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ARTICLE

Local intermediaries in energy transitions: bridging the gap from niche level to changing the regime

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Abstract The energy transition represents a complex and longterm process taking place at different governance levels and representing a set of policies and structural changes. The local level, especially cities and regions, can be considered as a central level for the implementation of energy transitions. These transitions are only in part technical ones, but essentially embedded in, based on, and consisting of changes in social practices and in the organization of societal problem-solving transforming infrastructure governance. This paper demonstrates one central form of organizational change in local energy transition strategies: The creation of local intermediaries, defined by their function and position in between other actors. Based on a case study in Frankfurt/Main, Germany, and referring to the multi-level perspective on socio-technical transitions and the concept of social innovation, it analyses how systemic intermediaries can e.g. bridge the gap from niche to changing the regime.

Keywords Intermediaries · Urban energy transition · Social innovation

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Lokale Intermediäre in der Energiewende – Brücken von der Nischenebene zu einem Wandel des Regimes

Zusammenfassung Städte sind ein wichtiger Kontext für den Ressourcenverbrauch, Innovationszentren und eine privilegierte Ebene für die Erprobung und Umsetzung neuer Problemlösungsansätze. Sie sind daher wichtige Ausgangspunkte für Nachhaltigkeitstransformationen. Diese Transformationen sind nur zum Teil technischer Natur, sondern im Wesentlichen eingebettet in, basierend auf und bestehend aus Veränderungen in sozialen Praktiken und in der Organisation gesellschaftlicher Problemlösungen. In diesem Beitrag wird eine zentrale Form des organisatorischen Wandels in lokalen Energiewende-Strategien aufgezeigt: Die Schaffung lokaler Intermediäre, die durch ihre Funktion und Position zwischen anderen Akteuren definiert sind.

Schlüsselwörter Intermediäre · Energietransformationen · Soziale Innovation

1 Introduction

The energy transition represents a complex and longterm process taking place at different governance levels and represents a set of policies and structural changes (Fabra et al. 2015). In Germany, the discussion on an energy transition or "Energiewende", the structural change of the energy system, originates in the 1980ies (Mattes et al. 2015). This article focuses on the role of the local level in transforming the energy system. Cities are a major context for the consumption of resources, centers for innovation, and a privileged level for experimentation and implementation of new approaches to problem solving (Fudge et al. 2016). Urban energy usages and production present a key domain for the shift towards sustainability of cities. Its forms and usages are decisive for an important part of resource consumption, but they also have impacts on social and economic development (Monstadt 2004, 2007; Moss et al. 2011). Consequently, especially since the 1990s, a variety of goals, indicators, strategies and actions have been developed and implemented for local energy production and consumption (Capello et al. 1999; Selvakkumaran and Ahlgren 2017). Even though the idea of local energy paths is not new in literature (Walker et al. 2007), and the role of cities had been increasingly recognized since the 1990s (Bulkeley et al. 2011), in transition research on energy/climate protection the focus has been on the national and international scales for a long time (Geels 2011; Hodson and Marvin 2010; Schreurs 2008). Since the years 2000, the local level, especially cities and regions, are considered as a central level for the implementation of energy transitions (Mattes et al. 2015; Rohracher and Späth 2014, Selvakkumaran and Ahlgren 2017). Still, as Selvakkumaran and Ahlgren (2017) conclude in a literature review on local energy transitions, literature was scarce preceding 2010. And they identify remaining research gaps, e.g. regarding institutional structures. Ehnert et al. (2018) confirm that cities remain underexplored, especially regarding the acceleration phase of transitions.

The hypothesis behind the research presented here is that urban actors not only implement new strategies and technologies but are also developing and experimenting with new approaches for enhancing energy efficiency, changing energy usages, and energy production. Cities are traditionally centres for innovation (Simmel 2006) and a privileged level for experimentation and implementation of new problem solving approaches. They are thus important starting points for sustainability transitions. These transitions are only in part technical ones, but socio-technical transitions (Selvakkumaran and Ahlgren 2017) and essentially embedded in, based on, and consisting of changes in social practices, e.g. in organization and behavior. Following a definition by Zapf (1989), this kind of sustainability transitions can be framed as social innovations—new ways of societal problem solving that are worthy of being imitated and institutionalized.

The paper explores the role of social innovation and intermediaries in urban energy transitions and intends to contribute:

1. to the understanding of local energy transition processes and the role the intermediaries play or can play for transforming the energy sector. Following Geels and Schot (2007) as well as Turnheim et al. (2015), these processes can be defined as 'Transitions pathways' which involve varying degrees of reconfiguration (Turnheim et al. 2015, p. 240).
2. to the development of the theoretical approach of socio-technical sustainability transition research with focus on social innovation as conceptual inspiration and key aspect and on questions around the bridging of the niche-regime divide and the role of incumbents in local transition pathways.

In the following, I will first briefly introduce the theoretical background and derived research questions, then introduce the case studies, method and database and finally exemplify on one case in Frankfurt/Main, the ABGnova as intermediary.

