. "Governing Societal Transitions to Sustainability." *International Journal of Sustainable Development* 15 (1–2): 18–19. doi:10.1504/IJSD.2012.044032.

Frantzeskaki, N., and A. Rok. 2018. "Co-Producing Urban Sustainability Transitions Knowledge with Community, Policy and Science." *Environmental Innovation and Societal Transitions* 29: 47–51. doi:10.1016/j.eist.2018.08.001.

Geels, F. 2002. "Technological Transitions as Evolutionary Reconfiguration Processes: A Multi-Level Perspective and a Case Study." *Research Policy* 31 (8–9): 1257–1274. doi:10.1016/S0048-7333(02)00062-8.

Hasu, M. 2001. "Critical Transition from Developers to Users." PhD Dissertation., Department of Education, University of Helsinki.

Hyysalo, S. 2009. "Learning for Learning Economy and Social Learning." *Research Policy* 38 (5): 726–735. doi:10.1016/j.respol.2009.01.003.

Hyysalo, S. 2021. *Citizen Activities in Energy Transition: User Innovation, New Communities and the Shaping of a Sustainable Future*. New York: Routledge.

Hyysalo, S., E. Heiskanen, J. Lukkarinen, K. Matschoss, M. Jalas, P. Kivimaa, J. Juntunen, F. Moilanen, P. Murto, and E. Primmer. 2022. "Market Intermediation and Its Embeddedness – Lessons from the Finnish Energy Transition." *Environmental Innovation and Societal Transitions* 42: 184–200. doi:10.1016/j.eist.2021.12.004.

Hyysalo, S., J. Lukkarinen, P. Kivimaa, R. Lovio, A. Temmes, M. Hildén, T. Marttila, et al. 2019. "Developing Policy Pathways: Redesigning Transition Arenas for Mid-Range Planning." *Sustainability* 11 (3): 603. doi:10.3390/su11030603.

Hyysalo, S., T. Marttila, S. Perikangas, and K. Auvinen. 2019. "Codesign for Transitions Governance: A Mid-Range Pathway Creation Toolset for Accelerating Socio-Technical Change." *Design Studies* 63: 181–203. doi:10.1016/j.destud.2019.05.002.

Jasanoff, S., ed. 2004. *States of Knowledge: The Co-Production of Science and Social Order*. London: Routledge.

Johannessen, Å., Å. Swartling, C. Wamsler, K. Andersson, J. Arran, D. Hernández Vivas, and T. Stenström. 2019. "Transforming Urban Water Governance through Social (Triple-Loop) Learning." *Environmental Policy and Governance* 29 (2): 144–154. doi:10.1002/eet.1843.

Kemp, R., and J. Rotmans. 2009. "Transitioning Policy: Co-Production of a New Strategic Framework for Energy Innovation Policy in The Netherlands." *Policy Sciences* 42 (4): 303–322. http://www.jstor.org/stable/40586542.

Köhler, J., F. Geels, F. Kern, J. Markard, A. Wieczorek, F. Alkemade, F. Avelino, et al., 2019. "An Agenda for Sustainability Transitions Research: State of the Art and Future Directions." *Environmental Innovation and Societal Transitions* 31: 1–32. doi:10.1016/j.eist.2019.01.004.

Lähteenoja, S., S. Hyysalo, and T. Marttila. 2022. "Kuusi muutospolkua Agenda 2030–tavoitteisiin: Agenda 2030 murrosareenatyön tulokset (Six Systemic Change Pathways to Reach the 2030 Agenda: The Results of the 2030 Agenda Transition Arena)." Appendix 3 in *Kestävän kehityksen toimikunnan Agenda 2030-tiekartta* (*The 2030 Agenda Roadmap of the Committee for Sustainable Development in Finland)*. https://kestava-kehitys.fi/documents/2167391/109172057/Agenda2030±tiekartta,±FINAL±2022.pdf/75abd43f-abb2-9c45-2881-041d9736ad3a/Agenda2030±tiekartta,±FINAL±2022.pdf

Lave, J. 1993. "The Practice of Learning." In *Understanding Practice: Perspectives on Activity and Context*, edited by S. Chaiklin and J. Lave, 3–32. Cambridge: Cambridge University Press.

Loorbach, D. 2010. "Transition Management for Sustainable Development: A Prescriptive, Complexity-Based Governance Framework." *Governance* 23 (1): 161–183. doi:10.1111/j.1468-0491.2009.01471.x.

Loorbach, D., and J. Rotmans. 2010. "The Practice of Transition Management: Examples and Lessons from Four Distinct Cases." *Futures* 42 (3): 237–246. doi:10.1016/j.futures.2009.11.009.

Lujanen, M. 2010. "Legal Challenges in Ensuring Regular Maintenance and Repairs of Owner-Occupied Apartment Blocks." *International Journal of Law in the Built Environment* 2 (2): 178–197. doi:10.1108/17561451011058807.

Masson-Delmotte, V., P. Zhai, A. Pirani, S. Connors, C. Péan, S. Berger, N. Caud, et al. 2021. *Climate Change. The Physical Science Basis: Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge: Cambridge University Press.

