Policy networks and power relations: what determines the success of social innovation in energy within cities?

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Abstract

Our ability to keep global temperature rise well below 2.0 degrees Celsius will depend not only on technological innovations but also on new ways of thinking, organizing, and doing. These new ways can be understood as social innovations in energy (SIE). SIE can be found on the energy supply side (e.g. energy cooperatives), on the energy demand side (e.g. community-based electricity/heat-storing options) as well as spanning across these classically distinct sides (e.g. prosumaging). SIE have the potential to substantially decrease energy demand and increase citizen engagement as well as acceptance for the energy transition in general and necessary measures in particular. Cities differ quite substantially in their success to implement local measures for global challenges and SIE might play a crucial part therein.

We argue that policy networks within cities might be crucial to explain some of these differences. We therefore study how patterns of coordination in policy networks promote or inhibit SIE. A combination of online surveys and qualitative interviews was used to collect network data and different forms of interaction in the exemplary case of the city of Mannheim (Germany). The networks were assessed quantitatively by means of social network analysis. This was supplemented by a qualitative content analysis of the interviews conducted. It was found that not many main players are clustered at the junction of social innovation and the energy system, where they encourage SIE. The focal players interact mainly on the basis of power and trust structures and not on the basis of similar beliefs in the field of SIE. This impedes the emergence of SIEs because they have the potential to affect relationships and network structures and are therefore only promoted in a controlled manner within a limited scope.

This work lays an important foundation for future work in which the policy network analysis will be expanded in a comparative manner across six European cities.

Introduction

To keep the global temperature rise well below 2.0 degrees Celsius and achieve climate mitigation goals is currently one of the most important challenges humans face. The transformation of fossil fuel based energy systems by increasing the shares of renewable energy and enhancing energy efficiency will rely not only on technological innovations. Instead, attention is now increasingly put on social dimensions of energy transitions and thus the concept of social innovations in energy (SIE) (Wittmayer et al. 2020; Hoppe and de Vries 2018; Sovacool 2014; Hewitt et al. 2019). SIE can be understood as new ways of thinking, organizing, and doing energy. They can be found on the energy supply side (e.g. energy cooperatives), on the energy demand side (e.g. community-based electricity/heat-storing options) as well as spanning across these classically distinct sides (e.g. prosumaging[1]). They have the potential to substantially decrease energy demand and increase citizen engagement as well as acceptance for the energy transition in general and necessary measures in particular (Wittmayer et al. 2020). For

1. Prosumaging combines producing, consuming and managing of energy (Brugger et al. 2021).

example, decentralization and decarbonization as parts of a successful energy transition (EEA 2019) are strongly linked to social changes and changing roles and relationships in the energy system (Sovacool 2014; Sovacool and Griffiths 2019). Local policy and a change in political objectives can promote or inhibit social innovations and thus change relationships and actor roles in the energy system. However, such policy change is dependent on the actors actively engaged in SIE and their positions in the governance structure. While social innovation (SI) is explicitly promoted in EU goals (BEPA 2011) as well as in national and local policies (Krlev et al. 2020; City of Mannheim 2019a), SIE are still underrepresented. Energy cooperatives are commonly advocated for, in the German Renewable Energy Act (EEG) for instance, whereas other kinds of initiatives and concepts such as collaborative eco-efficient housing and peer-to-peer-based concepts are only inadequately supported. Against this backdrop, cities differ quite substantially in their success to implement local measures for global challenges and SIE might play a crucial part therein. Therefore, we examine SIE in the industrial city of Mannheim where they are still an emerging topic as opposed to other cities with a background of grassroots initiatives.

While SI and SIE are often suggested to be and instrument for achieving climate and energy transition goals, Wittmayer et al. (2020) plead for an understanding that includes the SIE as a process and as such part of the transition. The measures taken to implement the German energy transition do not achieve the agreed Paris targets. The Climate Protection Programme 2030 for the implementation of the Climate Protection Plan was adopted in October 2019, one year late (BMU 2019b). Technological innovations such as photovoltaic systems or heat pumps promise to further increase the share of renewable energies. While their use is rising, non-homeowners, for example, are at a disadvantage. Likewise, people with only few financial resources often cannot participate in the offers. This is where SIE can be beneficial. Community-based concepts and improved accessibility for all people can not only help to advance the energy transition but also be part of the future energy system (Becker et al. 2017).