2 Theoretical background

2.1 Energy infrastructures as socio-technical systems

In contrast to an isolated consideration of individual technologies or the separate analysis of technology, performance and governance structures, in this paper, infrastructure systems are understood as socio-technical systems following the approach of the Large Technical Infrastructure/Large Technical Systems research going back to Hughes (Hughes 1987). In this approach, infrastructure systems consist of different components, on the one hand physical artifacts, but also organizations, laws and specific knowledge structures. These individual components are conceived as part of a system within which they interact and influence each other. For example, the technology structure and the management structure of companies strongly determine each other. These systems are situated in an environment that is essentially defined by the fact that it is not under the control of the system. Another description

(Rip and Kemp 1998) speaks of configurations ("configurations that work": i.e., Technological systems consist of elements that collectively perform a function).

The LTI/LTS approach provides a useful starting point for viewing the subject of infrastructure as a complex overall system in which different elements influence and stabilize each other. Also important as a basic assumption here is Hughes' observation that "they are both socially constructed and society shaping" (Hughes 1987, p. 51). Although LTIs are essentially shaped by technologies, these do not determine the design of the system but form corridors for its development and innovation (Mayntz 2008). In considering LTIs, Renate Mayntz (2008) differentiates technology structure, social organization, and external regulatory structure and considers the interrelationships between these areas. She concludes that technologies do play an important role, for example, in enabling liberalization/privatization of supply systems in the first place, or as barriers. However, the key driver, she says, is to be found in the regulatory structure/policy. LTIs serve to fulfill goals or solve problems (Hughes 1987). The research presented here focuses specifically on the supply of energy in cities as a social function for the fulfillment of needs, as well as on utilization structures. These and especially their transformation are the starting points. Both electricity and thermal energy are considered.

As a basis for analysing transitions in urban energy systems, the paper adopts the multi-level perspective, which is briefly presented below.

2.2 Urban energy transitions and the multi-level-perspective

2.2.1 Urban energy transitions

Transitions are defined in literature as complex and multi-layered processes of change (e.g. Geels et al. 2004). They can occur on different levels and "involve changes in socio-technical systems" (Geels et al. 2004, p. 3), based on a co-evolution of social, technological, institutional and policy changes. In Geels definition (Geels et al. 2004), urban energy transitions are transitions in a societal function. Later, Geels (2014) specifies "transition on the ground" (Geels 2014, p. 32) for specific kinds of urban transition pathways, "*reconfiguring local energy and transport systems*" (Geels 2014, p. 32).

The author of this paper refers urban energy transition to the process of transforming the urban energy system towards more sustainable use of resources. This involves the ways in which energy is produced, distributed and used. Goals are to reduce greenhouse gas emissions, enhance resilience of the system and energy security as well as energy justice and to meet the needs of society in a sustainable way (Bundesregierung des Deutschen Bundestags 2010; WGBU 2011). A further specification are sustainability transitions, focusing on "*systemic change for sustainable futures*" (Kivimaa et al. 2019a).

2.2.2 Multi-level-perspective (MPL)

The multilevel perspective (MLP) explains change in sociotechnical systems through the interaction of three levels: the overarching landscape, the regime as the level of

dominant structures, and the niches as the level of experimentation and change (Geels 2002; Geels and Schot 2007). These form a nested hierarchy; regimes are thus embedded in the landscape, niches in the regimes. In the MLP perspective, change happens when dynamics at the three levels come together and reinforce each other (Geels 2004; Verbong and Geels 2007).

The advantage of MLP lies primarily in capturing the multidimensionality of change, the multiplicity of actors, and its embeddedness in social contexts with different technical and social elements (Rohracher and Späth 2009). In the following, the three levels will be briefly presented:

The term "regime" goes back to the evolutionary economists Nelson and Winter (1982, Cited from Geels and Schot 2007). They used it to refer to developers of technologies, their shared cognitive routines and entrenched development paths (Geels and Schot 2007). Sociologists of technology broadened the concept, adding more actors (Geels and Schot 2007). Geels (2002) chooses to use the term 'sociotechnical regimes' refering to "the semi-coherent set of rules carried by different social groups" (Geels 2002, p. 1260). Regimes are dynamically stable (Geels 2002), but incremental change takes place within the regime level. Stabilization arises from the underlying rules as well as the close linkage and mutual conditionality of regime elements, which however also represents a potential for change (Konrad et al. 2004; "chain reactions" p. 9).

The landscape is the context of the regime. It influences the direction of regime evolution (Konrad et al. 2004), stabilizes chosen paths, exerts pressure on regimes or offers openings for the new ('windows of opportunities'). Van Driel and Schot (2005) distinguish three types of landscape: factors that do not change or change very slowly, (2) long-term processes of change, and (3) events.

Niches are considered in the MLP as the level of radical change that deviates from the prevailing regime structures (Konrad et al. 2004). They represent "*local development and application contexts for particular forms of technology*" (Konrad et al. 2004, p. 12; translation by author). Here, innovations can develop, learning processes can take place, and new social structures can emerge. In the literature, different types of niches are described, which differ according to their nature and emergence/contextual conditions. There are technical and institutional or organizational niches and "natural" and "artificial" niches (Konrad 2004). Späth/Rohracher also describe discursive niches, e.g. regional energy visions (Späth and Rohracher 2010). It should be noted that these are by no means exclusively technical innovations, but also new organizational approaches to fulfilling functions (Hoogma et al. 2002).

