Towards a better understanding of local reorganization processes – empirical findings from two case studies

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Abstract

Both currently dominant sustainability transition theories, the Multi-Level-Perspective and the Technological Innovation Systems approach, have been criticized for their insufficient conceptualization of local transformation processes. This partial blindness is highly surprising from the background of evidently strong local development differences. In this paper, we aim to contribute to a more nuanced understanding of local energy-related reorganization processes (comprising both, energy generation and demand), presenting results from case studies on two cities in Germany, Emden and Bottrop. Borrowing freely from ideas of the regional innovation systems (RIS) approach, we analyse various "institutional spheres" (science, local politics, city administration, industry, banking, intermediaries and civil society) and the ongoing change processes arising from their interaction. Conceptually, we distinguish between first order and second order innovation. First order innovation refers to small scale, piecemeal adaptations (e.g. singular experimentations by a particular actor) while second order innovation points at systemic reconfigurations at the level of the actor system. Drawing on institutionalist thinking, we examine these more encompassing accommodation processes along four analytical dimensions: a strategic dimension referring to changes on the level of power constellations; a normative dimension looking at the reshaping of definitions of appropriate behaviour; a procedural dimension analyzing refined patterns of interaction and organization; and a cognitive dimension examining the redefinition of shared perceptions of problems and solutions and the creation of new knowledge. Evidence for second order changes on all four analytical dimensions indicates a growing institutionalization of Local Energy Transition Systems in both cities. This finding raises questions on the relationship between first and second order innovation.

Introduction

Energy is gaining growing attention in public debates. Objectives such as the European 20-20-20 objectives aim to increase the share of renewable energy sources, reduce carbon emissions and energy consumption. A multitude of contributions has emerged in the last couple of years to analyse the resulting processes of decarbonisation and decentralisation of the current energy systems as well as the associated political and societal shifts, which are framed as *energy transition*. In this debate, both currently dominant theories, the Multi-Level-Perspective (MLP) and the Technological Innovation Systems (TIS) approach, have been criticized for their insufficient conceptualization of local transformation processes (Truffer and Coenen 2012, Coenen et al. 2010, McCauley and Stephens 2012). This partial blindness is highly surprising considering the prevailing strong local development differences that characterise the outlined energy turn. While some cities and regions are strongly engaging to become pioneering energy regions – for instance as "low carbon" and "smart" cities or as "100 % renewable energies regions" – others remain hesitant.

In this paper, we aim to contribute to a more thorough understanding of local energy-related reorganization processes (comprising both, energy generation and demand). Our core question is how regions institutionalize change, i.e. how change

is being transferred into permanent structures. We call these restructuring processes second order innovation as opposed to first order innovation. *First order innovation* are small scale adaptations (e.g. singular experimentations by a particular actor) while *second order innovation* involves systemic reconfigurations at the level of the system.

In order to shed more light onto the occurring processes, we first briefly introduce an analytical framework that was initially developed in a previous article (Mattes and Huber 2012). Borrowing freely from ideas of the regional innovation systems (RIS) approach, we suggest distinguishing between various "institutional spheres" (science, local politics, city administration, industry, banking, intermediaries and civil society) to grasp change processes. First- and second-order innovation can occur in any of these subsystems, with second-order innovation spanning over various subsystems. Drawing on institutionalist thinking, we distinguish between strategic, normative, organisational-procedural, and cognitive dimensions of change to classify the occurring type of second order innovation. We do not aim to develop a multi-scalar approach, but to understand the mechanisms of local energy transition processes.

The focus of this paper is then the empirical analysis of local energy transition processes. In the core of the paper, we present empirical results from two German cities, Bottrop and Emden. We provide evidence for change on each of the four analytical dimensions. Subsequently, we draw a comparison between the two cases and show aggregate results, commonalities, and differences. We conclude by discussing the relationship between second and first order innovation in the course of local energy transition processes.

Introducing space as a key element into the transition debate

In many aspects, energy is a topic that cannot be assigned to a singular spatial scale. Instead, actors on different spatial levels interact in a way which resembles a 'multi-territorial approach' of innovation (Heidenreich et al., 2012: 267). This implies several places being connected to each other, as the TIS approach acknowledges (Truffer et al., 2012). Nonetheless, there are strong signs of the growing importance of the small-scale regional or local level in the energy transformation (McCauley and Stephens, 2012). Municipalities are often the starting point of a system transformation and were hence characterized as "initial seedbeds for transition" (Geels, 2011: 22). In order to be able to describe the occurring change processes in detail, we thus take small-scale regions as a starting point to gain an in-depth insight into the involved processes of re-organization. Even though energy transition cannot be assigned to a single spatial scale, we regard the local level as a crucial trigger for change processes, which is why we focus exclusively on that level in this paper.

It is highly surprising that both dominant theories of system transformation, Technological Innovation Systems and the Multi Level Perspective, remain relatively vague on the importance of local constellations that drive or obstruct change processes.[1] The TIS concept does not have a substantial territorial perspective (Truffer et al., 2012). The analysis is not focused on space, but concentrates on sectoral borders. Carlsson and Stankiewicz (1991: 93) define aTIS as "network of agents interacting in a specific economic/industrial area under a particular institutional infrastructure or set of infrastructures and involved in the generation, diffusion, and utilization of technology. Technological systems are defined in terms of knowledge/competence flows rather than flows of ordinary goods and services. They consist of dynamic knowledge and competence networks." As TIS analysis focuses on interactive interplays between actors in different locations, it strives to include all the technologically relevant actors and hence explicitly avoids spatial restrictions (Truffer et al., 2012).