But since a comprehensive understanding of SIE is still rather new and local contexts differ, the political implementation on national and local levels is still challenging. To better understand SIE and the actors forming around them, a look at the policy network around the issue is useful. The analysis of policy networks serves to get a deeper understanding of the relations between key actors at the urban scale (e.g. policy-makers, city administration actors, energy utilities, businesses, initiatives and network organisations) and to identify enabling and impeding network structures for SIE. Policy network analysis allows for a comparative analysis of beneficial and conflicting relations and identifies structures in actor relations, such as the importance of actors, the density of relations, and the presence of supporting or conflicting relationships (Wasserman and Faust 1994; Henry and Vollan 2014).

This paper explores the interplay between actors' understanding of their role in the context of SIE and their experiences and perceptions in an industrial urban site. Therefore, the focus lies on actors related to SIE and the interactions between the different stakeholders as well as their individual roles in the Policy Network around SIE. More specifically we analyze how trust and power as forms of coordination influence the emergence of SIE in an urban context. As a frame of reference to address this question we draw on the Advocacy Coalition Framework (ACF) to analyze policy processes and policy networks in relation to coordination based on beliefs, trust and power. While shared beliefs on specific issues such as the transition toward a decarbonized energy system are often said to be the glue between actors cooperating on a policy issue (Weible and Ingold 2018), types of coordination such as power and trust play an important role for actors to decide to work together, including matters such as influence, access to resources and personal relationships. With the study we address the research gap around SIE as transformative processes. Individual forms of SIEs such as types of initiatives and organizations in relation to policy processes and change have already been studied (Brisbois 2020; Becker et al. 2017; Wagemans et al. 2019). However, there is a lack of holistic studies that take into account all dimensions of the subject (Wittmayer et al. 2020). Also, the approach of the ACF to research forms of coordination as enabling or restrictive in the context of innovation, especially SIE, has not yet been taken. Hence, the ACF is applied empirically on the network data gained through 10 surveys and 10 in-depth interviews after 23 relevant organizations had been identified and reached out to. The data is analyzed with respect to the influence of types of coordination on the development of SIE in a Policy Network and the underlying mechanisms to the formation of the current Policy Network.

The following sections provide further information on the conceptual background by defining relevant terms and describing possible outcomes of different types of interaction and coordination. We then describe the methodological approach for data collection and analysis before presenting findings. In the concluding discussion we find that central actors form a cluster around the issue of SIE in Mannheim at the junction of the fields of SI and energy. They interact mainly on the basis of power and trust structures and not on the basis of similar beliefs in the field of SIE. This impedes the emergence of SIE because they have the potential to affect relationships and network structures and are therefore only promoted in a controlled manner within a limited scope.

Conceptual Approach and State of Research

Policy processes and coordination around new political and societal issues can be assessed on different levels. The Advocacy Coalition Framework offers the concepts of coalitions, shared beliefs, and coordination to explore how actors form and act around an issue, in this case SIE. The framework is a well-developed and suitable fundament for analyzing a policy network with respect to network structure and different types of relations between the network members. It is based on the assumption that the public and political discourses around the topic as well as policy making processes take place in a policy subsystem (Jenkins-Smith et al. 2017). A policy subsystem is a specific policy domain within a clearly defined geographical scope that contains all relevant stakeholders who influence processes in said field of interest (Pierce et al. 2017).

Relevant actors are all those involved with the topic, including not only policy players but also individuals and organizations who attempt to influence policy processes. Based on shared ideologies and beliefs, they tend to form advocacy coali-

tions, informal alliances with the purpose of working towards a common goal (Weible and Ingold 2018). Policy resulting from this cooperation in a coalition are considered the translation of the coalition's member's beliefs and fundamental values (Jenkins-Smith et al. 2017).

These beliefs are regarded as the glue between coalition members which is needed for lack of formal aspects of membership (Henry 2011a). They are organized in hierarchic belief systems consisting of three kinds of beliefs sorted from broad to very specific (Weible and Ingold 2018). Deep core beliefs are normative and ontological axioms such as fundamental normative attitudes, a political stance for instance. The less abstract policy core beliefs are bound to the policy subsystem and based on political opinions and fundamental values such as strategies on how to achieve deep core beliefs. Furthermore, the specific secondary aspects refer to precise instruments and ideas for the implementation of goals. While there is a consensus on the importance of beliefs when choosing cooperation partners in a policy network (Henry 2011b; Weible 2005), (Ingold 2011) states that beliefs, specifically policy core and secondary beliefs may be sources of conflict as well as sources of cooperation within a policy network. When she researched Swiss climate policy networks, the author found that ally and enemy network structures reflect on prevailing belief systems (ibid.).

