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The evolving role of networking organizations in advanced sustainability transitions

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Abstract

In transition studies, formal inter-organizational networks – 'networking organizations' – are considered essential for inducing socio-technical change. Yet, there is little research on how their structural composition and role evolve in advanced transitions and which tensions arise over time. We address these gaps by combining insights from network research in social and economic science with transition studies, where networking organizations are conceptualized as intermediaries and key elements of Technological Innovation Systems. We synthesize a framework capturing the evolution of and resulting tensions within networking organizations in sustainability transitions. It is applied to two regional energy networking organizations from Germany. We draw on qualitative expert interviews and a complementary social network analysis. We show that networking organizations do not necessarily stabilize once the initial technologies they were centered around become established. Instead, their member base broadens to different sectors. This can lead to tensions over the networking organizations' scope. Tensions also arise from misalignments between 'private' goals of member firms and the 'public' goal of transforming system-level structures. Furthermore, complementary or competing networking organizations might emerge during the transition. Managers need to navigate these tensions and regularly review the networking organization's mission to maintain its relevance in the transition process.

Keywords

networking organizations; networks; regional energy transitions; sustainability transitions; intermediaries; technological innovation systems

Highlights

- Focus on networking organizations, their evolution, and role in transitions
- Contribution to debates on advanced sustainability transitions and intermediaries
- Empirical case studies on two energy networking organizations in Germany
- Tensions over scope and aim of the networking organizations might arise over time
- Technological change leads to restructuring of networking organizations

1. Introduction

The introduction and rollout of sustainable energy technologies, such as renewables, storage applications, or efficiency measures, is a prerequisite for mitigating the climate crisis (IPCC, 2018). Networking is considered essential for the development of such novel technologies, as well as for the continuation and acceleration of socio-technical transitions (Markard and Truffer, 2008; McCauley and Stephens, 2012). Consequently, a vast and growing number of formal, inter-organizational networks – 'networking organizations' in the following – is emerging worldwide. This includes regional innovation networks, national industry associations, European city alliances, or global research compounds (ECCP, 2020; REN21, 2020). Networking organizations serve a specific goal, deliberately grant or deny access to members, and are equipped with resources like their own management staff, a webpage, and a budget (Chetty and Agndal, 2008; Musiolik and Markard, 2011).

Transition scholars have emphasized the importance of networks especially in early phases of the formation of technological innovation systems (TIS) (Markard, 2018). As TIS mature, stylized models assume "inter-organizational networks [to become] well established and stable" (Markard, 2020, p. 119414). Yet, increasing stabilization within transition processes cannot be taken for granted. Even advanced transitions are inherently fragile and involve continued institutional and technological changes (Chlebna and Mattes, 2020; Löhr et al., 2020). For instance, once the electricity supply of a region is predominantly based on wind and solar, complementary technologies are needed to store fluctuating electricity or use it in other sectors (e.g. electrolysis plants or heat pumps) (Stephanos, 2017). This 'whole systems change' (Markard et al., 2020) requires the coordination of more heterogenous stakeholders than were previously engaged in the transition (Kemmerzell and Knodt, 2020; Kivimaa et al., 2020). Despite their importance throughout transitions, the networking organizations' impact and changing roles in advanced transitions remain under-explored (Kivimaa et al., 2019b). Thus, it is important to better understand how they evolve as to maintain or re-establish their position within shifting configurations of actors, institutions, and technologies (Knoben et al., 2006).

Networking organizations can be understood as intermediaries that shape transitions by coordinating organizations and their activities (van Lente et al., 2003; Howells, 2006; Kivimaa, 2014). They bridge boundaries between stakeholders from heterogenous backgrounds (Koehrsen, 2017) and facilitate the formation of system resources such as technological legitimacy or market access (Musiolik et al., 2012). Despite a rising interest towards networks and intermediaries in sustainability transitions (Fischer and Newig, 2016; Kivimaa et al., 2020), studies on networks are often "restricted to […] a metaphorical level" (Binz et al., 2014, p. 140). Within the literature on intermediaries, which covers a very broad and diverse set of cases, researchers tend to neglect the empirical characteristics and dynamics within organizational networks (Mignon and Kanda, 2018).

In their role as intermediaries, especially in the early transition process, networking organizations are expected to advance socio-technical change by linking actors, activities, skills, and resources; by formulating visions for the transition's direction; and by creating "new collaborations within and across niche technologies, ideas and markets" (Kivimaa et al., 2019a, p. 1073). But as the transition advances and new members join, networking organizations must professionalize and cater to the interests of their diverse members. Especially private firms expect direct and exclusive services from their participation as they weigh up benefits of collaborating within a network against potential costs and risks involved (Planko et al., 2019). Transition scholars sometimes take for granted that "firms join formal networks not only to gain access to the immediate services a network provides […], but also to establish or change institutional structures" at the level of innovation systems or transitions (Musiolik and Markard, 2011, p. 1911). We argue, however, that managing and balancing these 'private' and 'public' goals (Jungwirth et al., 2011) can be challenging, especially as transitions advance. The potentially arising tensions among members and between members and the networks' management are often overlooked (Mauritz, 2018). Furthermore, transition studies have been criticized for inadequately addressing how to organize collective action and govern transition networks (Mossberg et al., 2018), especially through the various phases of technological development (Söderholm et al., 2019) and subsequent large-scale diffusion.

In this paper, we maintain that networking organizations only persist if they 'co-evolve' with the transition of regional energy systems, navigate arising tensions successfully and manage their strategic orientation accordingly (Howells, 2006; Kanda et al., 2020). We aim to improve our understanding of this evolutionary process and clarify the specific role of networking organizations during socio-technical transitions. We focus on networking organizations that are primarily active at the regional scale, because transition scholars conceptualize regions as possible 'seedbeds' for socio-technical change (Geels, 2011) and regard networking organizations as "strong driving factors" (Lutz et al., 2017, p. 141) in the implementation of small-scale energy transitions (Mattes et al., 2015; Giurca and Metz, 2018; Köhrsen, 2018). Our investigation is guided by the following research question:

How do networking organizations and their role evolve as regional transitions advance?

We then synthesize the framework for our empirical investigation (chapter 3). Subsequently, we lay out the case methodology and case rationale of this analysis (chapter 4). We draw upon qualitative case studies on energy networking organizations from two regions in Germany (in Lower-Saxony and Hesse). Our results show dynamics both within the respective networking organization and in its relation to the ongoing regional transition (chapter 5). We then contrast the observed dynamics and shifting roles in both cases (chapter 6). The results might inform managers of networking organizations who need to moderate conflicts among members and steer the strategic orientation of the network (chapter 7).

2. Theoretical background

There are innumerable forms of inter-organizational networks in the empirical reality and network research is undertaken by multiple disciplines in social and economic science (Borgatti, 2003; Provan et al., 2007; Berardo et al., 2020). This diversity is perhaps also a reason why "a clear and commonly accepted definition of inter-organizational networks does not exist" (Bergenholtz and Waldstrøm, 2011, p. 540). Accordingly, in transition studies the term 'network' is both omnipresent and elusive.

To add some clarity to this debate, we briefly address inter-organizational network research from disciplines such as organizational studies, strategic management, and economic geography. We extract insights from these debates for our analysis of networking organizations and their evolution (cf. section 2.1) and then review the research on networking organizations in transition studies, particularly around TIS and intermediaries (cf. section 2.2).

2.1. Insights from inter-organizational network research

Inter-organizational networks most fundamentally consist of nodes (their members) and edges (any interaction among them). Formal networks are often distinguished from informal ones. While the latter emerge from routine interactions between organizations, formal networks grant or deny access to members and thus have distinct boundaries (Chetty and Agndal, 2008). Furthermore, formal networks pursue specific goals, which can be more private (e.g. providing exclusive benefits to members) or public (e.g. providing common infrastructures or strengthening regional development) (Jungwirth et al., 2011). [1]

Networks represent a form of governance distinct from markets and hierarchies and based around reciprocity, reputation, and mutual benefits (Powell, 1990). Organization and management scholars emphasize various benefits expected from networking: Firms might want to decrease transaction costs (Williamson, 1991) or access resources (Barney, 1991) like workers, information, reputation, or financial capital. Furthermore, members might join networking organizations to achieve political targets or regulatory change they could not attain alone (Powell, 1990). But networking is also associated with costs. Organizations usually pay membership fees. Active participation in workshops and conferences requires staff (often in top-level positions) to spend time off their routine duties (Mauritz, 2018). Furthermore, each network interaction can incite conflicts and networks "commonly involve aspects of dependency and particularism" (Powell, 1990, p. 305). For our subsequent investigation, this implies that members only remain part of energy networking organizations if the perceived benefits from the membership outweigh the costs in the medium and long term. Networking organizations might lose members to bankruptcies or re-

[1] Much of the network-related research we cite in the remainder of this section (implicitly) refers to informal networks and/or does not distinguish between the two forms. We assume that insights are generally also applicable to formal networking organizations which we focus on in this paper.

locations, but firms might also exit in response to diminishing legitimacy or external funding (Human and Provan, 2000) or as a result of exogenous technological changes (Knoben et al., 2006).