2.3 Social innovations

As set out by Hölsgens et al. (2018), literature on social innovations is diverse and there are a number of different definitions. In 2021, Howaldt et al. state that *"a theoretically sound concept of Social Innovation is still under Construction*" (Howaldt et al. 2021, p. 4). An early definition and systematic review of social innovations was delivered by Zapf (1989). He defined social innovations as *"new and better ways of societal problem solving, changing the direction of social change, and worth*

imitating and being institutionalized" (Zapf 1989, p. 177). They are part of processes of social change (Ibid.). Social innovations as part of social change are also described by Gillwald (2000), defining innovation theory as a practical contribution to theories of modernization. In relation to socio-technical transitions and a practice theory perspective of defining the regime as "a system of interrelated social practices" (Hölsgens et al. 2018, p. 5), social innovations can be of relevant impact on these systems (Hölsgens et al. 2018)[1].

Howaldt, Kopp and Schwarz (2014) have further developed the concept of social innovation, basing it on the micro-sociological theory of Gabriel Tarde, and relating it to the practice turn in social sciences. We will follow their definition of social innovation as an *"intentional re-configuration of social practices especially at interfaces between different rationalities"* (Howaldt and Schwarz 2010, p. 10; translation by author). Social innovations can make use of technology and often do so but technology is not the new aspect (Howaldt et al. 2014). Howaldt and Schwarz explicitly distance themselves from normative definitions, seeing the decisive distinction being 'new' and 'old', not 'good' and 'evil' (Howaldt et al. 2014, p. 64). But social innovations are a central element for achieving sustainable development (Schwarz and Howaldt 2013; Rückert-John 2013). A more recent definition by Reith et al. expresses well the character of social innovations as innovations which are based on the change of social relationships: *"social innovations are understood to be innovations that start by changing social relationships, for example through new forms of cooperation or by developing new business models, utilization or ownership structures"* (Reith et al. 2021, p. 45; translation by author). Intermediaries can represent such a new form of cooperation and ownership. The idea and concept of intermediaries as well as their potential roles in socio-technical transitions will be introduced in the following. This also links to the central and critical question of understanding how the diffusion of social innovations into mainstream practice can come about (Hölsgens et al. 2018).

2.4 Social innovations related to governance of local energy systems and the concept of intermediaries

Hoppe and de Vries (2019) identify different forms of social innovation in the field of energy. One of these relates to new forms of governance on a local scale. A central aspect for understanding the transformation processes of infrastructure systems is the analysis of their social organization and their social regulation. Renate Mayntz (2008), in her review of the governance of LTIs, notes that while technological developments play a major role, the impetus for change comes primarily from the political sphere. In addition, large infrastructure systems require considerable social coordination (Konrad et al. 2004). In this context, a governance perspective broadens the view from central government control to complex forms of social organization. The view is directed to interactions between state, market and society (Grin 2010).

[1] The concept of "social practices" as it is used here draws back to Giddens theory of structuration (1984). This article refers to the definition of social practices by Elisabeth Shove as consisting of the elements of meanings, materials and competences and their relationship (Shove et al. 2012).

The consideration of local governance structures in particular also represents a bridge from the theoretical concept to the empirical analysis of different local developments. In doing so, in the presented research the analysis of the social organization of urban energy infrastructure and its transformation uses an analytical notion of governance:

> "the totality of all coexisting forms of collective regulation of social circumstances: from institutionalized civil society self-regulation, to various forms of interaction between state and private actors, to sovereign action by state actors." (Mayntz 2005, p. 46; translation by the author).

A large number of studies point to the important role of actors who establish new connections within innovation systems and thus contribute to the creation, safeguarding and transfer of knowledge (Metcalfe 1995). Still, the focus in innovation research was often on utilities, regulators, and consumers, neglecting the actors in-between (Moss et al. 2011). Even though they have always existed, the growing significance of these actors 'operating across the traditional spheres of provision, use and regulation as well as between technologies, nature and the city' (Moss 2011, p. 21) is stated in the literature. Kivimaa et al. (2019a) identify a recent increase of articles on such intermediaries that recognize their influential role of "*linking actors ..., activities, skills and resources in transition processes*" (Kivimaa et al. 2019a, p. 1062).

Intermediaries perform their function in quite different ways (van Lente et al. 2003) and there are different understandings, conceptualizations and utilizations of the term 'intermediaries' (Kivimaa et al 2019a). The central criteria is based on 'where it sits' (Moss et al. 2011, p. 5), through their position in-between. Intermediaries have very different organizational structures[2]. Traditionally they often were bilateral and served in the scanning and dissemination of information, between science and policy or in counseling and management support for small and medium enterprises (Van Lente et al. 2003). But instead of only establishing bilateral connections between actors, they increasingly take over functions on the level of the overall system in innovation systems (Van Lente et al. 2011).