However, while shared beliefs are assumed to be the glue between stakeholders, coordination is an important aspect considered to outweigh them when faced with barriers such as funding problems or range of influence. Coordination can refer to planned political behavior such as sharing resources or not defined or officially established patterns of behavior (Weible and Ingold 2018). Such undetermined behavior can for one be based on trust and personal relationships which then reciprocally enhance assimilation between actors and their interests, as researched in the context of co-management in Sweden (Hahn et al. 2006). Another aspect of coordination can be power in terms of an actor's influence concerning the issue or ability to mobilize resources and pursue a goal (Henry 2011b). This relational approach to power assumes that actors reach various levels of power which results in dependency and exploitation between members of a policy network (Avelino 2017). Henry (2011b) has shown that trust, the desire for access to resources and a powerful position in relation to one's peers as well as corresponding beliefs are endogenous factors which enable the emergence and cohesion of networks and coalitions.

Data and Methods

CONTEXTUAL BACKGROUND

The present study has been conducted in Mannheim, Germany. The city has an industrial background, industry makes 37 % of the gross added value (as of 2018) and a large coal power plant situated there provides the majority of the energy for the region, including a district heating grid operated by the local utility. Furthermore, 5 km² of conversion areas, former Military sites, offer space for urban development and new concepts (City of Mannheim 2019b).

Social Innovation is considered an important part of the local economic development and part of the local 2030 targets (City of Mannheim 2019a). Energy and the energy transition, however are mostly included in the topic of electro mobility and partly as concepts for energy efficient buildings on the conversion areas. Thus, SIE are only just emerging and the concept is still to be implemented explicitly in the local policy.

DATA AND METHODS

For the study, a mixed-method approach was adopted to gather quantitative and qualitative data. The combination of an online survey and semi-structured interviews, both structured based on the conceptual background, helped to collect data on the network structure as well as in-depth knowledge about motives, backgrounds and circumstances. First important local actors in the energy system relevant for political processes around SIE were identified through a pilot interview with a specific administrative actor who also filled in a first version of the questionnaire. To prevent a bias through the restricted field access the sample was not only broadened through a snowball approach, but also with a further desktop research and through exchange with experts in the regional energy system. In the questionnaire, apart from demographic data and network partners, different types and qualities of interaction were assessed, e.g. competitive or conflictual relations. Moreover, the respondents were asked to rate different attributes of their contacts, in particular trustworthiness, innovativeness or supportiveness, perceived level of power and the perceived level of agreement. A total of 12 actors participated in the study, eight of whom both completed the survey and gave an interview. The sample consisted of three administrative actors, an NGO with a focus on energy, two companies in the energy sector, two associations, an architect and two R&D organizations. The unfamiliarity with the concept posed a problem as some contacted actors did not consider themselves to be part of this field and therefore didn't participate. Not only in the introductory e-mail, but also in both formats SIE were introduced via a definition and specific examples which could be fitted to the interviewees in the direct conversation.

Data collection took place between June and October 2020. All interviews lasted between 45 and 90 minutes and were, except for one, recorded and later transcribed for further analysis. The data was anonymized. The IDs assigned to the actors were based on the actor systematization. Based on an alphabetical sorting of these titles, numerical consecutive identification numbers were assigned to the actors in the network datasets. These differ in the two data sets due to the different number of actors.

DATA ANALYSIS

The data were analyzed for structures and positions that influence the development, implementation and diffusion of social innovations in the existing SIE field. By means of a qualitative content analysis of the interview transcripts, the network data obtained through the online survey was supplemented and supporting information on the network structure and thematic context was obtained. In a network analysis, the surveyed policy network was examined.