The MLP in turn describes system transformations as interplay between the three levels "niche", "regime" and "landscape" (Bijker et al., 1987; Geels, 2002, 2005; Loorbach and Rotmans, 2006; Verbong and Geels, 2007). The regime represents the dominant socio-technical configuration, which is stabilized by the interplay of existing material elements (technologies, infrastructures), social groups and actor networks as well as cognitive, normative, and regulative rules. These regimes are framed by institutions and infrastructures on the macro level (landscapes). Niches are small-scale socio-technical arrangements where settings different from the mainstream orientation are tested (Coenen et al., 2010). Change comes about when landscape evolutions ("external" developments) exert pressure on the regime and when bottom-up alternative solutions at the niche level challenge the dominant socio-technical configuration. Most of this change is incremental, i.e. the regime incorporates some elements of upcoming niches without changing its fundamental rationales. Only in rare cases, windows of opportunities for radical change open up and system "lock-ins" can be overcome for a complete de- and re-alignment of the socio-technical regime (Verbong and Geels, 2010; Geels and Schot, 2007). The Strategic Niche Management (SNM) approach can be seen as a real-life steered application of the MLP theory (cf. Schot and Geels, 2007; Loorbach and Rotmans, 2006). It suggests creating protected spaces – referred to as "transition arenas" – where diverse actors agree on commonly defined problem situations and shared visions and experiment with alternative solutions that, upon evaluation, are ultimately "upstreamed".

While the MLP theory implicitly recognizes the role of local action through its niche concept, it has failed to provide a systematic conceptual frame for the concrete local conditions that favor the growth and spread of alternative socio-technical configurations (Truffer and Coenen, 2012; Coenen et al., 2010). In this way, the MLP framework does not grant insights into how energy transitions are rooted in local regions. We lack knowledge on how exactly the transition processes occur, which actors drive them and how the actors interact with their institutional framework (McCauley and Stephens, 2012). In order to understand energy transition, we hence need to gain a better understanding of how change is being accommodated between diverse local actors, how historical roles and relationships are redefined in mutual learning processes, how cognitive, organizational, social, and geographic forms of proximity matter (Coenen et al., 2010) and which role power relationships play in these reconfiguration processes.

1. There is however a growing body of literature on some aspects of local change. For instance, an intense debate has evolved over the recent years on the potential of local communities to shape local socio-technical settings (c.f. Heiskanen et al. 2009, Middlemiss and Parish 2009, Seyfang and Smith 2007).

In order to fill this research gap, we suggest drawing upon Regional Innovation Systems (RIS) as a potential source of inspiration. RIS are defined as systems "in which firms and other organizations are systematically engaged in interactive learning through an institutional milieu characterized by embeddedness" (Cooke et al., 1998: 1581). They are understood as geographically concentrated and institutionally stabilized networks of socio-culturally embedded companies. The levels of analysis include institutions as rules of the game, political and business organizations as collective actors (Cooke et al., 1998), as well as individual actors (cf. also Asheim and Isaksen, 2002). In order to acknowledge the breadth of possibly relevant context factors, RIS are not restricted to directly innovation-related activities, but also include factors influencing innovation indirectly such as the economic structure in general, the education system, and political initiatives. Such a perspective implies that five subsystems are generally investigated (Mattes, 2010; Heidenreich et al., 2012; Kuhlmann, 2001): the scientific subsystem (made up by science and education), the industrial subsystem (consisting of companies which compete, cooperate or supply (with) each other), the political subsystem (i.e. municipalities, regional administration, political parties and related actors), intermediaries (mainly referring to labour unions and chambers of commerce), and the financial subsystem (related to funding schemes, venture capital and banks).

While – as far as we know – RIS have not been analyzed for the energy sector, this short outline of institutional change provides a useful starting point for understanding processes of transformation and learning in a specified territory. However, the concept needs to be adjusted to the particularities of the energy sector. As citizens, farmers and cooperatives have become important actors in the energy transformation (c.f. Trend Research Institut and Claus Novy Institut 2011, Mautz et al. 2008) , we add the dimension "civil society" (NGOs and mobilized citizens) as an additional subsystem to those outlined above. Moreover, we subdivide the political subsystem into "political parties" and "municipal administration" to distinguish between political agendas and day-to-day administrative intervention.

When looking at the occurring change processes in these subsystems, we differentiate between first and second order innovation. *First order innovation* refers to small scale and piecemeal adaptations (e.g. singular experimentations by a particular actor), while *second order innovation* involves systemic reconfigurations at the level of the system. Both processes go hand in hand and can facilitate each other. Our focus in this paper is on second order innovation, as we want to show how the investigated regions do not only accommodate minor adaptations, but also restructure themselves in the course of the energy transition. Such changes have elsewhere been described as complex "reinvention" of a region (Heidenreich, 2005).

To develop precise indicators which describe the processes of change in all the involved areas, we draw upon the seminal differentiation into regulative, cultural-cognitive, and normative pillars of institutions as outlined by Scott (2008). Following Heidenreich (2009), we understand the regulative or strategic dimension of transformations as changes in the set of "interests, actors, and organizations within the framework of the (…) action constellations" (ibid.: 31). Thus, the strategic dimension is about changes in the local power constellations. The cognitive dimension of transformation is defined "as establishment and strengthening of new (…) orientations (…) within the framework of (…) discursive arenas" (ibid). This cognitive dimension refers to the (re)creation of knowledge and understandings. It hence carries a mimetic aspect and is most directly related to learning in the narrower sense of the word. Finally, the normative changes refer to the "transformation of legal, professional, or organizational rules." (ibid.) Thus, it refers to the change of norms or routines. Largely governed by morals, these informal rules suggest which behaviour is appropriate for a certain actor in a given context. We add an organizational-procedural dimension, which examines patterns of interaction as well as forms and mechanisms of coordination. All four dimensions are summarized in Table 1.

In all dimensions, we are interested in analyzing encompassing second order innovation processes. They result in redefined configurations in the strategic, normative, procedural, and cognitive set-up of the local structure. In the following, we will illustrate these processes of reconfiguration with findings from two empirical case studies.