Coordinated action from heterogenous organizations is viewed as a fundamental driver of innovation (Lundvall, 1992; Corsaro et al., 2012). A continuous challenge in the innovation process is the dilemma of balancing 'opening vs. closure' (Heidenreich, 2004). This also applies to internal dynamics within formal, inter-organizational networks. 'Opening' implies an increase of heterogeneity which may bring new ideas to networking organizations, but also bears a risk of fragmentation. The size (e.g. large corporation vs. small and medium sized enterprise, SME) and type (e.g. private firm vs. public research institute) of member organizations is an important source of heterogeneity, but also their technology-focus as it relates to their knowledge base and capabilities (Corsaro et al., 2012). Maintaining too many strong ties to other organizations might be inefficient (Granovetter, 1977) as direct links are associated with costs and risks, especially if they exist between heterogenous organizations. 'Closure' implies that organizations are more likely to form links with similar organizations – a tendency known as 'homophily' in network research (McPherson et al., 2001). Building trust between homogenous organizations is easier and a common knowledge base decreases the cost of cooperation (Crespo et al., 2014; Sapat et al., 2019).

Network research also emphasizes that those organizations which already hold many links and a central position in a network are more likely to create additional connections (Gay and Dousset, 2005). Member organizations with similar knowledge, skills, and ideas tend to interact in 'cliques' – small groups with many links among them and few links to other groups (Glückler, 2007). If structures become too closed, rigid, and inflexible, technological lock-ins and economic decline might occur. Such a development has been documented for old coal regions (Grabher, 1993). Energy networking organizations could potentially display similar tendencies of closure. In our analysis, we therefore account for evolving structural shifts among members with different technological foci and of different organizational types.

Finally, geography influences the structure and evolution of inter-organizational networks. Economic geographers emphasize that innovation in complex technologies tends to concentrate in specific regions because of agglomeration effects like knowledge spillovers or localized resources and opportunities (Audretsch and Feldman, 1996; Porter, 1998; Doloreux, 2004; Glückler, 2007). The exchange of ideas is facilitated by spatial proximity, face-to-face interactions, and a 'local buzz' supporting innovative culture (Bathelt et al., 2004; Cantner and Graf, 2006; Heidenreich, 2011; Nilsson and Mattes, 2015).[2] This implies

[2] The terms 'cluster' and '(regional) network' are commonly used as synonyms and there are manifold, often confusingly different definitions of these concepts (Mauritz (2018)). In our perception, this is particularly apparent in sustainability transitions studies. We understand clusters in the sense of Porter (1998) as "geographic concentrations of interconnected companies, specialized suppliers, service providers, firms in related industries, and associated [organizations, e.g. universities] […] that compete but also co-operate". We thus view regional networking organizations as separate entities that might be part of economic cluster structures.

that networking organizations with a regional scope are potentially easier to govern than those with a global reach.

2.2. Networking organizations in sustainability transitions

As we analyze the shifting role of networking organizations within ongoing regional energy transitions, we now turn to their conceptualization in transition studies (Köhler et al., 2019) and focus on research insights around TIS and intermediaries. In TIS, networks are fundamental building blocks for innovation systems and the framework sheds light on the specific technological bases that shape networking activities of firms (Carlsson and Stankiewicz, 1991; Bergek et al., 2008). The literature on intermediaries allows for a focus on the role of networking organizations as mediators and brokers, both between their members and in relation to the ongoing transition (Mignon and Kanda, 2018).

In TIS studies, networks have been conceptualized and analyzed in a myriad of different ways: Researchers captured knowledge networks based on joint publications or patents; mapped the emergence of advocacy organizations and industry associations; looked at value chain relations; and analyzed interactions in formal but temporary pilot and demonstration projects (Binz et al., 2014; Bento and Fontes, 2015; Palm, 2015; van Rijnsoever et al., 2015; Stephan et al., 2017; Scherrer et al., 2020). While these studies usually also recognize the existence of formal networking organizations, few explicitly analyze their role in the TIS (Giurca and Metz, 2018) – most notably those by Musiolik et al. (2012; 2018) on hydrogen fuel cells. The authors show that firms strategically set up formal networks to advance the emerging TIS by creating system resources like knowledge and legitimacy. Musiolik et al. (2012, p. 1046) recognize that "network formation may be hindered because potential network members are afraid of 'giving away' valuable organizational resources" and point out that further research is needed on the "conditions which motivate firms" to create collective resources (Musiolik and Markard, 2011, p. 1921). Furthermore, they observe that we need to better understand the conditions under which "too much network formation" and an "uncoordinated emergence of [parallel] networks" occur (Musiolik et al., 2012, p. 1046).

There is also a lack of research on the evolution of formal networking organizations in transitions. We do not share the assumption that these networks automatically stabilize in mature technological systems (Markard, 2020), such as the PV solar or onshore wind energy TIS in Western Europe. An advanced rollout of these technologies requires "complementary innovations in e.g. electricity grids or energy storage [and the] interaction of multiple technologies and sectors […] to ensure overall sector performance" (Andersen and Markard, 2020, p. 119802). This increases the necessity for TIS actors to cooperate with further stakeholders and local consumers (Rohe, 2020), as to create not only new business models and knowledge-intensive services for firms, but also to "make regions more resilient to technology changes" (Gebauer and Binz, 2019, p. 370). Successful cases of constantly expanding regional networking organizations have been shown to strengthen multiple TIS resources (Giurca and Metz, 2018) and to enable their members

to keep pace with advancing transitions (Strambach and Pflitsch, 2018). Accordingly, the member base of energy networking organizations would need to broaden and include actors from other sectoral backgrounds, once 'core' technologies reach a certain level of maturity in the region.

The literature on transition intermediaries draws further attention to the role networking organizations are expected to fulfill, both by their members and for the energy transition. These roles can be described as mediation 'in-between' individual members vs. 'systemic intermediation' with a focus on institutional change (van Lente et al., 2003; Kanda et al., 2020; Busch and Hansen, 2021). As in-between mediators, networking organizations[3] provide meeting arenas to discuss potential collaboration projects and disseminate industry specific information to their members. However, not all members profit equally from these exclusive benefits (Mignon and Kanda, 2018). Within the networking organization, it is not necessary to achieve full consensus among interacting members over shared goals. Koehrsen (2017) emphasizes that boundary bridging arrangements allow heterogenous organizations to work together in spite of conflicts, for instance over the size and cost of technological showcase projects in urban energy transitions. In addition, while some members want to focus on energy production, others want joint engagement for more comprehensive transformational activities addressing cultural change. Nevertheless, organizations participate in demonstration projects or cooperate to win regional awards or certifications. These boundary objects and settings can be used to mediate in-between members (Koehrsen, 2017).

As systemic mediators, networking organizations (and particularly their management) also mediate between their members and the broader institutional setting (Kanda et al., 2020). Institutions in this context are a semi-coherent set of rules that structure socio-technical and innovation systems. To realize socio-technical change, actors must create, maintain, or disrupt institutions (Lawrence and Suddaby, 2006; Löhr et al., 2020). Established networking organizations are well-positioned to facilitate and steer regional energy transitions (Mattes et al., 2015; Strambach and Pflitsch, 2018). To effectively fulfill this system-level mediation, the network management must be trusted and viewed as an honest broker by their members (Klerkx and Leeuwis, 2009; Kivimaa et al., 2019a). This position, however, does not come naturally and is difficult to maintain. A particular source of tension is the funding of networking organizations – usually a combination of membership fees, public backing, and project-specific third-party grants. Shifts in this funding mix might damage claims of technological neutrality and create perceptions of putting interests of individual financiers above collective or systemic goals (Klerkx and Leeuwis, 2009). Furthermore,

[3] The authors term this type of intermediary 'cluster organization'. It should be noted that the literature on intermediaries does not have an explicit focus on networking organizations. Various other actors have been conceptualized as intermediaries, such as energy agencies, municipal governments, or project developers (Busch and Hansen (2021); Gustafsson and Mignon (2020); Mignon and Kanda (2018)).

limitations in finances and staff might force intermediary organizations to choose between the "broadness and system impact of services versus the customization of services" (Mignon and Kanda, 2018).