Starting from a 'systems of innovation' perspective and an analysis of dominant policy instruments for the transformation of socio-technical systems, Van Lente et al. (2003, 2011) postulate the need for 'systemic intermediaries'. These are defined as 'functioning at system or network level' (Van Lente et al. 2003, p. 275), connecting, translating and facilitating flows of knowledge (Van Lente et al. 2011). This concept takes into account the more complex settings and changing relations between the stakeholders as well as the notion of governance as a more fluid and relational approach to political action (Mayntz 2005). It relates well to the concept of system innovation presented by Schneidewind and Scheck (2013). Differing from the approach of Geels (2004) and the 'systems of innovation' concept, referred to by Van Lente et al. (2011), investigating an interplay of interconnected institutions but centering on technological innovations, Schneidewind and Scheck (2013) define them as innovations beyond technological changes. They encompass changes in infrastructures, institutions, user behaviours and charges of significance (Schnei-

[2] For a typology of intermediaries, see: Kivimaa et al. (2019a).

dewind and Scheck 2013). The ongoing energy transition processes are an example for system innovations, featuring multiple interlinked changes in governance and technological structures as well as in user practices. Moss (2009) analyses intermediaries as "window on the shifting governance of water and energy services" (Moss 2009, p. 1), defining them both as products and medium of shifts in the governance of socio-technical systems. The fields of activity of such intermediary actors thus lie at the changing interfaces of an infrastructure regime between the state, companies, users and the environment. From a governance perspective, they primarily coordinate the participation of different social networks in formal institutions of planning and thus create "arenas of new thinking" (Moss 2009, p. 21) for collective action. Their participation cannot per se be judged as good or bad. Intermediary actors also pursue their own political interests and might, for example, be interested in steering developments in a direction that is beneficial to them or to their specific goals (Moss 2009).

Kivimaa et al. develop the concept of Van Lente further towards "transition intermediaries" (Kivimaa et al. 2019b), defining them as "actors and platforms that positively influence sustainability transition processes …" (Ibid. 2019b, p. 111).

The present article takes a step back towards the more neutral definition of Van Lente. It focuses on transformations realized and coming through at the local level. Intermediaries are described here as part of social innovations as their creation presents an intentional re-configuration of practices and new ways of problem solving in the form of an organizational change in governance structures. As will be demonstrated, this organizational change has been well implemented into the Frankfurt energy system. But it is also present in other local contexts and other domains than energy.

Van Lente et al. (2011) link roles and instruments of intermediaries to typical transition phases: exploration, take-off, embedding, and stabilization:

In the exploration phase, the institution scans research and the market for inventions that could be further developed and adopted in the local system context. Then in the take-off phase, these inventions are tested and learning (knowledge-building) is realized in cooperation with different experts and local stakeholders. Then further network-building takes place, and the invention is embedded, thus adapted and integrated into the local system. The integration of the innovation is stabilized by communication, networking, and advice to energy users, e.g. house owners, local communities, housing associations, and enterprises.

In the following, the article presents the analysis of one example of an intermediary in the context of case studies in Frankfurt/Main. First, the empirical basis and methods are explained, followed by the analytical application of the theoretical concepts introduced above to the presented example.

3 Empirical basis and method

The basis of empirical analysis of the underlying research project are case studies in three urban regions/cities, Frankfurt/Main, Berlin and Main Metropolis, which, in addition to the evaluation of literature and documents (media reports, protocols,

energy concepts and programs, guidelines, reports), are mainly based on the analysis of qualitative guideline-based interviews with actors and experts. The qualitative interviews provide insight into the assessment and perception of key actors in local energy policies beyond official discourses and document-based information.

The analysis of the interviews and documents mentioned above was conducted using the MAXQDA software and was based on the procedure of qualitative content analysis according to Gläser and Laudel (2004). This constitutes a rule-guided and systematic procedure in which information is extracted from the material and thematically structured using categories. It allows to systematically reduce the abundance of information.

The category scheme was initially created on the basis of theory, starting with the questions and assumptions, and is further developed in the course of coding, starting with the material. The individual categories are not replaced but supplemented by new categories. In contrast to other methods, this procedure ensures a relatively high degree of openness in the process of analysis. The material was finally subjected to a second coding process.

The selection of the specific case studies, namely locally developed socio-technical innovations, is based on preliminary interviews and documents but the decisive factor for the choice was the attribution of meaning by local actors as expressed in interviews. Other criteria were the deviation from dominant local structures and an experimental character, i.e. the testing of new approaches outside traditional procedures, as well as an exemplary reference to the local context.

The article focuses on one specific case study in Frankfurt/Main, an intermediary institution (ABGnova) in order to better deepen the analysis on a particular case.

For this specific study, a total of 10 interviews with a length of between 45 min and 2.5 h were conducted in Frankfurt between May 2012 and August 2012.

The interviewees are representatives of the administration of the city of Frankfurt (Energy Department and Energy Management), Mainova, AGBnova, Chamber of industry and commerce (IHK), the Regional Association Frankfurt RheinMain (Department of Energy and Environment), the Regional Council Darmstadt (Department of Occupational Safety and Environment Frankfurt) of the State of Hesse (Ministry of Environment, Energy, Agriculture and Consumer Protection (HMUELV)), the former Energy Agency of the State of Hesse (Hessenenergie), which is now a limited liability company, and a member of the Sustainability Forum Frankfurt (from science).