Key findings from two German case studies

In this chapter, we illustrate the usefulness of the analytical grid that was introduced in the previous chapter. To this purpose, we will analyse empirical data collected during case studies in two German cities, Emden and Bottrop, along the suggested second order dimensions. The aim of the following paragraphs is hence *not* to analyse cities as part of the German multilevel governance system in the energy field. Nevertheless, in order to give the reader a better idea of the empirical setting, a very compact summary of the wider political context will be provided in a short section, followed by methodological information. Subsequently, the second order transition processes in both cities will be discussed.

THE GERMAN ENERGY TRANSITION

Germany's Energiewende (energy turnaround) aims to continuously increase the share of renewable energy sources for the energy supply, while gradually phasing out nuclear power and fossil energy sources, complemented by increased energy efficiency (for a more detailed overview on the Energiewende see Buchan 2012). Its origins date back to 1991, when the German government passed the "Stromeinspeisungsgesetz" (feed-in act), a predecessor of the Erneuerbare Energien Gesetz (Renewable Energy Act). The Renewable Energy Act from 2000 guaranteed fixed feed-in tariffs to producers of renewable electricity over a period of 20 years. In parallel, the former red-green government decided to gradually phase out nuclear power generation. The current conservative-liberal administration first revised this decision in 2010, but, following the Fukushima disaster and under the strong pressure of the German public, the government confirmed the end to nuclear energy by 2022 and the importance of renewable energies.

The public support schemes have boosted renewable energy production in Germany, which accounted for 20 % of the German electricity supply in 2011 (and is close to 25 % in 2012), compared to less than 7 % in 2000 (BMWI 2012). Despite recent criticisms on the rising renewable energy surcharge on customer electricity prices and rising concerns about the supply security as well as shortcomings of the high transmission

Table 1. Dimensions of energy transition.

	scientific subsystem	industrial subsystem	political subsystem	political subsystem (administration)	Inter-mediaries	financial subsystem	civil society
normative	changes of formal and informal rules and norms						
procedural	new patterns of interaction and coordination						
cognitive	(re)creation of knowledge and understanding						
strategic	changes in local power constellations						

Source: Own representation, partly drawing upon Scott (2008) and Heidenreich (2009). Cf. also Mattes and Huber 2012.

grid infrastructure, Germany's Renewable Energy Act has often been described as a success story that has been replicated by many other governments. One major shift in the energy system has been the empowerment of citizens, cooperatives, and farmers who have strongly responded to the policy incentives. With around 50 % of ownership in 2010, this group of actors holds the lion's share of RES installations (Trend Research Institut and Claus Novy Institut 2011). In parallel, local public utilities (Stadtwerke) regain importance for energy generation and the operation of distribution grids. This points at an increased decentralisation of the energy system and the growing importance of activities at the local level. The following chapters will present empirical results on our two case studies, Bottrop and Emden.

METHODOLOGY

When it comes to analyzing the innovation dynamics at the local level, multiple variables and interdependencies can be expected. Semi-structured, qualitative interviews appeared as the most appropriate methodology of data collection to grasp this complex and multi-layer character of local change processes. Thus, more than 30 interviews per region were conducted with representatives from the different "institutional spheres".

The selection of interview partners was made with the objective of balancing perspectives from all institutional spheres, i.e. having representatives for each of the different spheres. However, according to the particular situations in Bottrop and Emden, some categories of actors were more heavily represented in the panel, while others revealed to be less relevant in the course of the empirical work. For instance, as industry companies are strongly involved in the innovation processes in Bottrop and Emden, the category of economic actors was covered by a higher number of interviews, while other institutional spheres (banking and civil society) were less heavily represented in the samples.

The interviews took place between June and November 2012 and the duration of interviews ranged from around 60 up to 145 minutes. All of them were conducted face to face, led by one or several of the authors. They were based on a common project interview guideline, which broadly defined conversation contents. Thereby, the interviews were structured around three main blocks: after an introductory part on the interviewee's organisation and its history as well as activities and objectives in the energy field (1), the interviews explored the most important exchange relationships with other relevant organisations (2). In a final section, one exemplary project was discussed in detail to illustrate the interactions between actors (3). Yet, depending on the interviewed persons, the focal points of the interviews varied. All conversations were recorded and afterwards transcribed for the data analysis. Using the software MAXQDA, the produced interview transcriptions were subsequently coded along analytical categories ("codes"), allowing for a systematic and encompassing analysis of selected research issues.

THE EMDEN CASE STUDY

Presentation of Emden

Emden is a small harbor city of around 50,000 habitants located in the region of East Frisia (Ostfriesland) in the north-west of Germany. This region is known for its wind energy sector: many wind farms and a prospering wind industry are located here. Numerous projects have been realized over the last years, such as energy education programs in schools, energy advice services for citizens, the construction of wind and solar farms, the organization of energy exhibitions, the participation in the European Energy Award and the climate alliance ("Klimabündnis"), the refurbishment and energy management of public buildings etc. Moreover, Emden's economy has experienced a radical transformation from its historically very strong shipbuilding sector towards the wind energy sector. With the decline of the ship industry, a number of wind energy businesses have emerged in the city's harbor.

The first initiatives that initiated the local energy transition were already launched at the end of the 1980s. In the year 1987, the city and the municipal utility company (Stadtwerke) built the first wind mill to power the local water works. In the early 90s, a reorientation of the municipal utility company followed. A new CEO was employed who put renewable energy and energy efficiency at the top of the company's strategic agenda. Thus, the Stadtwerke constructed its first wind farm in 1993 and implemented different programs to encourage its clients to save energy. Due to the activities of the Stadtwerke and other local actors – city administration, local businesses, politicians etc. – Emden developed its own path of energy transition. In the course of this development, a growing number of projects were launched and new objectives were fixed. In the year 2003, Emden joined the European Energy Award program, and, in 2008, also the "Klimabündnis" ("Climate alliance"). Furthermore, the city set itself climate targets: a 10 % reduction of CO_2 emissions every five years and a 50 % cut of the total CO_2 emissions until 2020 (as compared to 1990 levels).