Qualitative Content Analysis

The interviews were semi-structured, based on an interview guideline featuring details about involvement in SIE, existing network structures including enabling and impeding aspects, relevant policy and policy processes for SIE as well as on power

structures in the existing policy network. They were then analyzed qualitatively according to Mayring (2015), i.e. systematically and rule- as well as theory-based. Categories were formed both deductively, i.e. based on the thematic and theoretical background, and inductively (ibid.). Some of the categories are oriented towards the concepts from chapter 2.1, while others are aligned with aspects of the SIE. Additional codes were created for information on "Meetings" and "Policy". The coding system evolved during the coding process according to new insights from the interviews. All codes were defined and clarified with anchor examples. The coding supports the understanding of the network structure. Furthermore, connections between the individual aspects can be displayed and evaluated in a structured way. A clear picture of connections between theory and observed patterns emerges.

Social Network Analysis

Based on a description of the network structure, it was analyzed how observed patterns affect the formation and success of SIE initiatives. The surveyed network is composed of the ego networks of the sampled actors, meaning only relationships of the interviewees (Egos) were sampled. Alteri relationships, meaning those between the named contacts, could not be surveyed within the sample size and because of limited field access. Hence, the quantitatively observable patterns are not necessarily representative of the SIE policy network structure. Insights from the interviews supported the identification of any deviations or confirmations of the interaction patterns. Two edge lists were created to map the relationships between the actors as well as edge attributes. One consists only of the relationships assessed in the survey while the other is an aggregated dataset complemented by relationships that were only mentioned in the interviews. Additionally, two attribute datasets were generated that characterize the properties of the nodes, such as actor type, geographical scope and the sector they are mainly active in.

On this basis, multiplex ego networks in the local SIE field were assessed. It contains different types of relationships between the same actors, assessed in the survey with a multiple choice. This allows for a record of various levels of relationships and thus several dimensions of social interaction in the SIE policy network (Bae and Feiock 2012). The aggregated network provides the basis for most of the analysis. However, for the analysis of the recorded quality of the relationships such as agreement trustworthiness and power, the first network was used because the qualities of specific connections could not be captured in detail in the interviews. Trust was sampled by asking if the other contact was perceived as trustworthy. Agreement, as an indicator for shared beliefs, and power were assessed by means of five-point Likert scales, reaching from totally agree to totally disagree and very powerful to not at all powerful. Power was defined as being influential and having access to resources, be they financial means, human capital, information or other. The evaluation was carried out with R, whereby in different steps on the one hand the aggregate network was considered, on the other hand only the ego networks. Since no relations between Alteri could be assessed, the analyses of the aggregate network are to be seen critically. Still, centralities were calculated. The indegree centrality, which is the number of edges pointed toward a node, allows for conclusions about who is particularly central in the network and distributes information. Betweenness centrality refers to the direct and indirect relationships in a network and expresses through which actors most resources, such as knowledge, are distributed (Freeman 1979). Moreover, group-level analyses could be applied.

Since not a whole network, but only the relations of few actors could be assessed, the evaluation of the ego networks was complemented by a qualitative approach based on the visual impressions (Jaspersen and Stein 2019). This process was combined with the results of the qualitative analysis of the interviews in order to be able to further explain the observed and quantitatively determined structures.

Results

THE POLICY NETWORK AND ACTOR POSITIONS

The assessed policy network consists of 56 actors identified through preliminary research and the survey and interviews. They were assigned the categories used in the multi-actor perspective by Wittmayer et al. (2021): in total, 12 were market actors, 12 were state actors (such as political parties and administrative actors), and the majority (32) were part of Civil Society, including both community actors and non-governmental organizations, consisting of NGOs, associations and R&D. This distribution fits the assessment of one administrative stakeholder who testified that there are too many intermediaries acting as enablers and too few actual SIE initiatives or organizations.

The actors were further categorized according to their background showing that the majority was active in the sectors energy (18) and SI (16), while only 5 were SIE-actors and 17 either active in either sustainability topics or in other sectors. Energy actors are divided into economic and civil society actors. The sectors SI and SIE, on the other hand, are more diverse in composition with only one market actor and more administrative and again many civil society actors. Above all it shows that the SIE-policy network consists mostly of actors at the junction between energy and SI with hardly any SIE-actors. The interviews confirmed that SI and energy both play important roles in the city and especially SI are largely promoted, whereas SIE are rather a subtopic in accordance to the energy transition as a subcategory to sustainability and climate issues.

These actors form a network with a density of 0.032, i.e. only few of all possible relations are realized. It features a core-periphery structure; the core is closely connected, whereas the periphery consists of only loosely connected nodes, mostly through one other actor.