In addition, official documents such as resolutions of the city council, guidelines and data of the energy management, information brochures of the Energy Department, energy concepts as well as studies/articles and newspaper articles serve as a basis for information.

The case studies refer to the specific time period between the beginning of the 1990s and 2012, a period of growing consciousness and activity regarding urban energy (e.g. Capello et al. 1999; Lutz 2018). The events in Fukushima in 2011 accelerated this further and constituted a window of opportunity (Schmid et al. 2016) for transforming the German energy system. They were put forward by several interviewees as a wake-up call about the needs to act. The events and discussions around helped them in their argumentation in regard to increasing energy efficiency

and a shift to renewable energies and for receiving the necessary resources for the implementation of their plans. This situation can be described as a "window of opportunity" as defined in the MLP. It represents a putting into question and destabilization of the regime opening possibilities for a transition. Still, as on German national level, this window of opportunity accelerated a discourse and development prepared since a far longer time period (Lutz 2018).

4 Case study example: ABGnova in Frankfurt/Main as a local intermediary

Results of our empirical work underlined that a key for breaking up lock-in situations, meaning the persistency of a dominant solution, are changes to the social organization of infrastructure systems, especially at cutting edges between producers and consumers, policy and producers, but also between different infrastructure systems like energy and waste or energy provision and habitation. This is a strong element when looking into the case of Frankfurt/Main, as e.g. illustrated by the local energy agency and the case of ABGnova, a local intermediary.

4.1 Presentation of the case study context

Frankfurt/Main, with around 700,000 inhabitants, is the fifth largest German city. It is at the centre of the Frankfurt/Rhine-Main metropolis region, a polycentric region with around 2.2 million inhabitants (Regionalverband Frankfurt Rhein Main 2014). Frankfurt was in 1990 one of the founding members of the Climate Alliance[3], the largest European city network dedicated to climate action. The city administration then set the goal of 10% CO_2 reductions every five years (IFEU 2008). In 1989, a local energy agency, the *Energiereferat* was founded as a part of the city's environmental department with the mission to develop and implement climate protection measures in Frankfurt. It concentrates on the fields of electricity saving, energy planning, and combined heat and power supply, as well as residential buildings and renewable energies. It 'promotes climate protection aims' involving different partners (Energiereferat Frankfurt am Main n.d.). The energy department is the central authority in local energy policy for local strategy development and the implementation of local political decisions. Its establishment was a decision of the then red-green coalition in the city against the backdrop of a political transition situation and in the course of the establishment of an environmental agency. The energy unit is also the interface between the administration and other players. And it is described in an interview as a kind of "central star" that needs satellites. It often initiates things that others then realize and disseminate further.

The Energy Agency is complemented by an energy management unit, founded in 1991 in the context of joining the Climate Alliance (with a small precursor established in 1983). Its task is to lower public spending on water and energy, and

[3] https://www.climatealliance.org/home.html (02.02.2023).

to 'exemplary implement' (Linder 2012, p. 1) the climate protection goals of the municipality.

Particularly within but also outside the administrative levels, there has been deliberate work on networking and cooperation between the different actors. According to several interviewees, good networking was an essential feature and conducive factor of Frankfurt's energy policy. For example, one interviewee from the administration states: "*our strength really lies in this [networking] now in recent years,—as in soccer sometimes—in the interaction*".

A distinctive condition of the energy policy of Frankfurt is the fact that the city is a major shareholder of the local energy utility Mainova AG (75.2% at the moment of the empirical study in 2012), and of one of the largest housing companies in Germany, the ABG Frankfurt Holding. These enterprises are shareholders of the intermediary ABGnova GmbH, the case study example chosen for this article.

The ABGnova was created in 2009 by the City of Frankfurt/Main, the housing association ABG and Mainova, the local energy utility, as a 'daughter' of these two companies. It focuses on energy efficiency in housing and mobility. The initiative came from the city administration. The goal of this 'open house for innovations' (ABGnova 1 n.d.) is the transfer of knowledge as well as cooperation on innovative solutions for a transition of the city and region of Frankfurt/Main to more and more energy efficiency (ABGnova 2 n.d.). In qualitative interviews with local stakeholders realized by the author, the institution is locally described as a 'dinghy to the two tanker ships', 'connective', and an important transformative actor. It is working at the interface between housing and energy, including new mobility concepts linked to these two areas (e.g. electric mobility). Another background for the creation of this institution is the need for coordinated long term planning of infrastructures. Central elements of its work are observation and evaluation of innovations on the market and in research, as well as the implementation of innovations in the local regime, network building, and energy efficiency consulting, including advice on funding opportunities for different target groups. According to an interview with the city administration, the idea had come from the office of the mayor at the time, who in her function was also head of the supervisory board of both companies. It was therefore "supported from the highest level" (interview with administration). Both companies had already been active in this respect for some time and were nationwide pioneers in their field. Now the idea of joining forces seemed obvious. Another representative of the administration describes the genesis of the idea as follows: *"They [Mainova] said we want to do something. The transformation is practically in their cradle. Where does the energy transition take place? In the city. And where in the city? In buildings. And who owns the buildings? The ABG. And who supplies energy? Mainova. Then let's do something together in our buildings. And so, on closer inspection, it became clear there are all kinds of interfaces, interfaces housing-energy."* (interviewpartner in the city administration). From the point of view of both partners, there are issues that they cannot solve alone and, as an interview partner in Mainova expresses it, "*if everyone puts their knowledge in a bit, approaches the other, better solutions, joint solutions can be found and that was the intrinsically motivated approach to found this company"* (representative of Mainova).