3. Evolution and tensions of networking organizations

In the previous review, we highlighted insights from the vast research on inter-organizational networks to better grasp evolutionary tendencies and potential sources of tension in regional energy networking organizations. We also reviewed research on TIS and intermediaries. While this literature stresses the importance of networking organizations in sustainability transitions and helps to conceptualize their activities and functions, some gaps remain. They primarily concern the evolution of networking organizations and their role over time – especially with an empirically informed view on the internal tensions that go along with the evolutionary processes of adapting to advancing transitions.

Figure 1 displays the analytical framework for our subsequent analysis of networking organizations in regional energy transitions. It takes into account the perspective of individual member organizations, the structural characteristics of 'whole network' configurations and network-level interactions (Provan et al., 2007), as well as the influence of the networking organization on the socio-technical change within the region and vice versa. Based on the literature review, the framework highlights issues of analytical focus for each level of analysis.

Level of analysis	Issues of analytical focus	Aims of the analysis
Member organization 	• Characteristics of the member organization • Motivation for membership • Perceived benefit of membership	 Understanding how networking organizations and their role evolve as the transition advances  Understanding the sources of tension and whether and how they are resolved
Structure of networking organization 	• Homogeneity/heterogeneity of the members • Formation of cliques	
Role of networking organization in transition 	• Technologies in focus • Creation of collective resources • Types of intermediary activities	

Figure 1: Framework for the analysis of networking organizations

The organizational characteristics of the members, the degree of heterogeneity in the overall network, and the technological focus of the networking organization are important issues in our analytical framework. As described in chapter 2, manifold types of organizations, with different technological and sectoral

backgrounds, are involved in networking organizations and regional energy transitions. For analytical purposes, we aggregate them into three heterogenous groups: [4]

- Firms with renewable energy technologies as their core business: The activities and business models of these firms primarily center around producing, planning, or operating technologies for harvesting renewable energy. This group therefore includes organizations like project developers for onshore wind, companies installing solar panels, or manufacturers of biogas plants.
- Firms with a broader sectoral background: These member organizations are primarily rooted outside the (renewable) energy sector. They might be housing associations, operators of sewage treatment plants, or providers of car sharing or IT services.
- Public entities, organizations active in research and education: Contrary to the previous groups, organizations from this group are not private, profit-oriented companies. The group does not only include research and education organizations, but also administrative bodies or civil society initiatives. The technological orientation of these organizations might range from very focused (similar to the first group, e.g. a research institute specialized on the physics of wind turbines) to very broad (similar to the second group, e.g. regional business development agencies).

Throughout the analysis, we pay special attention to evolutionary dynamics and the tensions that arise between the analytical network levels and over the course of the transition. The framework does not explicitly emphasize or hypothesize causal relationships, but we return to this in the discussion of our empirical results. First, we continue with describing our methodological approach.

4. Methodology and case rationale

4.1. Methodology

Our analysis is based on qualitative case studies (Yin, 2018) of two German regions, Western Lower-Saxony and Northern Hesse, where the investigated networking organizations are located. The case studies have been conducted in the context of a [blinded] research project on energy transition dynamics in the respective regions.[5] They are mostly informed by expert interviews and flanked by desk research and the analysis of documents such as websites or reports (cf. to [blinded publications] for more information about this methodology). Between 2018 and 2021, we carried out a total of 60 interviews in both regions. Some interviewees are staff in the networking organization's management; others are board members or representatives of founding organizations; some are members of the network but do not really engage.

[4] This aggregation is primarily relevant for the social network analysis. Insights from the case study and underlying qualitative and quantitative data allow us to contextualize the organizational character of member organizations in a more nuanced way (cf. next chapter for methodological details).
[5] [Further context on the case studies and our research project, currently blinded for review purposes].

Other interviewees do not even have membership status but provide information about the overall state of the regional energy transition and an external perspective on the networking organization (cf. to annex for more information on the interviewed organizations). The semi-structured interviews were transcribed and coded in MaxQDA, following the principles of qualitative content analysis (Mayring, 2019). Furthermore, we regularly participated in public discussions and workshops as 'partially participating observers' (Bryman, 2016). These events were hosted by the networking organizations and we complemented our case study material with the field notes.

Such qualitative research is common in studies on transitions, as it is suited to deal with their systemic nature (Zolfagharian et al., 2019). Expert interviews are also most commonly used for grasping the fuzzy social connections between organizations and the strength of their networks (Andersson et al., 2018; Lukkarinen et al., 2018; Wesche et al., 2019; Kanda et al., 2020; van der Loos et al., 2020). The opposite holds true for cluster research in economics and geography, where quantitative approaches are frequent and networks are drawn based on patent or labor mobility data (Cantner and Graf, 2006; Mauritz, 2018). In transition studies, such approaches have so far been rarely used. Social Network Analysis (SNA), however, is increasingly applied to trace, for instance, a TIS network (Binz et al., 2014; Wen et al., 2015; Giurca and Metz, 2018; Scherrer et al., 2020) or compare transition networks at one point in time (Decourt, 2019; Nochta and Skelcher, 2020). While combined (mixed methods) approaches are considered promising, they remain uncommon (Franke and Wald, 2006; Menzel and Fornahl, 2010; Hansmeier et al., 2021).

To triangulate results from the qualitative case studies, we complement our analysis with insights from a descriptive SNA of the networking organizations' members (nodes) and their interaction (edges). Using the software Gephi, we illustrate the shifting configuration of members within the two networking organizations and compare the development between two periods. One period covers the time starting from a few years after the networking organizations' conception. The other period covers the most recent time with available data (2017-2019).[6] All organizations that are formally members within at least one year of the respective time interval are represented as nodes in that period. As a proxy for interaction, we combine several indicators: If members simultaneously participate in events[7] or work on the board of the networking organization, an edge between them is created for that period. If multiple interactions occur

[6] deENet was founded in 2003 and OLEC in 2007. We choose not to compare network structures directly in these years and instead give the networking organizations some time to 'get going'. Therefore, the first analyzed period for deENet is at an earlier time (2008-2010) than the first for OLEC (2011-2013). These periods also correspond with the time at which the initial steady annual growth of members came to a halt for each respective networking organization. We aggregate data from a three-year window into a single period as to offset singular fluctuations.

[7] In the case of OLEC, we obtained the list of attendees for the 'annual meeting' (held first in 2010) and the annual 'new year's networking event' (held first in 2013). In the case of deENet, we obtained this information for the 'general meeting' (held annually since 2003; except in 2004 and 2007). These meetings represent flagship events for the network organizations. Participation is open to non-members. However, as we use membership within the network organization to draw network boundaries, we did not assign edges and omitted participating non-member organizations from the network visualization.

within one period, they are summed up to create a weighted edge. These meetings create opportunities for participating organizations to exchange information, induce dialogue, and potentially create trust and a shared understanding. Thus, such co-participation is commonly used as an indicator for organizational ties (Berardo et al., 2020). We obtained data on member organizations and their participation directly from the offices of the network organizations.

4.2. Case studies: OLEC and deENet

We investigate two regional energy networking organizations from Germany: The *Oldenburger Energiecluster e.V.* (OLEC) and the *Kompetenznetzwerk dezentrale Energietechnologien e.V.* (deENet). OLEC's office is situated in the city of Oldenburg and the around 60 members are mostly located in the Western part of the federal state of Lower-Saxony ('Weser-Ems region'). The 120 members of deENet are based in Northern Hesse in and around the city of Kassel. The deENet is run in cooperation with the regional development office. Both regions are close to the German average regarding population density and economic indicators (cf. to chapter 5 for details on the respective regional energy transitions).

In selecting these two networking organizations, we follow a theoretical sampling logic (Eisenhardt and Graebner, 2007). Theoretical sampling is appropriate where more theory building is needed and there are few former studies on the topic at hand – in our case, how networking organizations co-evolve with regional energy transitions and what tensions arise in the process. The cases have been selected because they are especially fit to illuminate this gap and promise revelatory potential and exceptional research access (Eisenhardt and Graebner, 2007). To deduce "better grounded, more accurate, and more generalizable" theoretical insights (Eisenhardt and Graebner, 2007, p. 27), we explore more than one ideal-typical case of a successful network organization. In chapter 5, we separately present the evolution of each networking organization and observed outcomes of tensions over time. While the comparative analysis of the two cases is not our primary focus, we highlight overarching dynamics in chapter 6.

