An area-based research approach to energy transition

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1 INTRODUCTION: AN AREA-BASED RESEARCH APPROACH TO ENERGY TRANSITION

1.1 The energy system is changing

The energy system is changing due to the uptake of renewables and low carbon practices. Renewables are defined as energy resources that are naturally replenished on a human timescale, such as solar, wind, water, tidal, geothermal and bio-energy (Ellabban, Abu-Rub, & Blaabjerg, 2014). Low carbon practices are activities that facilitate the use of power sources with a minimal output of greenhouse gases, such as local energy exchange, renewable energy generation and energy conservation (e.g. Martin et al., 2014; Middlemiss & Parrish, 2010). Renewables and low carbon practices give rise to new spatial developments. Local landscapes, for example, accommodate wind farms and solar PV fields. Such spatial developments change the relationship between the energy system and the landscape in terms of land use, socioeconomic relationships and governance, indicating a new challenge in the field of spatial energy planning (De Boer & Zuidema, 2016).

The focus of this research is on energy transition and local energy initiatives in their spatial contexts. The term ‘energy transition’ often refers to the pursuit of a shift from the fossil fuel-based energy system to a sustainable low carbon energy system (Grin, Rotmans, & Schot, 2010; Markard, Raven, & Truffer, 2012). Energy transition as a whole is the result of many smaller energy transitions that interact, such as transitions to the electric car, to energy neutral housing and to smart cities, and thus it is a complex transformation involving many entangled processes. The uptake of renewables and low carbon practices contribute to the shift towards a more sustainable low carbon energy system. In particular, local energy initiatives are one way of generating and facilitating renewable energy and energy saving through their adoption of low carbon practices. Such initiatives are based in the local landscape and the practices are developed in interaction with the spatial context (De Boer & Zuidema, 2015b). These practices provide insight into novel relationships between the energy system and the landscape: physically, socioeconomically and institutionally. This research studies the interaction of local energy initiatives with their spatial contexts to better understand energy transition.

This research uses an area-based research approach to study energy transition. The approach combines transitions research with spatial planning. Transitions research studies transformations of societal systems, such as the energy system, which is considered a

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1 This thesis uses the general term ‘energy’, since local energy initiatives not only generate electricity (solar and wind community initiatives), but also biogas and heat (bio-energy initiatives). Moreover, some initiatives also run programs for energy saving.
complex system governed at multiple levels. Spatial planning studies the interaction between society and space in order to understand and govern spatial developments. Thus, an area-based approach addresses interrelated societal and environmental issues in a local situation.

The area-based research approach also allows the study of the transition of the energy system in relation to the landscape, with transition research linked to practical cases in energy landscapes. In doing so, this research follows up on the work of colleagues. Firstly, it builds on work by De Roo (2003) and Zuidema (2017), who both studied environmental planning at the local level, while De Roo addressed the area-based approach, Zuidema addressed decentralisation; and secondly, it follows up on work by Van Kann (2015) and Stremke (2010), who studied the potential of sustainable energy at the regional level from energy systems and energy landscape perspectives, respectively. It is hoped that this research will inspire other scholars and practitioners to improve transitions research and to base interventions and regulations for spatial energy planning on lessons drawn from the spatial development of local energy initiatives in energy landscapes.

This chapter is structured as follows: Section 1.2 describes the motivations for this research topic and for this research approach; Section 1.3 describes the research objective; Section 1.4 the research approach; Section 1.5 the research questions; Section 1.6 the research design; and Section 1.7 the research outline.

1.2 Motivations

1.2.1 Energy Transition towards a Sustainable Low Carbon Energy System?

This research began with an interest in the question of how we can move towards a more sustainable society and how spatial planning can support this process. A core environmental problem is human-induced climate change, which is making the safe operating space for humanity uncertain (Rockström et al., 2009). It is widely accepted that to overcome human-induced climate change, societal change towards sustainable development is needed (Biermann et al., 2012; Rockström et al., 2009); that is, sustainable development that meets the needs of the present without compromising the ability of future generations to meet their own needs (World Commission on Environment and Development, 1987). A shift from the idea ‘humans can conquer nature’ to ‘humans coevolve with nature’ could facilitate sustainability, as sustainability requires a coupling of human-natural systems on all scales and all governance levels (Liu et al., 2007). Human-nature interactions across spatial scales and governance levels trigger non-linear feedback mechanisms in human and natural systems, which makes governing sustainable development a complex problem. Understanding even the most local human-nature interactions requires progressive contextualisation, in which local actions are understood in
terms of landscape, regional and national factors, which in turn depend on global forces (ibid.) Such contextualisation can be promoted with area-based approaches that provide the starting point for studying complex human-nature interactions in practical cases. Therefore, governing sustainable development can benefit from area-based approaches that help to interpret human-nature interactions in their contexts.

The focus of this research is narrowed down to the energy system. A sustainable energy system is an essential condition for sustainability (Van Vuuren et al., 2012). At the moment, fossil-based energy resources are not harvested at a rate that can meet the needs of future generations (Smil, 2010a). The combustion of fossil fuels is contributing considerably to climate change due to CO2 emissions (Höök, Sivertsson, & Aleklett, 2010), while the harvesting of fossil fuels causes damage to natural landscapes (Pasqualetti, 2012). Fossil oil that can be harvested economically is becoming increasingly scarce due to the depletion of fossil fuel reserves (McGlade, Speirs, & Sorrell, 2013; Sorrell et al., 2012), while the concentration of reserves in politically unstable countries gives rise to geopolitical uncertainties (Correljé & Van der Linde, 2006). Moreover, since energy use is intrinsic to activities in our daily environments, the energy system is strongly entangled with our society. The large impact of the energy system on human and natural systems and the entanglement of the energy system with all kinds of human and natural systems make it very difficult to pursue sustainability in general without addressing the energy system in particular. Therefore, a sustainable energy system is considered crucial to the pursuit of sustainability.