The focus of ABGnova is on innovations in the field of energy efficiency in buildings and also the connection of new mobility concepts (electromobility) with the field of housing. It is intended to *"ensure a continuous transfer of knowledge and the dissemination of innovations for improving building energy efficiency"* and, based in particular on the experience of the two companies involved, to *"develop possible solutions for the further development of the city of Frankfurt and the Rhine-Main region into an ever more energy-efficient region"* (interview partner at the city administration). Building blocks here are the observation and evaluation of new findings and of developments in the legal situation, technology and the market, the implementation of new approaches and the provision of information and advice on energy efficiency issues. The latter is realized within the framework of an energy consulting centre. This also includes mobility issues (electromobility, car sharing), which are often left out elsewhere. Concrete topics also include subsidies and research funds, building renovation and new building construction. In addition to companies and municipalities as target groups, it also addresses architects and engineers as well as private property owners and, to some extent, other private individuals (although these are less in focus). At the time of the observation, seven employees were available for these tasks. ABGnova is involved (mainly as a practice partner) in various research projects and programs also outside the narrow energy framework (examples are the "Climate-KIC" as well as the project "netWORKS 3: Intelligent Water Management System Solutions in Frankfurt am Main and Hamburg" of the German Institute of Urban Affairs (difu) and the EU project "Retrokit", funded in the 7th Framework Program, which dealt with approaches to renovate buildings from the post-war period).

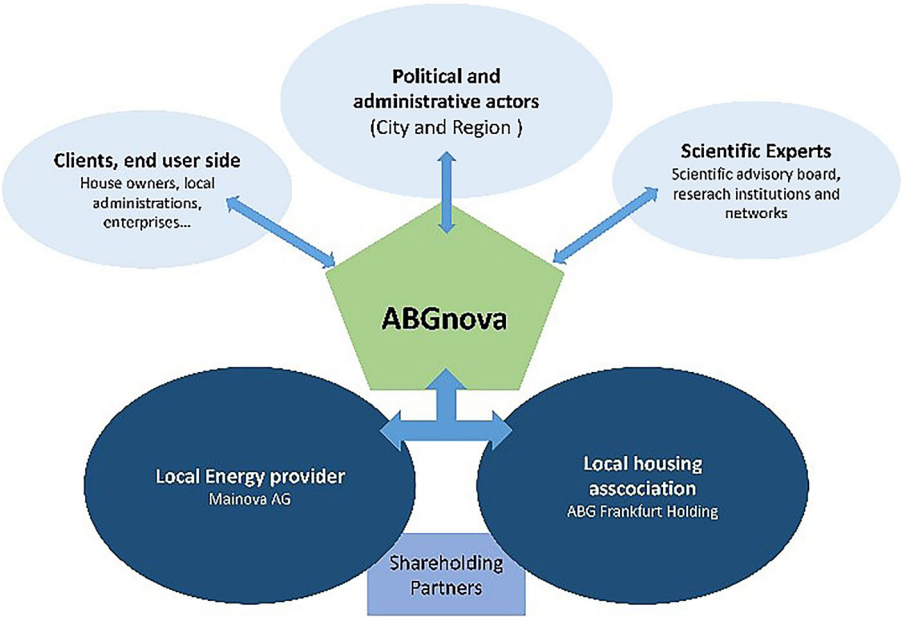

Fig. 1 Overview of ABGnova and its local partners and clients. (Illustration by the author)

Table 1 Transition phases and key roles and activities of ABGnova. (Based on Van Lente et al. 2011)

Transition phases	Key roles and activities	Examples
Exploration	Search for innovations, assessment of innovations, make variety of options more visible, identification of stakeholders	Virtual power plant (see below)
Take-off	Testing of innovations, knowledge-building	Virtual power plant (see below)
Embedding	Communication, network-building, implementation into the system	Information and discussion events, networking e.g. among users of micro cogeneration units. Practice partner in research projects
Stabilization	Communication, advice to users	Consulting different target groups

Figure 1 illustrates the structure of the presented intermediary. It links on the one hand two major local regime actors on the side of enterprises, on the other hand local administration, scientific institutions, the user side, and niche actors developing new approaches. Its role is described in an interview with representatives of Mainova as a target executor. It provides the instruments. "*The goals come from politics, from the EU to the federal government, to the state, to the city. And then the instruments, such as a virtual power plant, come from the companies as an innovation or an idea, and they then implement it in principle, and that is then a set of instruments that is, of course, sufficient for the city to achieve its goals*" (Interview with representative of Mainova). This underlines the critical role of local government, as postulated e.g. by Fudge et al. (2016), but also the interplay with other local actors, providing the 'instruments'.