The assessment of different centralities has shown that a few players stand out in particular. Naturally, the egos stand out but nevertheless, the measures can convey an impression of the actor positions in the network. Three egos have an indegree centrality and a betweenness centrality of 0 since they weren't named by any other contacts. In contrast, four egos stand out in particular because of their high centralities. Their significance reflects in the subgroups resulting from a hierarchical cluster analysis based on the Euclidian distance between the nodes.

Five subgroups were identified, where two groups consist of peripheral actors only (see Figure 1) and include no egos, which is why they were mostly excluded from further analysis. More striking is the second group consisting of five egos who are very central in the network and have the highest indegree

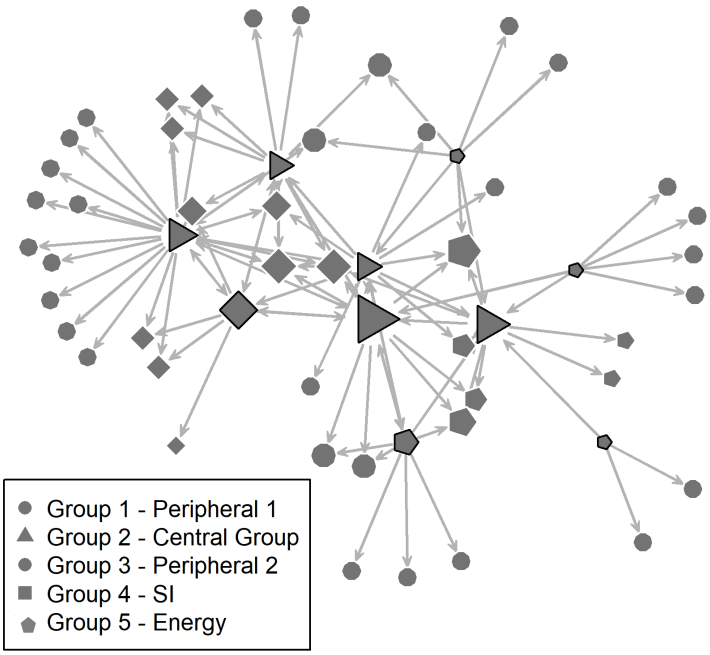

Figure 1. Local SIE Policy Network. Black vertex borders indicate egos.

Table 1. Identified Clusters.

Group	Number of nodes	Average indegree	Average betweenness
1 – Peripheral 1	10	1	0
2 – Central	5	4.4	0.068
3 – Peripheral 2	20	1.2	0
4 – SI	11	2.63	0.001
5 – Energy	10	1.5	0.002
Network average	56	1.78	0.006

Table 2. E-I-Index.

Group	External Relations	Internal Relations	E-I Index (group level)
1 – Peripheral 1	10	0	1
2 – Central	63	16	0.59
3 – Peripheral 2	24	0	1
4 – SI	25	8	0.51
5 – Energy	34	4	0.78

as well as betweenness centralities. Thus, they were frequently named as important contacts in the context of SIE and are connected better than the others. The average indegree as well as the average betweenness in this group is above average compared to the other subgroups (see Table 1).

The group is also considerably smaller than the others. Yet, more connections are realized between the members than in other groups. The E-I-Index, where a positive value means more external than internal relations, is in no case negative and has the highest possible value of 1 in the peripheral groups (Table 2). Furthermore, three of the four members of the central group are administrative actors and the other two are dominant players in the energy sector which mirrors the top-down organization of SIE in the local context which was confirmed in the interviews.

The two additional groups are less well connected, but do seem important in the policy network, considering their centralities. They are only connected through the central subgroup. When comparing this classification to the sector distribution, actors in the fourth group focus on SI, SIE and sustainability whereas the last group mostly consists of actors with an economic focus, mainly in energy or other sectors.

INTERACTION AND FORMS OF COORDINATION

Beliefs

According to the ACF, shared beliefs are the glue between members of a coalition. Although individual groups were identified, no distinct coalition was found. The findings on shared beliefs based on the assessment of the level of agreement be-

tween the egos and their contacts support this result. No clear pattern was found and only in a few cases was it stated that there was no or only little agreement. The interviews confirmed this, and especially a dominant actor from the energy sector stressed that many people with the same motivation are supportive and calls them the "network of the willing".