Actors from different spheres (sub-systems) have contributed with their specific competencies to the local energy transition. Politics, local energy related businesses and the city administration have been from the beginning highly engaged in the

reorganisation processes. Politicians have promoted the local energy transition by their decisions, for instance, by reorienting the Stadtwerke towards RES and energy efficiency. Local businesses have carried out energy transition projects such as the construction of wind and solar farms and the implementation of energy saving measures. Their projects have been supported by the city administration which has provided a favourable context for transition projects and, in addition, has also implemented its own transition projects. While actors from these three subsystems have from the very beginnings been involved in the local energy transition, the science sphere with the local university has only more recently started to play an important role in Emden's energy transition by providing scientific knowledge and expertise to different local actors.

The changes in the involvement of different subsystems go along with second order innovation. In the following, we will provide evidence on changes on the four analytical dimensions introduced above. Our data indicates differences with regard to the magnitude of the change processes on the four dimensions. Changes on the procedural and cognitive dimension are more visible than on the normative and strategic dimension. Moreover, the change processes of different dimensions are often intertwined. For instance, changes on the cognitive and strategic dimension are strongly interrelated.

Changes on the normative dimension

On the normative dimension, a certain moral commitment to the energy transition has evolved. As a result of the activities of different local actors (e.g. energy saving campaigns, citizen wind farms) and the general rethinking of Germany's population, citizens became morally more committed to the energy transition. This commitment is, for instance, illustrated by the vast mobilization of citizens against the plans to construct a coal power plant in the outskirts of Emden. Over the last twenty years, the ideal of a sustainable, green city has spread and the idea of an energy system based on renewable energy sources has established as a general moral value which increasingly binds local actors. Politicians who were initially in favour of the construction of the coal power plant finally voted against this project due to the high public pressure. Hence, an informal normative commitment to the energy transition increasingly defines the limits of appropriate action and orientates the activities of local actors.

At the same time, the development of formal working standards that could standardize and coordinate the activities of the involved actors is still in its very beginnings. Local actors rather tend to coordinate through direct, informal communication. This aspect is related to the procedural dimension.

Changes on the procedural dimension

The procedural dimension concerns mainly the coordination of actors. With the advance of the local energy transition, an increasing number of actors have become involved and launched projects related to the energy transition. A central organization for coordinating these actors and their projects does so far not exist. Instead, most projects emerged out of informal relationships between local actors. Social and geographic proximity are of crucial importance for the cooperation of actors. Most of the joint projects are based on personal contacts, sympathy, confidence, and the geographical proximity of the involved actors.

> Irrespective of what issue I talk about, personal contacts are very, very important. This is a relatively small region where… I don't want so say: everyone knows everybody, but at least those persons who are engaged and involved in the projects and who are interested in regional development network with each other to a high degree. Correspondingly, not everything is institutionalized that much (…). Furthermore let us not forget different associations like the Lions Club or the Rotary Club (…). These informal networks should not be underestimated regarding the establishment of ties. (Interviewee 5)

One example for such an informal network is the cooperation between (1) the ex-mayor of Emden, (2) an entrepreneur in renewable energy, and (3) the CEO of the Stadtwerke. Backed up by their organizations – the city administration and city council, a business, and the municipal utility company– these three key players initiated numerous projects and rendered the local energy transition publicly visible. Each of these actors assumed a specific role in this network: political supporter (power), innovator (ideas), and implementer (organization and financing). The informality of their relationships, their social and geographic proximity, and the powerful position of each of these actors allowed realizing projects in a flexible and non-bureaucratic way and responding quickly to challenges. Thus, these three actors paved the path of the local energy transition. Although informal networks have until now facilitated the local energy transition, relying only on them may obstruct the further development of the transition. For this reason, several efforts are made to create a more formal coordination structure. These efforts can be classified as three types: 1) coordination through fixing long term objectives, 2) the formal establishment of central coordination actors, and 3) the creation of formal networks.

The first type of coordination effort consists in fixing long term objectives and binding different actors to them. The European Energy Award and the "Integriertes Kommunales Klimaschutzkonzept" are examples for this type of coordination. Both entail clear objectives, detail measures to achieve the objectives, and bind different actors to these objectives and measures. The second form of coordination concerns the establishment of formal coordination roles in the local system. The recently established position of a climate manager of the city of Emden is an example for this type of coordination. His responsibility will be to network and coordinate between actors from different subsystems. Finally, intermediaries such as the Chamber of Commerce and the Climate Centre North aim for creating formal networks of actors who are involved in the local energy transition system.

Changes on the cognitive dimension

Changes on the cognitive dimension imply changes in the self-definition of the city and its actors. These changes are influenced by a variety of factors. First of all, strategic concerns play an important role when it comes to the cognitive redefinition of the city and its actors. Thus, the cognitive and strategic dimensions are closely interrelated. Emden has identified the local energy transition as an opportunity to boost its economic development, to attract funding for public projects, and to improve its reputation within the greater region. Being situated in

a windy sea region and hosting a harbour (which allows for the shipping of wind energy equipment), the city realized its great conditions to develop the onshore and offshore wind business and redefined itself from a shipbuilding city to a production site for the wind industry. Thus, the city aimed for an economic transition from the declining shipbuilding sector towards the growing wind energy industry. Strong efforts were undertaken to attract the wind industry to Emden:

> When the offshore-boom started, we were among the leaders. In 2002, when the issue of offshore came up, we organized a marketing event at Emden harbor with the slogan: "Emden ready for take off(shore)". (…) At that time we raised our voice, announcing: look, in Emden offshore is possible. (Interviewee 44)

As a consequence of these efforts, several wind energy companies moved to Emden and created a new source of employment and economic revenue. At the same time, the local energy transition is also perceived as an opportunity by many of Emden's traditional local actors. Actors from different subsystems realized that the energy transition forms a valuable asset, a sort of capital that can be employed in different ways. Local politicians understood that they could generate public visibility, employment, and finally gain votes by engaging in the energy transition. Similarly, citizens and businesses realized that they could benefit from local energy projects in various ways, for instance by improving their public image, saving energy costs, gaining revenues from investments in renewable energy, etc. The energy transition was hence increasingly recognized as a profitable activity. Perceiving the local energy transition as a chance to improve their position, some actors redefined their role and started to engage in the energy projects. For instance, a big shipbuilding company re-orientated its business model and became a supplier of construction material for offshore wind farms. Moreover, the local university of applied sciences established itself as a local provider of knowledge for the energy transition.