ABGnova can be considered a systemic intermediary (Van Lente et al. 2003, 2011; Hannon et al. 2014), thus an institution operating at interfaces and on the system level, coordinating multiple actors, representing a central instrument for the alignment of actors and possibilities (Van Lente et al. 2011), and local learning processes. Table 1 relates the activities of ABGnova to the typical transition phases distinguished by Van Lente, Hekkert and Smits (see also Chap. 2.2 on intermediaries):

A concrete example of ABGnova's activities is the virtual power plant[4] of Frankfurt (for more information and an illustration see ABGnova 3 n.d.). This concept, integrating different energy sources into one virtual plant, already existent for big power plants, has been adapted for creating a local network of small, decentralized power plants, renewable energy plants, and energy users.

The basic software for the power plant coordination was initially created by cbb, a German software engineering company, so the invention was not on the side of ABGnova or its shareholders, but was created for their system. ABGnova served as a niche for developing it further and adapting it for the local energy infrastructure system.

The approach of a virtual power plant took up the changing production and consumption patterns and actor configurations manifesting in the rise of decentralized

[4] https://www.abgnova.de/pdf/forschungsprojekte/2012-04-26_PK-VK_Grafiken.pdf?m=1500286726 accessed 01.02.2023.

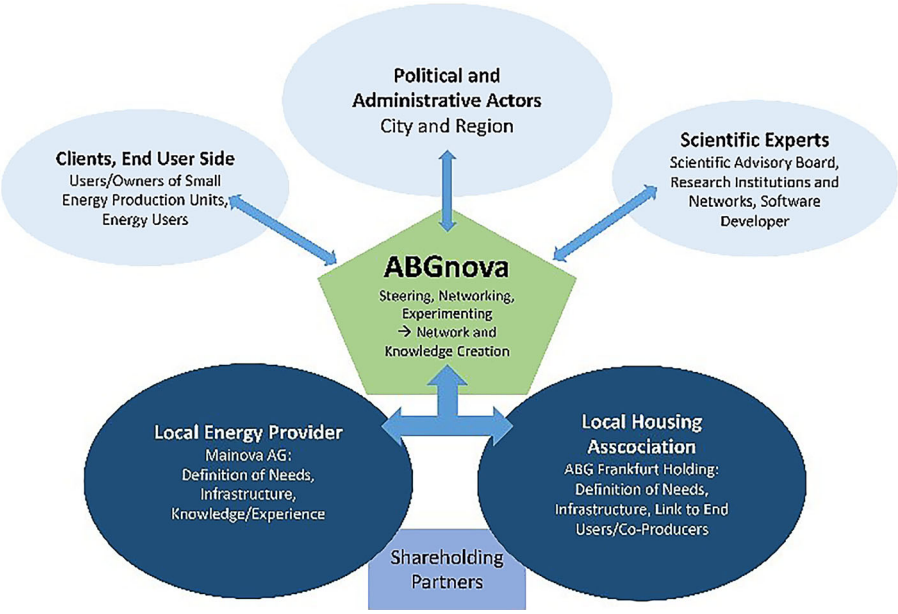

Fig. 2 Overview of the actor structure around the virtual power plant project. (Illustration by the author)

energy production units in Frankfurt, and additionally in the aim to foster e-mobility. It constitutes an answer to the problem of fluctuations in the energy production, e.g. because of solar and wind power, and aims at embedding and stabilizing decentralized and renewable energy production. The advantage of the inclusion of the housing association is the energy production and consumption in their buildings as well as the direct link to energy users (housing and mobility) and small building-based energy producers (Fig. 2).

In interviews with stakeholders, ABGnova was generally situated between the first invention by niche actors, or basic research and application. Their active contributions in the innovation process are the combination of new elements, the adoption to the energy system, the adaption of the system to new problem-solving solutions, and knowledge and network creation as well as knowledge transfer. The mayor of Frankfurt appreciated Frankfurt to become a laboratory: *"If ABG and Mainova make the city of Frankfurt a laboratory for the energy transition, then I'm happy to support that."*[5]. An interviewee at Mainova describes ABGnova as those who drive an innovation forward. In the interview, this is described as follows: *"When do we step in? Basic research is at the front, so to speak, applied research is at the back, and we enter between basic research, which must have already taken place, i.e. we ourselves do not develop this idea, then a medium-sized company must already have been found that finds this basic research interesting and worthwile, then we look for this medium-sized company and then we push it, and that is our task. To get innova-*

[5] https://www.stadt-und-werk.de/meldung_14787_Laboratorium+f%C3%BCr+die+Energiewende.html accessed 01.02.2023.

tive approaches from medium-sized companies and to combine systems. And that's maybe the innovative thing that we really do and that's the value creation that we do." (interview partner at Mainova). While they are not able to develop new systems, the midsize companies are not able to implement them because they lack the resources such as knowledge, money and the appropriate equipment, he said. *"We have a great deal of knowledge and we then apply these components that had been developed by medium-sized companies in the system. We combine that and we then generate products from that and generate names and bring that into the lobbying. And so the shoe is on the other foot, the medium-sized company alone cannot do this. I think it's always a symbiosis, and if you look at products that have been successful, it's actually always been like that"* (interview partner at Mainova).