Trust

Trust as a basis of coordination was assessed in the survey by asking for the trustworthiness of one's contacts. The resulting network reveals that collaboration between actors does not necessarily require trust. The network consisting of trust relationships is less dense, i.e. has less relations realized, and even has two egos separated from the network. One of those is part of the central group 2, which shows that trust is not a primary factor for cooperation. When asked about the importance of trust and personal relationships when working together though, the interviewees stressed the importance of it on a professional level. Hence, it plays a secondary, but also important role and seems to facilitate cooperation since it implies trust in the peer's abilities and loyalty. Also, ideas and goals are discussed rather in small and oftentimes informal rounds with people already known, for this reduces uncertainty. Other actors also explained that the use of such relationships enhances the opportunity for exerting influence in the policy network and policy processes, one interviewee called this "old-boy networks". These indicate a connection to power relations and the desire for resources and influence in order to pursue one's own goals.

Power

In the survey, power and power relations were asked for in detail; the perception of one's own power as well as the perception of other actor's power were inquired. The results show that the actors in the network core are connected via the perception of power of one's contact, especially in the central group (Figure 2).

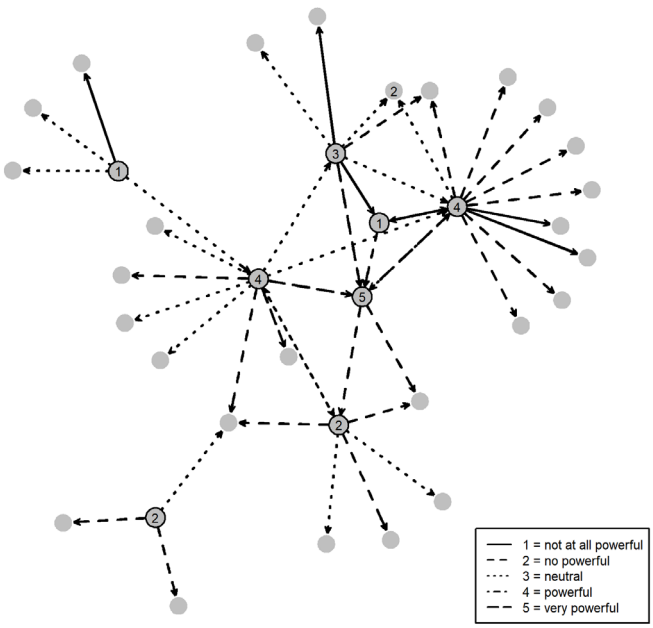

Figure 2. Power Relations in the local Policy Network. Labels are the perceived own power. Black vertex borders indicate egos.

Also, the assessment of one's own power coincides with how others perceive it. In this context, the actor's power also reflects on the levels of centrality. In line with this observation, the interviewees stated that the major players interact with each other, using the already existing relationships. Moreover, it was notable that actors, especially the most powerful players, mainly perceived themselves as particularly innovative with regard to SIE and then refused to recognize other members of the SIE policy network as such.

Personal relationships and shared expectations between actors reduce uncertainties in the interaction. These structures of trust and power are the forms of coordination on which actors join forces and mutually influence local policy processes and development.

Discussion

The observed network structure and actor positions within the policy network indicate that group 2 forms as a central cluster around SIE in Mannheim at the junction of the fields of SI and energy. In the context of the ACF and the concepts of policy subsystems and advocacy coalitions, no subsystem hast yet emerged. However, the results suggest that an SIE subsystem might establish. Considering the question of how trust and power as forms of coordination influence the emergence of SIE in an urban context, different paths seem possible.

The study indicated that the major players have an interest in maintaining control over SIE activities and continue to organize them top-down.

> I think it's more of helping people help themselves and taking ownership of the issues and doing that translation work. I don't think we need different power relations. The political power relations are quite good at the moment to solve the problems. It should stay that way if possible and not shift in another direction.