The emergence and evolution of the networking organizations is shaped by different contexts and starting positions. OLEC was strategically set-up in a relatively top-down manner and the regional energy transition had already been underway at that time, whereas deENet emerged in a more bottom-up process in the early 2000s, when Northern Hesse could not be considered a frontrunner of the German energy transition. Both networking organizations, however, are similar as they were established to promote sustainable energy solutions and support businesses and research activities in their region. Both are also members of the 'cluster excellence program' by the Federal Ministry for Economic Affairs and Energy (BMWi) and have been awarded with the 'silver label' of the European Cluster Excellence Initiative (ECEI)[8] (BMWi,

[8] This certification is based on a variety of quality indicators, capturing the structure, governance, financial management, objectives, services, and achievements of the networking organization (ESCA (2021)). By 2020, ten

2021). Therefore, they are long-running and relatively 'successful'. In this regard, they represent promising cases of long-lived networking organizations successfully managing tensions.

Both networking organizations are embedded in the German *Energiewende*. The country is regularly described as a leading nation in the transformation of its energy sector, particularly in electricity (Essletzbichler, 2012; Geels et al., 2016). In 2020, renewable energy contributed around 46 % of the electricity consumption. Having achieved such rates in the electricity sector and with the underlying technological systems being increasingly mature, the country faces the essential challenge of pushing decarbonization efforts in areas like transport, heating, and industry. This implies growing complexity, both in the realization but also in the management and coordination of the involved processes (Kemmerzell and Knodt, 2020), which may affect the regional networking organizations.

5. Empirical Results

The regional energy transitions that form the context for OLEC and deENet differ. Wind energy dominates the West of Lower-Saxony. In some districts, electricity from wind covers more than 100 % of the demand. The first offshore test site was installed off the coast of the region. Many firms active in manufacturing, project development, or services, as well as specialized research institutes are located in and around Oldenburg (Fornahl et al., 2012; MacKinnon et al., 2019; Rohe and Mattes, 2021). Accordingly, the legitimacy of the technology is relatively high in the region (Rohe and Chlebna, 2021). An additional bioenergy cluster in the Southern districts is characterized by leading biogas plant manufacturers and high demand from the intensive agricultural sector (Tamásy, 2013; Franz et al., 2018). Recently, large scale projects around smart power grids and hydrogen use are carried out to integrate increasing amounts of renewable electricity into other sectors and the regional energy system (Goldkamp and Schallenberg, 2020; NWZ, 2021).

In contrast, wind energy use in Northern Hesse is a relatively recent phenomenon and the roll-out is not as advanced. Following the accident at Fukushima in 2011, several actors came together at the 'Hessischer Energiegipfel' and decided to commit 2 % of the area to wind energy (Energieland Hessen, 2011). Given the natural conditions, this makes the inclusion of sites in forests necessary (RP Kassel, 2017). Wind developments there remain hotly contested (Henke, 2019). The transition is strongly driven by the regional energy utility who has an exceptional focus on regional value added (Gottschalk et al., 2016). It formed the nationally renowned SUN (Stadtwerke Union Nordhessen) group in which small energy providers from surrounding municipalities collaborate to be more competitive against larger, conventional energy companies. Citizens' cooperatives also significantly contribute to the diffusion of renewables in the region. The University of Kassel and the local Fraunhofer IEE research institute play important roles for the

'energy technology' networking organizations were awarded with the 'silver label'. Not a single networking organization had achieved the 'gold label' (BMWi (2021)).

national reputation of the area. The regional renewables industry consists of some larger firms in PV and machine equipment, as well as numerous smaller industrial suppliers and service firms (KEEA, 2015).

Having briefly introduced the regional energy transitions which form the context for the respective networking organizations, in the following we analyze each case separately.

5.1. OLEC

OLEC originates from an informal "*club of advisors*" (OL21)[9] to the former mayor of Oldenburg that was established in 2004. The mayor was well networked not just in the region, but also nationally. He had been one of the architects in the German parliament of the renewable energy act (EEG), which has been highly influential for the Energiewende (Rohe and Löhr, 2020). When OLEC became a formal networking organization in 2007, it had 26 members. Membership levels rose steadily until the early 2010s, when a stable size was reached. Figure 2 illustrates the development of the shares of member groups. Whilst initially firms with renewables as core business had a large share in the networking organization (42 %), it decreased to only 11 % by the period between 2017 and 2019. In parallel, firms with a broader sectoral background, which had a strong presence from the beginning (35 %), increased to a recent share of 70 %. Together, SMEs from both groups make up around two thirds of all members in all periods. The share of public entities and research and education organizations remains remains relatively stable around 18 % in the last decade.

Many of the initial OLEC members were onshore wind project developers and researchers wanting to consolidate the local university as a wind energy competence center. Thus, OLEC in its early days has been described as a *"wind energy network"* (OL10, OL32). The university background of many early member organizations served as a further 'focal point' (Menzel and Fornahl, 2010).

An important founding idea was for the networking organization to lobby for political support and financial resources for the industry (OL06) and frame renewable energy as a "*winner's topic*" (OL24). Some founding members were described as coming from the "*radical"* corner regarding renewables (OL10). Their motivation for engaging in the networking organization was primarily driven by ecological values. This led to some tensions in the early years about how open OLEC should be towards organizations like the local energy utility, which had and has fossil energy in their portfolio. Members eventually agreed on a draft of OLEC's statutes, according to which the mission of the networking organization is "*the efficient integration of renewables into the regional energy systems of the future*". The statutes also emphasize the networking organization's goals of improving economic development, creating jobs, and facilitating

[9] Refer to annex for (anonymized) background on the interviewed organizations which we quote using this abbreviation scheme.

knowledge- and technology transfer by mediating between diverse organizations. 'Lobbying' was deliberately left out (OL10).

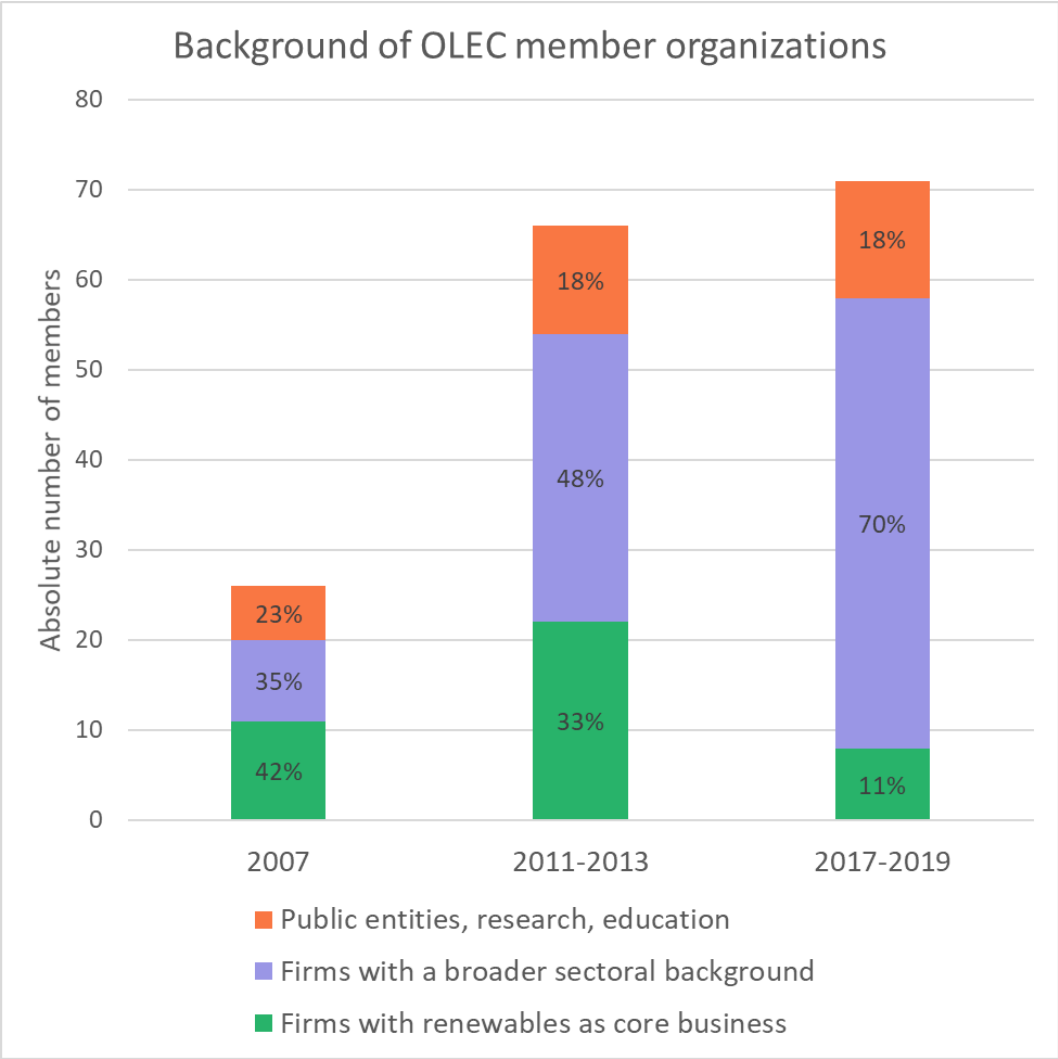

Figure 2: Background of OLEC member organizations (own figure)

These trend setting decisions at the formal founding of OLEC had implications for the structure of the member base. Almost half of the 41 organizations quitting their membership over OLEC's lifetime are firms with renewables as their core business. Some of them went bankrupt in the mid-2010s, when especially German solar PV firms faced domestic market slumps, increased cost-pressures, and fierce Chinese competition (Hoppmann et al., 2014; Binz et al., 2017). However, other members criticize OLEC's broadening technological focus and increasing intermediary activities (OL14, OL18). Some left the networking organization as a result.