Another aspect of the cognitive dimension is the creation of new knowledge through cooperation. Actors combine their competences and knowledge to implement energy transition projects. For instance, in a common project the local university and the Stadtwerke aim to construct a power-to-gas pilot plant. Both organizations contribute their specific skills and knowledge to the project, thus creating a new pool of knowledge to construct a power-to-gas plant.

To sum up, the general belief that the local energy transition is an opportunity constitutes a common frame of perception for actors in Emden.

> The region looks back on a long history of activities in the energy field. People are very aware of the importance of this topic. This does not only apply to actors inside the company network, but it also applies for the whole population. (…) It has been recognized in the whole region that renewable energy is very, very important. And therefore the cooperation is of high quality and straightforward. One does not have to convince the people of the importance of the issue, they already have recognized its importance so that working together is quite uncomplicated. (Interviewee 47)

This frame of perception has an impact on the procedural dimension since it spurs the cooperation of actors in the energy transition and facilitates the creation of new knowledge.

Changes on the strategic dimension

As pointed out above, changes on the strategic dimension are closely related to the cognitive dimension. The local energy transition is increasingly perceived as a strategic advantage for the region. Moreover, the participation in energy projects has become an important asset for local actors from different subsystems. Economic, political, scientific actors etc. feel increasingly impelled to take the local energy transition into account when designing their strategies. Thus, during its reorientation process in 2009, the local university decided to make the involvement in the local energy transition a central pillar on its strategic agenda.

> Three years ago, when the university Emden/Leer was reorganized, we started to think about the issues energy, offshore and onshore wind energy, which is a broad area of topics. (…) both, sustainability and renewable energy, were big issues in this process. As university, we see ourselves as important player giving impetus to the region. For instance, that means if we say something must happen in the offshore related area we also see ourselves as pushing actor in that field. That means we take the initiative. (Interviewee 63)

The commitment to the local energy transition increasingly constitutes a strategic asset, which can be converted into political power, economic capital, legitimacy, and credibility. Therefore, a growing number of actors engages in the local energy transition and aims to achieve a dominant role in Emden's energy transition. The ambition of these actors to reach a powerful position in the local energy transition may lead to latent combats about the dominant role and public recognition. So far, the Stadtwerke assumes the dominant role in the local actor constellation. It has achieved this position due to its participation in many local projects and due to successful marketing as the pioneering actor in the local energy transition. However, in the long run the power relations in the local actor constellation may change and other actors – such as the university of applied sciences, the local ecology centre, or the city administration – may progressively assume leading roles.

THE BOTTROP CASE STUDY

Presentation of Bottrop

Bottrop is situated in the metropolitan region Ruhr, which used to be the industrial heart of Germany. With the rise of coal mining and steel industry in the late 19th century, this formally rather rural region turned into Germany's most densely populated and economically strongest region. The Ruhr region was the backbone of Germany's economic success story until the late 1980s. Due to the declining competitiveness of coal exploitation in the Ruhr region, the region had to face a heavy economic downturn from the 1980s onwards. The federal government of Germany alleviated the region's crisis with massive subsidies for German coal, thus allowing for a less harsh transition, but structural changes were indispensable. Bottrop shares this history of coal mining with other major cities in the region such as Dortmund, Essen, Duisburg, Gelsenkirchen,

and Bochum. Until today, around 6,000 people are employed in the last coal mine in operation, and, according to estimations of interviewed experts, another 2,000 jobs depend indirectly on coal extraction. In 2018 this last coal mine will be closed down, bringing also a definite end to the coal business in the whole region.

Given this background, the city of Bottrop started a process of restructuration relatively early, reshaping its legacy in the energy field without radically abandoning it. Already back in the 1980s, it launched its first environmental policies, followed in the 1990s by a Local Energy and Climate Concept. In 2009, the city was granted the European Energy Gold Award for its energy conservation measures and, shortly afterwards, it joined the Covenant of Mayors. Finally, in 2010, it was awarded the title Innovation City Ruhr (in the following IC) by the industry association Initiativkreis Ruhr, a non-profit organisation involving 70 large industry companies from the Ruhr region that aims to foster structural change processes in the Ruhr region.

In its application, Bottrop suggested the energetic transformation of a complete city area, comprising around 70,000 inhabitants, businesses and industry zones. It set itself the extremely ambitious objective to cut its CO_2 emissions by 50 % until 2020 (on a 2010 level) and wants to act as a role model for other cities. To reach this goal, the city has initiated or planned over 100 single projects together with industry and practice partners, covering the areas of urban planning, housing, industry, tertiary buildings, and transport. To name just a few: there are three multi-stakeholder projects on retrofitting existing buildings to plus-energy standard; a smart grid shall be realised in a pilot city area, e-mobility charging infrastructure shall be installed; and industry waste heat shall be stored in specific containers and transported to supply distant tertiary buildings, etc.

In contrast to the new construction of energy efficient and renewable-energy based cities or neighbourhoods, Bottrop's IC project represents an attempt to create a sustainable, low-carbon city by reshaping an existing housing, transport, and energy socio-technical regime. With regard to the introduced institutional spheres, the transition process in Bottrop is interesting as it represents an attempt of steered transformation between public and private institutions. The current dynamics appear to be most strongly shaped by the newly created intermediary organisation Innovation City GmbH (Limited Liability Company) and the city administration, which, in collaboration with allocated industry companies, steer the lion's share of the current energy-related activities in Bottrop. Therefore, it is particularly interesting to analyse the ongoing reorganisation processes, although the IC project has only been running for two years – which calls for a cautious interpretation. Today there is evidence for change on all introduced analytical dimensions. However, the reorganisation processes on the cognitive and the organisational-procedural dimensions appear particularly strong.