These power structures act as a barrier to the development of new SIE in the policy network. First of all, group 2 is closely interconnected, linked through trust and power relations. Against the background of homophily, this can be advantageous because shared characteristics facilitate cooperation (McPherson et al. 2001). However, such structures are also susceptible to biased assimilation, i.e. the tendency to take on new information rather from partners instead of actors with different attributes and beliefs. As such they can be a hindrance to innovation unless bridging ties to other cohesive subgroups also exist (Henry 2011a). In the present network, it is problematic that nodes within the respective groups around SI and around energy are not closely connected to each other. This suggests less coordination among the corresponding actors and thus the flow of new information into the central group (Newman and Dale 2007). Also, there are no direct links between the two groups. In this respect, actors in the central coalition are prone to reproduce existing structures and decide on changes within a narrowly defined space. Second of all, with regard to the ACF it can be assumed that the formation of a new coalition could lead to changes in the power structures. Currently, however, the central actors are at the same time intermediaries who connect groups with different interests. There is a possibility that this status quo will remain, especially since the incumbents currently occupy

the SIE field for themselves. Ingold et al. (2017) have argued that previous collaborations and cooperation as well as acquaintance are important factors for the formation of coalitions in newly emerging subsystems. The key actors in the observed policy system are important and well-connected in the city of Mannheim. Personal overlaps and trust relationships already bind these members of the network to each other. The administrative connection alone, as well as the connection of social and economic interests, indicate a high range in the network. Also, the results have shown that the central actors are mostly to be considered powerful. They have good access to various resources and can assert themselves well. The degree of agreement between these actors is high. Thus, several parameters are fulfilled that can promote the emergence of a coalition. However, the current policy focuses on a few energy efficiency programs for the development of the conversion areas and electro mobility without considering further developments in the field of SIE.

Yet, another path may develop in the future when the coal power plant is shut down in the course of the German Coal phase-out which is set for 2038. The plant in the city of Mannheim is set to be turned off in 2034 at the latest. While the industry as well as private households are very dependent on the district heating grid fed by waste heat from the power plant, a transformation of the local energy supply has to be developed. This condition as well as changes in public opinion, namely the desire for new business models and a decentralized energy system could lead to bottom-up initiatives. This desire seems to be underrepresented by the policy makers and incumbent players most central to the development of SIE, but may be supported further when an acute need for change occurs. Judging by the statements made in the interviews, it can be assumed that a change in public opinion or in the energy subsystem would be necessary to bring about such initiatives. If relevant actors develop from the societal level, they can become central actors who form a coalition with actors from group 4 or 5 or with others who have not yet been included. Another alternative is for members of the identified groups around SI and around energy to come together to form a coalition concerning SIE, possibly also with actors from the central group. In the case of policy change as a result of changing circumstances, SIE and policy concerning energy efficiency in a societal context may be further promoted.

Moreover, administrative actors may try enabling SIE further without changing their own position in the policy network. Local policy was repeatedly mentioned as conducive. In relation to SIE and against the background of theories on expectations, it can be argued that the policy is currently formulated too broad. The focus in Mannheim is on sustainability in general, SI and climate protection. Energy is explicitly covered by energy efficiency in new buildings on conversion areas and partly by mobility. Hielscher and Kivimaa (2019) argue that certain topics that are specified in policy generate and maintain expectations through this concretization. By specifying goals and expected benefits, such expectations are transported into society. As a broad field, SIE cannot be formulated as a single goal. Rather, decision-makers need to be aware of possible as well as necessary types of SIE in the local context. SIE are strongly associated with energy cooperatives and prosumaging. In order to promote specific types of SIE, they must be clearly defined and openly promoted. Participation by stakeholders and citizens in new concepts is linked to the debates that are held (Becker et al. 2017). In order to anchor SIE in the minds of citizens and generate debates, the formulation of the goals should also be linked to the benefits for the energy consumer (Hielscher and Kivimaa 2019). Since SIE are a very abstract concept, users also need to be aware of what they want to achieve with them and what form of initiative they can imagine.