> *"Most of the members actually earn their money elsewhere. I would have liked OLEC [...] to have taken a much clearer position against the EEG 2017 [that impeded conditions for wind energy nationally], but that did not happen. [...] [For OLEC it seems] more modern to deal with 'smart cities' and 'smart this' and 'smart that' [...]. That's all well and good, but you can't say, "We'll take care of renewables and wind energy for five years and then we'll do something else." They change horses pretty quickly. That's why their profile disappears." (OL09)*

Closely related to the sentiment from the quote above is the critical perception by some actors of a dominance of public entities (OL14, OL18) "*when really [OLEC] should be there for the industry*" (OL04). This is not confirmed by merely looking at membership shares (figure 2). However, the perception may stem from the centrality of public entities, including research and education organizations. Figure 3 illustrates the centrality of each member in the network structure. [10] Although the share of public organizations is stable, almost all of them are well connected and hold relatively central positions over both analyzed periods of OLECs existence.

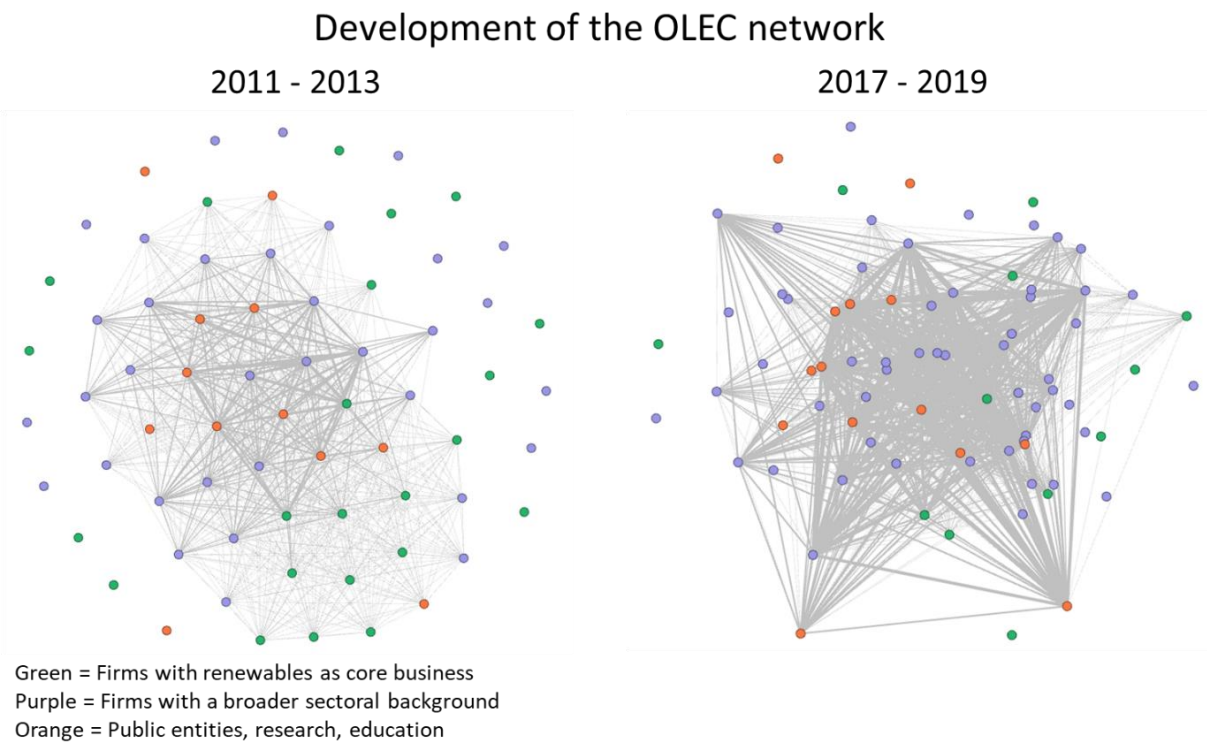

Figure 3: Development of the OLEC network (own figure)

Overall, figure 3 shows the OLEC member network becoming denser and more interconnected over time. This indicates that most members regularly engage with each other in events and workshops. Yet, the few remaining firms with renewables as a core business became relatively sidelined. The SNA does not indicate the formation of distinct subgroups or homogenous cliques. Multiple stakeholders, however, stressed the importance and strategic influence of the around 15 organizations represented in OLEC's management board (OL10, OL25, OL32).

[10] The network was calculated in Gephi based on the standard Fruchterman-Reingold algorithm that is useful for illustrating structural characteristics of medium-sized networks. In this forced-based layout, nodes are positioned closer together and towards the center if they share more direct and indirect edges (Cherven (2015)). To highlight structural changes, the position of each node is fixed in both time periods. If a node only becomes part of the network in the second period (because the organization it represents was not an OLEC member between 2011 and 2013), it appears in a more or less central position within the layout based on its centrality values.

Members with a broader sectoral background are not only becoming more numerous and more central; the group also became more heterogenous itself. Accordingly, OLEC covers an increasing range of technological foci, including hydrogen, energy storage, electric mobility, car sharing, smart cities, or energy-efficient buildings. OLEC's management portraits these structural and technological shifts as a reaction and adaptation to developments in the energy sector.

> *"At our annual event, we look back at what we've been up to. The topics change every time [...]. We are long finished with PV, wind and biogas because these technologies are established" (OL16)*

> *"I would say that change in the network is more a result of the energy transition changing overall. You can't say "We have defined new ideas", but the industry and the market, as they have developed, have contributed to this. [...] [OLEC] has grown naturally in part, [...] but in part it was also influenced by our formulated original vision [...] to focus on the entire energy system." (OL32)*

Most interviewees state that the prime reason for their participation in recent OLEC events is the exchange of information and knowledge (OL05, OL16, OL26). Staff or organizations that are new to the region also use events as a "*door opening opportunity*" (OL06). In part, members acknowledge further motivations for their participation. Some want to show presence and be perceived as regionally relevant stakeholders (OL15). Others feel obliged to engage because of their size and relative importance in the region (OL14) or simply participate because "*networking is part of their corporate culture*" (OL32).

OLEC recruited consortia for regional projects in various technological fields among their members and successfully secured external funding (OL10). These business opportunities meet the private goals of many members. This also led to shifts in the internal funding of OLEC, which is now covered by third parties to about half. To avoid conflicts, however, OLEC explicitly aims to focus on knowledge-transfer and coordination – "*those tasks that a network organization can meaningfully contribute*" – while leaving strategic decisions and funding for expert employees to the involved members (OL32).

Intermediation activities, however, are not only performed by OLEC'S staff, but also by some members. This applies especially for banks and consulting firms. At the observed meetings, these organizations had particularly high attendance rates. On the one hand, they act as in-between mediators because they use meetings to inform the heterogenous members about new business opportunities in sector coupling projects. In the long run, they hope to gain new customers and revenue streams from this (OL18, OL25, OL34). On the other hand, this activity can also be viewed as systemic intermediation for the regional energy transition, because raising awareness among stakeholders for collaboration and business opportunities is vital for achieving change in complex and configurational sectoral systems, such as housing and heating (Bögel et al., 2019; Wesche et al., 2019; Löhr et al., 2020).

Most recently, the focus of OLEC is broadening once more. The statutes of the networking organization were adapted after a thorough discussion in 2019. *"Contributing to climate mitigation"* was added as a

primary mission and purpose of OLEC. This institutional change was triggered by the Fridays for Future movement (FFF), which emerged in 2018 and quickly grew and diffused. It was particularly impactful in Oldenburg, where a young generation that was previously criticized as too passive and disengaged (OL11, OL29) actively worked with stakeholders from the city council, large organizations, and OLEC to formulate a shared vision and plan for carbon neutrality by 2035 (Die Tageszeitung, 2020; Oldenburger Nachrichten, 2021). Within OLEC, the process was driven mostly by members of the management board who felt a new "*sense of urgency*", because their own children were active with FFF or brought up the topic at home (OL32). This ever-broadening thematic focus might expand OLEC's member base further, for instance towards civil society organizations. While they are currently not represented (OL10, OL11), their inclusion could potentially reinforce some of the tensions we described above.