Changes on the normative dimension

The most important evolution on the normative dimension of change is the creation of shared standards of qualification, advice services, and tariffing systems among crafts businesses that are organised in the "IC partner network". All members of this partner network commit themselves to certain quality standards specific to energy efficient retrofitting which have to be acquired in additional vocational training courses offered by the Chamber of Crafts or equipment producers. After the successful completion of these training modules, the crafts businesses get listed as partners in the IC partner network, and are hence recommended to home owners by the IC GmbH.

A second relevant evolution is the development of an ad-hoc assessment tool for any new project which is suggested as part of the IC project. This tool has been conceived by the Fraunhofer Umsicht Institute in collaboration with the IC GmbH to examine the eligibility of project proposals according to four main analytical categories: sustainability (mainly carbon emissions reduction), the degree of innovativeness, the implementation potential (likelihood of realisation) and the success potential. For each of the categories, several appropriate indicators have been designed and tested with partner companies. This assessment tool hence defines certain quality standards that will have to be taken into account by all organisations willing to contribute to the IC project, as explains the interviewed Fraunhofer Umsicht expert:

> We distinguish green, yellow and red projects. Green means: ready to start. Yellow means: needs to be adapted. And (…) of course it then has to be discussed what exactly is missing. And, according to my understanding, projects marked as red cannot be realized in their current shape. (Interviewee 1 Bottrop)

Changes on the procedural dimension

The IC project has given rise to a number of new organisational forms that structure the interaction of important stakeholders in Bottrop. Most importantly, a Friday project round table was launched by the IC GmbH director, where all responsible project leaders as well as directors/heads of units from the city administration and the involved companies meet once per week to review the progress of ongoing projects. If necessary, participants decide on measures to overcome identified problems. According to several interview partners, the deliberate intention of this round table is to maintain a permanent pressure on all responsible partners to push forward their projects:

> None of the project managers can afford (…) showing inaction over a long period of time. Progress is evaluated very precisely...the project documents contain sharp deadlines for goals: until a certain given day you have to clarify this and that (…) And in case any deadline has expired, the project will be marked in red and the responsible project manager has to suggest solutions and discuss this with the assembled people. (…) This creates commitment. (Interviewee 2 Bottrop)

Other former formal exchange forums have been abolished to avoid inefficiencies. Another, very recent evolution in terms of procedural innovation is the decision to mandate a consortium of external consultancies, led by an internationally renowned planning office, to develop a Master Plan. This Master Plan shall be an overarching road map that defines necessary steps and milestones to achieve the strategic goal of cutting CO_2 emissions in the project area by half until 2020. The consultancies are expected to combine insights from diverse fields of expertise – urban planning, urban transportation, communi-

cation etc. – that help to adopt a holistic view and overcome important identified shortcomings:

> (…) look at the whole pilot area, examining the energy supply infrastructures. What does make sense from an energetic point of view – not just because Viessmann is interested to join in (…). And then, if, let's say, there is a settlement from the 50's, carry out thermal insulation and, whatever, install condensing boilers or things like that and that's it. But I may also have another area which is, let's say, a settlement under preservation order where I don't want to carry out thermal insulation. In this case I rather have to consider how to make energy supply as carbon neutral as possible. (…) And [it is the task of the master plan] to ensure effective coordination. (Interviewee 3 Bottrop)

The Master Plan is hence likely to become a reference guideline document with a strong coordination function between the involved stakeholders.

Changes on the cognitive dimension

Changes on the cognitive dimension seem to be among the most frequent ones, which is due to the living laboratory character of Bottrop – a setting where learning is explicitly required and welcomed. It is very likely that such learning effects will be even higher by the end of the IC project. Subsequently, we will distinguish four sub-categories of cognitive changes: the recombination of knowledge fields; practice-related learning; the re-definition of identities and roles; and the redefinition of transition belief sets.

The *re-combination of knowledge fields* results from the experimental setting in Bottrop which allows for exploring new combinations between previously separated fields of expertise. This concerns Smart Grid projects which bring together the issues of energy generation, demand, and storage. Similarly, "smart" or low-energy, and in particular plus energy houses require the close collaboration of architects, energy planners, insulation industries, heating equipment producers, home automation providers, software industry, building industry, various crafts businesses, etc. According to several interviewees, bringing together such traditionally separated knowledge areas (and their existing technologies) is one of the main achievements of IC.

Practice-related learning is the outcome of day-to-day experiences in ongoing projects in Bottrop. This practice "feedback" is relevant for re-organising business activities (companies) or planning and decision making processes (city administration). For instance, an interviewed representative of the RWE subsidiary RWE Effizienz explains that, due to the installation of its SmartHome devices in a kindergarten in Bottrop, his company gained important insights for the adaptation of its SmartHome service package to non-residential buildings (and in particular to their users):

> Seven or eight kindergarten teachers had to deal suddenly with this technology. (…) And in the beginning we received calls like: 'It is not working, it is always cold in here. Your thermostat must be broken.' We hence had to send out a technician to check the system and he told the ladies: 'No, it is not broken.' 'But the heating system is cold!' Yes, (…) that's the purpose of SmartHome that if you open the window the heating system will stop heating and if you then close the window again the installation will automatically start heating again.' (…) We understood that if we (…) want to get into this market we definitely have to offer sufficient training. (…) Because otherwise in the end it will negatively affect our reputation. Then everybody will say: The system is not working. (Interviewee 4 Bottrop)