5 Discussion and conclusions

Referring to the multi-level perspective (Geels 2002), which analyzes transformations as the interplay of three different levels: landscape, regime, and niches, ABGnova can be described on the one hand as creator or support for niche experimentations and on the other hand as a bridge between the niche and regime levels. It has niche characteristics and functions, bringing inventions to the status of innovations ready to change the regime. It also opens up lock-in situations and can use frictions, like needs for better problem-solving solutions and for transforming the regime. An example for both functions is the virtual power plant responding to changing production and consumption patterns and corresponding challenges like fluctuation and the need to organize decentralized energy generation. At the same time this innovation fosters e-mobility, new ownership structures and networks. ABGnova has a main role for transferring former niche technologies into the regime, embedding them and thus changing the regime e.g. towards more decentralized structures. There is a parallel to the role of cities bridging the niche-regime divide as described by Rohracher and Späth (2009). Kivimaa et al. (2019b) stress the role of translating at the niche-regime interface which includes different functions. For the case studied here, e.g. translating regime priorities and articulation of expectations as well as the development of shared rules and infrastructure play an important role related to this role of translation. Following the typology of Kivimaa et al. (2019a), the presented case study "ABGnova" thus has both characteristics of a systemic as well as a regime-based intermediary. The conceptualization as social innovation may seem less obvious. It may be understood linked to the definition by Reith et al. (2021: 45, translation by author): *"social innovations are understood to be innovations that start by changing social relationships, for example through new forms of cooperation or by developing new business models, utilization or ownership structures"* but also Zapf (1989) mentions institutional innovations as form of social innovations. The conceptualization as social innovation helps to understand ABGnova as institutionalisation of changing social practices in the governance of the local energy system. It e.g. transforms the way in which key stakeholders cooperate and organize the local energy system, i.e. consciously operating at and improving interfaces.

There is need for further research and "solid conceptualization" regarding intermediaries (Kivimaa et al. 2019a). This also concerns insights on their role in infrastructure governance as new actors not fitting into the classical categories of provider, user or regulator (Moss 2009) and how their role changes adapting to different transition phases. Here, the concept of Van Lente et al. differentiating between different roles and linking them to transition phases provide a useful starting point for empirical and conceptual research.

Moss et al. (2011) point out that one should not take the transformative capacity of intermediaries for granted. The role of established regime actors could often be a critical point in this aspect and presents an interesting question for further research. In the presented case, the fact that local regime actors are directly involved seems to be an important and supporting factor, giving direct integration possibilities to the system. In contrast to classical niche actors, they have access to infrastructure and other relevant resources, important for real life testing and the implementation of technical innovations. This aspect was clearly stated in interviews as outlined above, and confirms findings of Bush et al. (2017) in their study on the role of intermediaries in the field of district heating in the UK that their embeddedness within the regime and thus access to resources was a determining factor for their ability to deliver systemic responses. However, the link to the regime may also restrict them to "fit and conform" (Bush et al. 2017, p. 146) approaches. Hölsgens et al. (2018) bring in the aspect of alignment with the regime. On the one hand (as seen in the example of ABGnova), such an alignment can help with the diffusion of a niche innovation and the integration into the regime but this may also lead to loosing "the transformative edge" (Hölsgens et al. 2018, p. 10). The results in Frankfurt confirm their findings that the regime actors should get more attention, e.g. when the regime gets destabilized due to changes of regime actors and 'windows of opportunity' such as the Fukushima Events mentioned above or the energy policy of the city of Frankfurt. On the other hand, regime actors tend to resist to destabilization of dominant structures (Geels 2014), often forming an alliance between policy makers and incumbents (Geels 2014). In his analysis on regime actors and power and politics in the MLP (and the UK context), Geels (2014) stresses to put a stronger focus on the regime actors' role and on their destabilization. Turnheim and Sovacool (2020) take up the discussion and paint a more nuanced picture of the role of incumbents. They emphasize the diversity of these actors, criticize a mis-representing of crucial actors and dynamics of change and ask for more pluralized exploring of incumbencies (Turnheim and Sovacool 2020). The presented research in this article confirms their view and provides empirical insights e.g. on the important aspect of resources of the incumbents as well as their potential for bridging the niche-regime divide. Further analysis should focus e.g. on the specific local conditions, and the ability of cities to use room in regime structures for deviations from the dominant regime (Rohracher and Späth 2009) as well as on the question on how these 'transitions on the ground' (Geels 2014) are upscaled to transitions on higher governance levels, "*driving the energy governance from the local level*" (Fudge et al. 2016, p. 16).

Through its integration in different networks as well as the exemplary implementation and testing of innovations, the ABGnova has impact beyond the borders of its local context. It supports the potential of intermediaries for advancing transitions

and demonstrates well how local organizational innovations can be an instrument for system transformations. At the same time, their work of organizing novel forms of cooperation and interaction is significant for the transformation of infrastructure governance. They are both results of changes in governance as well as drivers of governance change. Thus, further empirical and conceptual investigation on intermediaries and their role in transition processes can provide important contributions both to innovation and transition focused research, policy and practice and to the field of governance concepts and research.

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