5.2. deENet

We now turn to our second case, deENet from Northern Hesse, which had a more bottom-up origin (Mauritz, 2018). It was founded in 2003 upon an initiative by a professor for energy research at University of Kassel (NH10). The intention was to pass ideas, knowledge, and competencies from the university along to regional firms (NH10, NH18) (KEEA, 2015). These circumstances explain why public entities and research and education organizations made up over half of the 34 initial members (cf. figure 4). Their share, however, decreased to around 30 % as deENet grew to its current size of more than 100 members. This is mostly because the absolute number of members from this group remained stable (8 in 2003 vs. 9 between 2017 and 2019). Firms with renewables as their core business never had a large share in the networking organization. It decreased slightly from 24 % to 19 % over 16 years. After an initial jump, the share of firms with a broader sectoral background remains at around 50 %. The growth of deENet is mostly attributable to SMEs. Their absolute number increased from 13 in 2003 to 56 in 2008-2010 and to 72 in 2017-2019. Throughout deENet's lifetime, only 2 start-ups and 6 large corporations have been members.

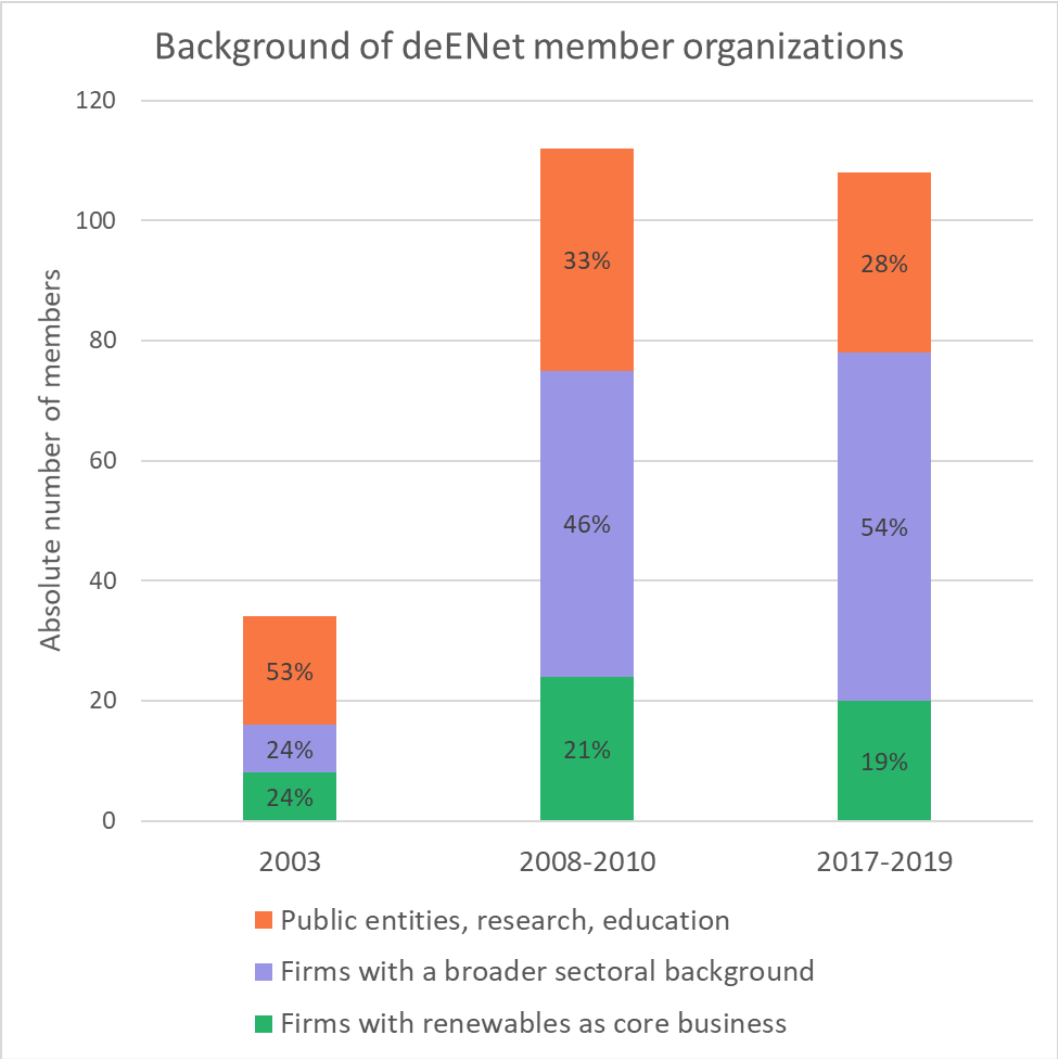

Figure 4: Background of deENet member organizations (own figure)

The statutes of deENet emphasize regional economic development and regional value creation as important missions of the networking organization (NH20). One of the first projects initiated by deENet was a study that showed how 20.000 new jobs in the regional sustainable energy sector could be created by 2020 (deENet, 2007). In 2016, this thematic focus was institutionalized when the management of deENet was practically integrated and "*married into*" the regional management office (NH13). Thereby, the executive director of deENet also became responsible for the energy cluster and the overall management of both organizations, putting them in "*a key position […] to solve conflicts and [bring stakeholders] to agree on shared visions*" (NH13). Moreover, many interviewed members state that deENet is giving important innovation impulses to the region (NH11, NH19).

> *"It is like a nucleus. When people have these conversations, sometimes an idea is planted and […] carried back into the [organizations that participants represent]. Therefore, these meetings make sense and the exchange is good to connect the region and facilitate cross-fertilization for further, new ideas." (NH18)*

However, there are also critical voices that lament too much "*muddling through*" (NH20). They call for deENet to draw together a more ambitious and comprehensive regional vision and offer more concrete project opportunities for members to engage with the regional transition (NH03, NH18).

> *"If you are in a region like ours, you would have to implement a bit more yourself. "Centre for renewable energy" is written on their banners, but the rest doesn't really fit in yet." (NH07)*

This quote underlines that deENet has been particularly successful in locational marketing. Some even argue that it has successfully created a nation-wide "*radiance*" of the region as a best practice for the energy transition (OL14, OL26). Others lament that this positive image and its impact usually stays attached to the city of Kassel or some key organizations.

> *"To have the Fraunhofer Institute in Kassel is of course a great contribution to its reputation as energy city or Energiewende city. This helps, but it doesn't really go beyond the city of Kassel. This doesn't really affect Hersfeld-Rothenburg or Werra-Meißner [neighboring districts]." (NH15)*

Beyond creating a positive regional image, the SMEs that make up more than half of the members expect to realize private goals with their membership. In addition to exclusive access to information and the exchange with other stakeholders in the region, many wish to acquisition new business opportunities by "*contributing with expertise*" (NH21). This expectation has not always been met. There was a pronounced and open conflict about this in the early 2010s. Back then, deENet successfully acquired much external project funding. This benefitted, however, mostly the networking organization itself and manifested in up to 20 staff positions in the management office. As a result, many members had the impression that deENet was becoming a regional competitor for resources, instead of a neutral broker between their interests (NH26). As a result of this conflict, deENet scaled back its staff and range of activities (NH18). It now focuses on the organization of 'big tent' networking events, like a 'barcamp renewables'; workshops with citizens or municipalities on energy efficiency in buildings; cross-sectoral meetings with representatives from mobility, IT, or mechanical engineering; and an annual 'future forum energy & climate'.

While the member base of the networking organization had always been rather heterogenous, private firms with a renewable energy focus played a relatively small role from the start. Although a large supplier firm to the PV industry holds a central position, wind turbine manufacturers and project developers are rarely engaged within deENet – the networking organization is not relevant for most of their work (NH06). Supporting renewable production technologies is not the priority of the deENet management.

> *"We focus on topics that still need to be supported to achieve a breakthrough. Wind energy here in the region over the last ten years needed little support from our side. […] We also have limited 'women-and-man-power', so we focus on fields like the heat transition, where there are still larger challenges and where you are at a different point in the development than you are in the electricity sector or wind energy. […] An important focus for us now is […] to achieve a comprehensive energy*

transition and to seize the potentials of sector coupling. For this, deENet has a strong justification and added value because we can make the platform available." (NH13)

Most interview partners emphasize the diversity of the network members and the persistent collaborative attitude as a particular strength.