Matschoss, K., E. Heiskanen, B. Atanasiu, and L. Kranzl. 2013. "Energy Renovations of EU Multifamily Buildings: Do Current Policies Target the Real Problems?" *Rethink, Renew*. Restart: Proceedings of the ECEEE 2013 Summer Study. https://www.eceee.org/library/conference_proceedings/eceee_Summer_Studies/2013.

Miettinen, R. 2002. *National Innovation System: Scientific Concept or Political Rhetoric*. Helsinki: Edita.

Miettinen, R. 2013. *Innovation, Human Capabilities, and Democracy: Towards an Enabling Welfare State*. Oxford: Oxford University Press.

Murto, P., M. Jalas, J. Juntunen, and S. Hyysalo. 2019. "The Difficult Process of Adopting a Comprehensive Energy Retrofit in Housing Companies: Barriers Posed by Nascent Markets and Complicated Calculability." *Energy Policy* 132: 955–964. doi:10.1016/j.enpol.2019.06.062.

Nicolaides, A., and D. McCallum. 2013. "Inquiry in Action for Leadership in Turbulent Times: Exploring the Connections between Transformative Learning and Adaptive Leadership." *Journal of Transformative Education* 11 (4): 246–260. doi:10.1177/1541344614540333.

Rotmans, J., and D. Loorbach. 2009. "Complexity and Transition Management." *Journal of Industrial Ecology* 13 (2): 184–196. doi:10.1111/j.1530-9290.2009.00116.x.

Schot, J., and F. Geels. 2008. "Strategic Niche Management and Sustainable Innovation Journeys: Theory, Findings, Research Agenda, and Policy." *Technology Analysis & Strategic Management* 20 (5): 537–554. doi:10.1080/09537320802292651.

Scott-Kemmis, D., and M. Bell. 2010. "The Mythology of Learning-by-Doing in World War II Airframe and Ship Production." *International Journal of Technological Learning, Innovation and Development* 3 (1): 1–35. doi:10.1504/IJTLID.2010.031051.

Statistics Finland. 2021. *Dwellings and Housing Conditions*. Helsinki: Statistics Finland. http://www.stat.fi/til/asas/index_en.html.

van Mierlo, B., and P. Beers. 2020. "Understanding and Governing Learning in Sustainability Transitions: A Review." *Environmental Innovation and Societal Transitions* 34: 255–269. doi:10.1016/j.eist.2018.08.002.

Van Mierlo, B., J. Halbe, P. Beers, G. Scholz, and J. Vinke-de Kruijf. 2020. "Learning About Learning in Sustainability Transitions." *Environmental Innovation and Societal Transitions* 34. doi:10.1016/j.eist.2019.11.001.

Van Poeck, K., L. Östman, and T. Block. 2020. "Opening up the Black Box of Learning-by-Doing in Sustainability Transitions." *Environmental Innovation and Societal Transitions* 34: 298–310. doi:10.1016/j.eist.2018.12.006.

Voß, J.-P., A. Smith, and J. Grin. 2009. "Designing Long-Term Policy: Rethinking Transition Management." *Policy Sciences* 42 (4): 275–302. doi:10.1007/s11077-009-9103-5.

Vygotsky, L. 1987. "Thinking and Speech." In *The Collected Works of Lev Vygotsky*, Volume 1, edited by R. Rieber and A. Carton, 39–285. New York: Plenum Press.

Weatherall, D., F. McCarthy, and S. Bright. 2018. "Property Law as a Barrier to Energy Upgrades in

Multi-Owned Properties: Insights from a Study of England and Scotland." *Energy Efficiency* 11 (7): 1641–1655. doi:10.1007/s12053-017-9540-5.

Appendix. Interview guide.

Transition arena work

1. How did you experience arena work? What were the benefits and what were the challenges related to the process?
   a. Did the goal-setting of the transition arena meet your expectations?
   b. Was enough time set aside for goal formulation?
2. Were the right participants involved?
3. Was any topic overemphasized or was an important topic left unaddressed? If so, why?
4. Did you feel that there were conflicting interests involved? How did this affect the results of the work?

Learning

5. Did you learn anything during the arena work that you can directly utilize in your work/activities? If so, what and what plans do you have for applying this?
6. Did new ideas (related to, for example, business, politics, practices) arise for you as a result of the work in the arena?
7. Did you come across questions in the work that are not known enough? How could challenges and information needs be addressed after the arena?

Transformation and politics

8. How should the recommendations of the Citizen Energy Arena be taken forward?
   a. Who should be involved in the transition work after the arena phase?
   b. To which policy processes should the results be fed?
   c. How can the effectiveness of the citizen energy transition arena be improved?
9. In a few sentences, could you summarize your own views on how citizen energy should be promoted over the next five years?
10. Were there any development paths or actions in the proposals of the other path groups that, from your point of view, are not workable or supportable?
11. Do you have any other comments?
12. After the interview, we will send you a form in which you can evaluate the most important recommendations for action.