On a more global level, there is also some evidence that the different ongoing projects in Bottrop are accompanied by a *redefinition of actors' identities and roles*, for instance a utility transforming from a traditional energy provider to an "energy manager" and service provider. Finally, the interviews also revealed several examples of a continuous collective *redefinition of the paradigmatic belief sets* structuring the design of the IC project as a whole. In general terms, most of the involved actors, and in particular industry representatives, seem to share a vision of the IC project, which follows to a large extent the *Green New Deal* paradigm. According to this thinking, efficient and "greener" technology will enable our societies to cut carbon emissions without the need to adapt current lifestyles. From a *sufficiency* perspective this view may be challenged, as some critical interviewees comment, advocating a stronger attention to the role of consumption practices for the energy transformation. For the moment being, the Green New Deal perspective is prevailing, but growing concerns that the currently dominating industry-led projects alone may not be sufficient to reach Bottrop's ambitious climate protection goals may also lead to new debates on this paradigmatic orientation. This points to a second subtle learning process: there is an increased awareness that interest-driven industry projects need to be complemented by a stronger role of urban planning. More holistic, cross-sectoral approaches may be essential to achieve the carbon emission reductions, as illustrates the following quote:

> We (…) realize that the current projects cannot cover the whole range of issues that would be necessary to achieve a climate-friendly urban renewal in its full complexity. The master plan shall close existing gaps to ensure that we go not only for projects where certain stakeholders aim to pursue their interests, but that we tackle also those issues where no partner sees an instant interest. (Interviewee 6 Bottrop)

Finally, our data also indicates that ongoing public criticisms on "big" technology-oriented projects lead to a gradual reorientation towards easy-to-implement, pragmatic solutions that first of all respond to the needs of the citizens in the neighbourhoods and include the latter more strongly in the implementation of the IC project:

> We don't want to teach science to the people in the neighbourhoods, but we want (…) practical ideas on how to achieve these very tough objectives of CO_2 reductions together with citizens. (Interviewee 7 Bottrop)

Changes on the strategic dimension

There is some evidence for changes in Bottrop's local energy transition system on the strategic dimension. Most importantly, this refers to the set-up of new organisations or organisational units to steer and influence transformation processes. A new

body was set up with the Innovation City GmbH to coordinate, steer, and moderate the transformation processes – which is also a crucial element for the evolutions on the normative-procedural dimension. With staff coming from the industrial partners and the city administration and with a determined and well-connected director it has become a powerful actor in the actor system whose importance is recognised by all interview partners.

Another indicator for changes on the strategic dimension is the strong company efforts to be publicly visible as innovative, pioneering, sustainable, and locally committed actor in the IC process. The great attention that is given to the IC project at the local, national, and even international levels creates pressure on the involved companies to be perceived as important contributors to the project by the public. Thus, some companies invest large budgets of several hundred thousand Euros into projects, public relations, and advertisement activities.

To sum up, our data indicates reorganisation processes on all analytical dimensions of institutional change. Compared to the strategic and normative dimension, cognitive and organisational-procedural changes appear to be the most relevant local adaptations in the actor system.

Discussion: Increasing institutionalisation of energy transition systems

In the following, we compare the developments in Emden and Bottrop for each of the four dimensions. Table 2 summarizes the change processes in each of the cities as presented in the previous chapter.

First, concerning the *normative dimension***,** there is some evidence for a trend towards normative standardization. However, this process differs in the two municipalities. In Emden, there seems to be a certain moral commitment to the transition towards a low-carbon, energy-efficient local energy system based on renewable energy sources. "Turning green" becomes an ideal, which makes conventional energy generation solutions such as coal power plants unpopular. At the same time, the development of formal norms and standards with regard to this low-carbon energy transition is still in its beginnings. In contrast, in Bottrop we found first examples of shared formal standards, while there is only weak evidence for moral pressure on actors to follow a certain model of energy transition.

Coming to the *organisational-procedural dimension*, data from both case studies indicates *increasing attempts to co-ordinate the ongoing activities* between involved actors. This results from a growing number of actors intervening in both cities and the set-up of a growing number of complex projects which require collaboration between various actors. Interviewees from both cities emphasize the high importance of informal, personal networks that have contributed to the dynamic evolution in both regions. The close and in many cases long-lasting relationships have created an atmosphere of mutual trust and a problem-oriented culture, which have allowed for quick, flexible decision making processes between key actors such as Stadtwerke and the mayor (Emden), or the IC GmbH and the city administration (Bottrop). In addition to this informal coordination, we have found evidence for growing formal coordination in both cities. Thus, both cities have set themselves objectives for cutting greenhouse gas emissions and have committed themselves to develop common communal action plans in the frame of the European Energy Award. However, Bottrop displays a higher degree of formalized coordination. While in Emden there is "merely" a climate manager who was appointed to steer local innovation processes, the Ruhr city set up a completely new organisation – the IC GmbH – with the explicit function of coordinating ongoing energy projects. Furthermore, the Friday project round table in Bottrop is a regular exchange forum where important day-to-day decisions are taken.

With regard to the *cognitive dimension*, we found that in both cities the involved actors increasingly share a *common frame of perceptions and belief sets*, which tends to structure actor activities. Thus, most interviewed Emden and Bottrop representatives seem to agree implicitly on the promises of a Green New Deal, which, based on renewable energy sources and more resource efficient technologies, is considered as a chance to maintain current lifestyle patterns and to assure continued growth for the local economy. This common paradigm is only rarely questioned. Within this common reference frame, actors re-adapt and explore new roles and identities, for instance the role of an energy manager rather than an energy generator. This search for new roles implies also the experimentation of new collaborations and the re-combination of previously separated knowledge fields, for example for the development of the power-to-gas plant in Emden. In both cities, various actors also regularly communicate about ongoing activities, leading to the contours of a shared discourse arena. Yet, there are also considerable differences between Emden and Bottrop on the cognitive dimension of change. From the very beginning, Bottrop's Innovation City project has been conceived as a multi-actor urban

Table 2. Energy transition in Emden and Bottrop: Overview on empirical results.