"You have the director of the regional energy utility, the head of built environment at the City of Kassel, the colleagues from the regional development agency, the University, the Fraunhofer institute, and the firm representatives – that's great, because we all have to attune to this transformation together." (NH18)

Figure 5 shows deENet's network structure. It further underlines that only few firms with renewables as their core business are well-connected and hold central positions. While there is no obvious, stable, and distinct clique of homogenous organizations at the center of the network, a clear divide exists between some central organizations on the one hand, and manifold unconnected organizations on the other hand.

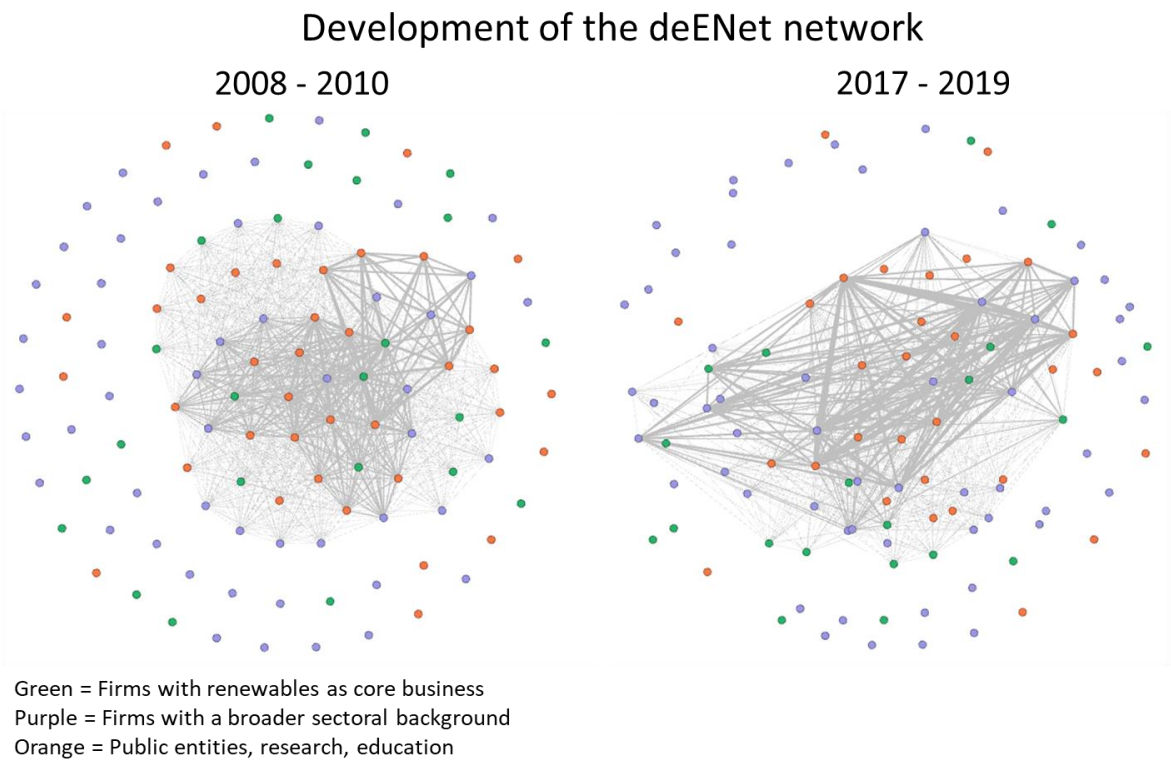

Figure 5: Development of the deENet network (own figure)

The fact that a relatively steady group of well-connected members tends to dominate the network organization was commented on by interviewees and may affect the willingness to engage by other members (NH18). Successive, ill-fated leadership changes in the recent years are likely to have reinforced this situation (NH11, NH14). The disengagement of some of the unconnected organizational members might partially explain the formation of parallel networking organizations, a striking feature of the regional energy transition in Northern Hesse.

> *"I view very critically when you keep constructing and funding numerous parallel structures in a region […] At the moment, everyone talks about energy, about hydrogen, and everyone wants to be leading H_2 region or have projects. And then we have the chamber of commerce, the regional management and so on and this just makes it wearisome." (NH26)*

One example is a relatively recent initiative of two well-connected individuals, who aim to integrate the around 100 smaller firms that supply to the wind energy industry from the region in a 'Wirtschaftskreis Windenergie'. The rather informal network has existed for over two years now (NH26).

> *"Some of these are traditional industrial firms [that] actually supply the wind industry. […] At the first meeting we realized […] that they didn't know each other. […] there seems to be a real need for networking here." (NH14)*

Another example of a parallel networking organization is the 'House of Energy' (HoE) which was installed in 2015 by the Land Hesse as part of a wider initiative to better connect science and business. Kassel was chosen as location because of its reputation as 'energy city' (NH15). There was, however, already a well-established institute at the university who carried this remit – an initiative by deENet together with the university. The funding of this institute was discontinued and moved to HoE. This caused tensions with some of the acting personnel (NH18). Whilst there is general awareness of HoE, its concrete mission seems to be less clear. Some interviewees even identify it as a rival to deENet as both networking organizations potentially compete for funding (NH18, NH23).

> *"I don't know what they do and with whom. […] They were meant to be more science focused. […] They are not visible. In terms of something happening on the ground, something that HoE implemented: I could not name anything." (NH20)*

The Fridays for future movement also had an impact on Northern Hesse, leading to the formation of local pressure groups and the implementation of a 'Klimaschutzrat'. This climate protection advisory board is supposed to discuss and identify concrete measures for implementing the vision of a carbon neutral city of Kassel by 2030. It is made up of citizens from across various economic sectors as well as civil society groups. This could further erode deENets position in the region, as the networking organization is not directly involved with the Klimaschutzrat so far.

6. Discussion of cross-comparative results

In the previous chapter, we analyzed the evolving structures, roles, and tensions of networking organizations in advanced transitions, using OLEC and deENet as examples. Both emerged in the mid-2000s; OLEC was established in a more top-down manner by the former mayor of Oldenburg, deENet more bottom-up by an initiative around a university professor. In both cases, this highlights the importance of engaged individuals in the formation of networking organizations. They might recede to the background once structures have become more established (Chlebna and Mattes, 2020). We could not identify homogenous

cliques of members within the networks' centers or in distinct subgroups. However, organizations active within the management boards are generally well-connected and influential. We find that representative management boards are well-positioned to mediate between members, management staff, and wider transition dynamics. Furthermore, organizations with a university background hold central positions in both networks, which is in line with previous studies on regional transition networking organizations (Giurca and Metz, 2018).

In terms of their structural evolution, the share of members with broader sectoral backgrounds (beyond energy and renewables) grew in both regional energy networking organizations. Surging SME memberships mostly drive this change. The increase in heterogeneity is particularly pronounced in OLEC – which originally started relatively narrow as a pro-renewables and pro-wind lobbying initiative – whereas deENet was comparatively diverse from the outset. At the same time, the interconnectedness and 'level of integration' (Söderholm et al., 2019) between members appears denser in OLEC. This might be explained by the relative durability and consistency of OLEC's professional network management team, as well as by the decrease in third-party funded project activities coordinated by deENet. Overall, the size and membership structure of both networking organizations became relatively stable as the regional transitions reached more advanced stages by the mid-2010s.

Yet, the role of the networking organizations and their scope of activities shifted and broadened. Knowledge transfer and information exchange have always been key activities in both cases. Initially, both networking organizations were focused on gathering funding, creating positive expectations, and rallying resources to the renewable energy industries of the regions, especially from the national scale. This role is expected for intermediaries in early transitions (Kivimaa et al., 2019a). To maintain relevance in more advanced transitions, both analyzed networking organizations engage more comprehensively in transformational intermediation beyond the electricity sector, where mature renewables are well-established. At the same time, they risk losing focus and established members disengaging. The networking organizations' management must navigate this tension.

> *"We try to tackle issues across topics and technologies. That has been one of the elements of success in recent years. However, […] this is also a great challenge [...]. Sometimes I would prefer more focus, because [...]success would be easier to measure. [...] But that's the trade-off." (OL32)*

The broadening member base and technological focus are the largest source of tension within OLEC. This confirms earlier assumptions about intermediaries in advancing transitions (Kivimaa et al., 2020). The tensions are, however, not voiced or resolved in confrontational face-to-face meetings. Conversely, OLEC meetings are consistently described as particularly harmonious. Dissatisfied members tend to leave quietly. In the long run, this could impede OLEC's ambitions to advance the regional energy transition by driving forward comprehensive sector coupling and climate mitigation solutions, if key and established

renewable energy firms are disengaged. A viable strategy for addressing this challenge might be the continued effort to secure external funding for regional project consortia. They represent boundary bridging arrangements and align with the private goals of many member firms (Koehrsen, 2017).