The network structures in the policy network show that subgroup formation is strongly based on perceptions of power and trust relationships. On the other hand, there is mistrust between important actors, which complicates interaction between them as well as other related actors. Although trust is not entirely necessary for collaboration, it can facilitate it and also the development of new approaches to the transformation of the energy system such as SIE. The qualitative analysis showed that a devil shift can be observed here, which refers to behavior in which actors perceive their opponents as more influential than themselves and emphasize negatively perceived actions and thus evaluate them less favorably. Members of the network also tend to perceive themselves as innovative rather than others. The results show that it is primarily power and personal relationships that enables this structure. Since the estimations of individual power of others approximately corresponds with the other's own perceptions, actors can use this knowledge to decide with whom they want to cooperate. SIE as such are not decisive for the choice of contact. The cooperation partners have rather come together about energy or social topics. In this respect, it can also be concluded that actors are not yet familiar with the concept and would therefore not assign themselves to a SIE subsystem. Even actors who play an important role for SIE in Mannheim perceived their own part differently. Such members of the network, however, who already play an important role in the city or the respective subsystems around the energy transition or SI and also connect them, may see the intersections between the related issues. A new subsystem would therefore possibly not be formed around these central actors, but around those who are actively involved in SIE. So far, these are still few, which may be due to different reasons. For one, the most central actors in the current SIE network are the incumbent players who already play important roles in the energy sector and urban development. Even though they know and support the idea of SIE and the energy transition, they have conflicting objectives. Hence, these incumbents are limited in their actions and in this context, disruptive innovation appears to be an undesirable process to them. Considering this, incumbents attempt to be enablers, but can also be the resistance against advances by new or smaller players. Furthermore, it was revealed that at least two SIE, including an energy cooperative, had emerged but did not survive which may have been due to conflict, but also because these SIE were not widely adopted by the citizens. This may also reflect the difficulty in coordinating the local groups in the relevant participation processes. Moreover, SIE are difficult to scale which demands for specific ideas and goals that are adapted to local conditions to support a broader implementation of SIE. However, if the awareness of different types of SIE increases due to policy adaptation and a changed narrative in society and economy, there is also the possibility that other actors will join forces. At the same time, it is expected that at least some of the actors in the central group would also pursue SIE-related goals in response. Since SIE and transformation processes also have

an impact on the incumbents, it can be assumed that they would defend their position of power. However, looking at the individual nodes at the edge of the network, one gets the impression that the network represents only a fraction of the actors in the identified subgroups. In order to gain a clearer picture of this development, conducting a more comprehensive study might be necessary in which the various policy subsystems can be observed. This would allow a better classification of the extent to which power structures can also lead to cooperation beyond belief-based coalition formation.

Conclusion

In this paper, we investigated how trust and power inhibit or promote the emergence of SIE in a policy network and thus support energy transitions toward energy efficiency goals. With the help of the ACF, a policy network was mapped in which the actors active around SIE in Mannheim were represented. SIEs are innovations that can potentially change relationships and actor positions in networks and thus successively also the energy system and energy behavior. Different theoretical approaches have helped to assess the data and to evaluate the structure of the network. The positions of relevant actors in the policy network were related to different types of relationships in order to capture the importance of different characteristics that contribute to group formation.

The mixture of quantitative and qualitative analyses made it possible to compare the different data and to better understand the background behind the network data supported by the interviews. On this basis, it has become apparent that actors from the subsystems of SI and of the local energy transition are forming a cluster around the new concept of SIE. While shared beliefs play an important role, they were for one difficult to assess because of the research design. Furthermore, shared beliefs are not essential when faced with a more general topic such as the energy transition as a means of mitigating climate change or dealing with social issues such as poverty or educational inequality, since mostly, those have been adopted as central aspects of current policy making. With this in mind, trust and power play a more important role than such shared beliefs in the present case which matters for these more general aspects. On the one hand, SIE and the lack thereof are the reason why the SIE subsystem has not yet emerged and only a few actors are active in the policy network around SIE. On the other hand, they can also be the process that changes relationships and establishes new approaches through which the network is strengthened and possibly implemented as a policy subsystem (Wittmayer et al. 2020).

The work shows that SIE are difficult to assess in an industrially based city such as Mannheim. While cities like Bristol or Freiburg have a long history of grassroots movements and have long brought together social issues with the environment, Mannheim is organized differently. The study showed that political action is primarily organized in top-down structures and that instead, the support of bottom-up processes and a change of the incumbent's roles and positions in the network and in policy processes might be enabling. The concept of SIE is strongly linked to bottom-up processes (Avelino et al. 2019). The success of SIE, at least in the local case, seems to heavily depend from incumbent player's perception of a specific concept's use. A possible solution might be to support projects and initiatives without putting a focus on one's own role and instead empower other actors and thus, not develop and enable SIE primarily in top-down processes. In this respect, a comparison between Mannheim and other cities with similar but also diverging backgrounds will help gaining further insight on different modes of organizing and implementing SIE in urban contexts. A comparative analysis offers the opportunity to assess other important factors and to verify the presented results in diverging contexts.

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