	Emden	Bottrop
Normative dimension	Expansion of the ideal of a sustainable, green city	Development of shared standards of qualification and an ad-hoc assessment tool for new projects
Procedural dimension	New coordination forms: formal networks, central coordination, long-term objectives	New coordination forms: round table, master plan
Cognitive dimension	Redefinition of belief sets, recognition of energy transition as profitable activity, redefinition of actor's identities, re-combination of knowledge fields	Redefinition of belief sets, redefinition of actor's identities, re-combination of knowledge fields, practice related learning
Strategic dimension	Energy transition becomes a strategic advantage, new actors appear and leadership struggles emerge	Energy transition becomes a strategic advantage, new organisations and organisational units are created

laboratory, while Emden has never given such an explicit frame to its activities. The opportunities for practice-related feedback and experimentations with new actors are hence more numerous and institutionalised in the Ruhr city than in the East Frisian municipality.

Finally, on the *strategic dimension*, we observe a rising importance of the local energy transition in the two cities. Moreover, new power relations emerge. The local actors in both municipalities regard the energy transition as an opportunity. Their commitment to the energy transition can become beneficial for single actors in different ways as it may convey public recognition, economic profit, or political power. Therefore, a growing number of actors participates in the energy transition in both municipalities and seeks to be perceived as sustainable innovative actors. These efforts indicate that being part of the energy transition is becoming a strategic asset. Furthermore, power relations are developing. In both municipalities, some actors assume leading roles in the local energy transition. In Bottrop, the Innovation City GmbH coordinates and monitors most of the local transition projects, while in Emden the Stadtwerke has succeeded to position itself as pioneer in the local energy transition as it shapes many of Emden's transition projects. Nevertheless, there are also clear differences: unlike Bottrop's Innovation City GmbH, the Stadtwerke does not assume the role of a coordinator of the local energy transition. While the powerful position of the Innovation City GmbH is due to its formally defined role, the dominant position of the Stadtwerke results from its strong engagement, which is recognized by the public and makes Stadtwerke a credible powerful actor. Power struggles around those powerful leaders may arise in both cities – a few critical voices challenge both dominant actors already today.

Altogether, both case studies point to an increasing institutionalisation of a *Local Energy Transition System*. On all four dimensions, there is evidence for second order innovation on the level of the actor system, which complements small-scale, first order innovation. These second order innovations are about to create a kind of organisational field (DiMaggio and Powell 1991) where a growing number of actors engages in energy innovation dynamics. However, we have also encountered significant differences between the two cases, for instance the quite centralised coordination of activities in Bottrop against a rather fragmented actor system in Emden. This points to differing historical developments in both cities and also differing influences from the wider surrounding "landscape" – the strong political and economic support of external actors in Bottrop is without any doubt a very particular situation. At the same time, the different ways taken by the two cities demonstrate that there is not a singular best form of local energy transition.

Outlook: second order and first order innovation as mutually reinforcing dynamics?

In this paper, we have analysed local energy dynamics drawing on ideas from the Regional Innovation Systems approach. In this sense, we understand innovation as an outcome of the interaction of several institutional spheres, comprising the economic, financial, political, administrative, scientific, civil society, and the intermediaries' spheres. We have introduced a distinction between first order, small scale innovation and comprehensive second order innovation at the level of the whole actor system. Both are constitutive elements of *Local Energy Transition Systems*. The focus of this paper was on analysing ongoing second order innovation in the cities of Emden and Bottrop, distinguishing between normative, procedural-organizational, cognitive, and strategic reconfiguration processes. The evidence from these case studies shows a growing institutionalization of Local Energy Transition Systems in both municipalities. Local actors tend to share the Green New Deal paradigm as common cognitive frame for their actions and they increasingly perceive the local energy change projects as a strategic opportunity for realizing moral, political, or economic benefits. There is also evidence for some early normative standardisation and increased attempts to coordinate activities between stakeholders around common objectives, strategy plans, and formalized organisational structures.

This evidence opens up a research field on the impact of second order innovation on first order innovation, and vice versa. Based on our findings, we assume a mutually reinforcing relationship between the two levels of innovation. Many of the ongoing multi-actor projects in both cities are hard to imagine without a corresponding underpinning through favourable second order innovations. Informal, mutual trust relationships, shared belief sets, similar strategic interests, and moral commitments are likely to support collaborative projects as observed in Bottrop and Emden. On the other hand, positive experiences in singular projects may also contribute to the refinement and stabilisation of an organizational field of favourable second order innovation.

However, as the study is only based on the exploration of two cases studies, it can only provide limited empirical evidence and first insights into the theoretical relationship between involved concepts. Moreover due to the individual characteristics of regions, we expect path-dependent institutional change processes. Therefore, local energy transitions will vary from region to region. Several types of local energy transitions are likely to coexist, bringing about different forms of first and second order innovation. For this reason, we suggest further research on different types of Local Energy Transition Systems. For instance, the comparison of the two cases presented in this paper has revealed a centralised (Bottrop) and a more fragmented, multi-polar system (Emden). Similarly, one might distinguish industry-driven transition systems, public-private-partnership structures, or systems pushed by civil-society and political actors. For all different types, it appears interesting to explore the nature of second order innovation and its interplay with first order innovation. With this paper, we want to contribute to such investigations on the spatial dimension of sustainability transitions.

Despite the limited scope of the case studies, we can derive some policy implications. The two cases of Bottrop and Emden show that local energy transitions are not the outcome of the action of one actor or sub-system (institutional sphere), but result from the interaction of several subsystems that contribute with their specific competencies and functions to the local energy transition. Policy makers will have to take this multi-systemic and multidimensional character of local energy transition into account. They should involve actors

from different subsystems for designing their strategies and also consider profound second order change processes (e.g. coordination of transition projects) as crucial elements of local energy transitions. Policy makers may assume the role of "enabler" and "connectors" by creating a favorable context for second order change processes and spurring the communication and coordination between different local actors. Their success in fulfilling this role will depend – among other factors – on their persuasive power and their embeddedness in local actor networks.

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