The networking organization's management, however, cannot profit disproportionally from this funding. In the case of deENet, such an 'overstretch' was a key source of tension in the past. For some time, the various roles of the networking organization – as a provider of potential project funding and business opportunities to members and a facilitator of the regional transition – were not well aligned and an open conflict broke out. It resulted in a reorientation towards providing services and networking occasions for members (Mauritz, 2018). This restructuring may have weakened the networking organizations' position, as it remained heterogenous in its member base while losing density in terms of member connectivity and depth in terms of its activities (Söderholm et al., 2019; Bjerkan and Ryghaug, 2021).

Another likely source of tension in Northern Hesse are parallel networking organizations, especially the HoE which was founded and implemented in a top-down manner by the federal state. It seems that policy makers in this case lacked awareness of potential conflicts arising between intermediaries with similar roles and competencies (Kanda et al., 2020). A further reason for the emergence of parallel networking organizations in this case might be that the mission and purpose of the networking organization were not continuously discussed with and clear to the member base. This issue was further exacerbated by an unfortunate lack of leadership consistency. Whilst the networking organization maintains a focus on general networking activities, more specific needs of member groups are not met and thus allow for the emergence of additional networking structures.

7. Conclusion and implications

This paper contributed to the research on networks in sustainability transitions by conceptualizing and analyzing the structural evolution, shifting roles, and associated tensions that regional energy networking organizations undergo in advanced sustainability transitions. By combining insights from inter-organizational network studies in social and economic science with research around intermediaries and TIS, we synthesized an analytical framework to capture the evolution and tensions of and within networking organizations over time. Empirically, we contributed a detailed analysis of two energy networking organizations from regions in Germany. They do not necessarily stabilize once the initial technologies they have been centered around become mature and established. Instead, members are increasingly recruited from different sectors. This puts energy networking organizations in a good position to promote more comprehensive energy transitions in their regions. However, members from the original 'core' technologies might disengage if they perceive the activities of networking organizations as too broad. This is closely related to another source of tension, which concerns the expectation of firms to achieve private goals through

their network membership, while not necessarily being interested in changing system-level structures and common resources. New networking organizations might emerge even in advanced regional transitions. In relation to existing networking organizations, they can be very similar (thus leading to conflicts over members and resources) or complementary (by specifically addressing the interests of a select and narrow group of members or technologies).

To triangulate our qualitative interview data, we integrated a complementary SNA to the analysis. While this approach has been useful to put insights from expert accounts into perspective, our SNA ought to be understood as an exploratory effort rather than a comprehensive analysis. We encourage future contributions to take on the challenge of measuring organizational ties within networking organizations more profoundly. We chose event co-participation as a proxy for interaction, a method common but somewhat limited in capturing the complexity of organizational relations. Our approach to the SNA hides certain dynamics altogether: For instance, if organizations start a close collaboration after attending a meeting of the networking organization in one year, but then do not attend a meeting in the next period while their collaboration continues or even intensifies, this is not captured by an edge in the SNA. Future studies could map ties within the networking organizations by adding additional potential edges such as formal collaborations or a more systematic survey of contacts between members through 'snowballing' (asking members individually with whom they had contact with or collaborated) or by handing out questionaries at the end of events. Nevertheless, we still argue that our approach of using SNA in a descriptive and illustrative way is worthwhile to pursue, if combined with other methods of exploration.

We analyzed energy networking organizations at the regional level, where we observed an increasingly broadening member base and thematic focus. This is certainly impacted by geographical proximity, which facilitates cooperation across sectoral and organizational boundaries, and the particular challenges of the energy sector, where renewable electricity must now be applied and integrated into other sectorial contexts and managed as part of a wider energy mix. The facilitating influence of geographical proximity is limited in (inter-)national networks. Therefore, we except that the member base and thematic focus of networking organizations at this level tend to remain narrower and more focused, even as transitions advance. Further research could test this assumption and compare the evolution of networking organizations operating at different scales. It might also be worthwhile to investigate whether (regional) transition networking organizations rooted in other sectors – such as organic agriculture, carbon free mobility, or sustainable industrial production – also broaden their member base and focus, as the underlying technologies mature and diffuse. If this is the case, conflicts might arise as several regional generic sustainability transition networking organizations try to co-exist.

From a practical view, our research supports the conclusion that active support for networking organizations should be part of the policy mix even in advanced transitions (Söderholm et al., 2019). To promote

system integration of maturing technologies, policy instruments should facilitate the inclusion of a greater diversity of organizations. Such increasing network heterogeneity must be accompanied by manifold opportunities for cross-sectoral business cooperation. These projects should ideally be designed to equally address the private goals of profit-oriented companies and the public goals of systemic, socio-technical system change. However, the allocation of project funding should not result in the constant formation of new and potentially competing networks. Instead, consistency in the management of regional networking organizations is an important stabilizing element in their evolution. In close cooperation with the members, managing staff can successfully navigate and shape advancing regional transitions if they regularly reflect and reevaluate the purpose and strategy of the networking organization.

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Annex

Expert interviews in the Oldenburg region

Code	Organizational Background	OLEC Membership? (if yes, since when?)	Eigencentrality score[1]
OL01	Public entities, research, education	No	
OL02	Public entities, research, education[2]	2007	0,729
OL03	Firms with renewables as core business	No	
OL04	Firms with renewables as core business	2007	0,726
OL05	Firms with a broader sectoral background	No	
OL06	Firms with renewables as core business	2007	0,327
OL07	Public entities, research, education	No	
OL08	Public entities, research, education	2008	0,815
OL09	Firms with renewables as core business[3]	2009	0,000
OL10	Staff of networking organization[2]	//	
OL11	Public entities, research, education	No	
OL12	Firms with a broader sectoral background	No	
OL13	Public entities, research, education	No	
OL14	Firms with a broader sectoral background	2007	0,817
OL15	Firms with a broader sectoral background	2011	0,894
OL16	Public entities, research, education[2]	2007	0,760
OL17	Firms with renewables as core business	2007	0,428
OL18	Firms with renewables as core business	2007	0,662
OL19	Public entities, research, education	No	
OL23	Firms with a broader sectoral background	2007	0,817
OL20	Public entities, research, education	2007	0,765
OL21	Public entities, research, education	2007	0,729
OL22	Public entities, research, education	No	
OL24	Public entities, research, education	2007	0,948
OL25	Firms with a broader sectoral background[2]	2007	0,948
OL26	Firms with renewables as core business	2018	0,219
OL27	Public entities, research, education	No	
OL28	Public entities, research, education	No	
OL29	Public entities, research, education	No	
OL30	Firms with renewables as core business	No	
OL31	Public entities, research, education	No	
OL32	Staff of networking organization	//	
OL33	Firms with a broader sectoral background	2007	0,817
OL34	Firms with a broader sectoral background	No	

[1] Influence of the node in the network, ranging from 0 (very low) to 1 (very high). Calculated with gephi, based on all unweighted edges between 2007 and 2019
[2] Interviewee is or has been part of the networking organizations' management board
[3] Interviewed organization left the networking organization

Expert interviews in the Kassel region

Code	Organizational Background	deENet Membership? (if yes, since when?)	Eigencentrality score[1]
NH01	Firms with renewables as core business	No	
NH02	Public entities, research, education	No	
NH03	Firms with renewables as core business	No	
NH04	Public entities, research, education	2004	0,852
NH05	Public entities, research, education	No	
NH06	Firms with renewables as core business	No	
NH07	Firms with renewables as core business	2011	0,336
NH08	Public entities, research, education	No	
NH09	Firms with a broader sectoral background[2]	2003	0,988
NH10	Public entities, research, education[2]	2003	0,395
NH11	Firms with a broader sectoral background	No	
NH12	Public entities, research, education	No	
NH13	Staff of networking organization	//	
NH14	Public entities, research, education[2]	2003	0,751
NH15	Public entities, research, education	No	
NH16	Firms with renewables as core business	No	
NH17	Public entities, research, education	No	
NH18	Firms with renewables as core business[2, 3]	2005	0,126
NH19	Public entities, research, education	No	
NH20	Staff of networking organization	//	
NH21	Firms with a broader sectoral background	No	
NH22	Public entities, research, education	No	
NH23	Firms with a broader sectoral background	2008	0,670
NH24	Public entities, research, education[2]	2003	0,887
NH25	Firms with renewables as core business	No	

[1] Influence of the node in the network, ranging from 0 (very low) to 1 (very high)
Calculated with gephi, based on all unweighted edges between 2003 and 2019
[2] Interviewee is or has been part of the networking organizations' management board
[3] Interviewed organization left the networking organization

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