Pursuing a sustainable low carbon energy system is often referred to as energy transition (Grin et al., 2010; Markard et al., 2012). Energy transition is considered to be a long-term unpredictable process in which the existing energy system transforms into another system in interaction with other physical and social systems in the context (Geels, 2011). Transitions research in particular, but also spatial planning, aims to determine how such energy transition can be stimulated through planning and governance strategies.

Over the last few decades, policy goals and an increased awareness within society of the causes of climate change have given rise to various fragmented developments, among others to the search for renewables and low carbon practices. On the global and European scales, climate policy goals have been formulated that require the energy system to become more sustainable. A long-term energy vision was developed at the United Nations Rio+20 conference on sustainable development (Van Vuuren et al., 2012), and European Union policy has formulated targets for moving towards a low carbon energy system by 2050 (European Commission, 2014). However, while the setting of goals is important, the means of getting there have not yet been defined or agreed on. There is also an ongoing debate on how to pursue a sustainable low carbon energy system.
1.2.2 Implications of Low Carbon Energy for Spatial Planning

Arguably, the spatial planning of the emerging energy system requires more attention from spatial planning scholars and practitioners than the existing fossil fuel-based energy system. While the existing energy system is complex, spatial planning tasks are not so complex. The existing energy system is a generally centrally organised, globally nested system, with a one-way distribution network from high to low energy densities in terms of gas pressure or voltage level (Pagani & Aiello, 2014). Spatial energy planning in this context was merely limited to the allocation and regulation of artefacts such as power plants, high voltage electricity poles, filling stations and underground gas infrastructure.

By contrast, the ambition to move towards a sustainable low carbon energy system has huge implications for spatial planning (Van Hoorn, Tennekes, & Van den Wijngaart, 2010) and triggers political debate (e.g. Leibenath & Otto, 2013; Wolsink, 2010). Firstly, increasing the share of renewable energy in the energy system has spatial consequences for landscapes, such as competing land uses, decreasing aesthetic environmental quality, and large-scale transformation of cultural landscapes (Pasqualetti, 2013; Stoeglehner et al., 2016; Van der Horst & Vermeylen, 2011). Secondly, the recent rise of affordable renewable technologies has opened up possibilities for decentralised energy generation on a relatively small scale. These technologies include wind turbines, solar panels and bio-digesters, which have resulted in the swift rise of small-scale energy initiatives instigated by local citizens and entrepreneurs (Arentsen & Bellekom, 2014). Thirdly, as the low carbon energy system is emerging and its future configuration is unclear, the spatial and institutional designs of the future energy system remain a challenge for the future.

These area-based implications raise questions about, for example, the planning of two-way distribution networks, energy conservation in neighbourhoods, the allocation of small and large-scale wind turbines, solar PV panels, bio-energy plants, energy storage systems, and so on. In addition, questions relating to specific actors who install such artefacts, ranging from municipalities to project developers and civic initiatives, are also being raised.

An additional complicating factor for the spatial energy planning of the emerging energy system is that practitioners are faced with uncertainty about the effects of a planning strategy, often leading them to use planning theory merely as a justification for their spatial plans (Hoch, 2011). Part of the problem is that the translation of planning concepts in practice often involves the flattening of concepts. For example, in practice, the notion of self-organisation is used as an equivalent to self-governance rather than understood as the organising principle which is meant in the field of complexity (Rauws, 2015). Ongoing shifts take place in the spatial governance of environmental problems (AESOP Young Academics Network, 2016; Allmendinger, 2016). For example, over recent decades, the focus in the
governance planning field on environmental problems has shifted from centralised to more decentralised and market-oriented approaches, giving rise to disciplinary research on communicative and integrated approaches (Zuidema, 2017). However, extensive evaluation of different planning strategies for similar problems is lacking (Hoch, 2011; Stolk, 2011). At the same time, the gap between planning theory and the planning field is not getting any smaller (ibid.).

To address these challenges to sustainable development and spatial planning, this research aims to improve the disciplinary knowledge on spatial energy planning. To do so, this research not only makes use of spatial planning theory, but also of approaches from other research domains.

1.2.3 Complex Concepts and their Conceptions
Many concepts used in spatial planning and governance literature are rather complex normative concepts that are interpreted and conceptualised in various ways (Taylor, 2003). Concepts such as ‘sustainability’ and ‘energy transition’ are generalised, abstract and broad concepts that may bring together potentially conflicting goals, such as sustained economic growth and affordable and clean energy (cf. United Nations, 2015). Politically, such woolly use of concepts can be practical, as people and institutions with different aspirations can agree on them, by picking out what suits their interests (Taylor, 2003). For research and practice, however, woolly definitions are not easily operationalised and the evaluation of planning and policy effects is obscured (ibid.).

Figure 1: Navigating between abstract concepts in theory and concrete situations and processes in practice (Source: author).

Given the broad scope of complex normative concepts, further analysis is needed, directed at interpreting what these concepts mean. The translation of abstract concepts from theory into concrete situations and processes in practice, and vice versa, is at the heart of PhD research in the field, including this dissertation (see Figure 1). Conceptions that are formulated as clearly, precisely and transparently as possible will enable users of the
definition to apply and test the concept in practical cases. This research aims to contribute to this ambition, since the empirical evidence for transition research is still rather weak due to its conceptual abstraction (cf. Coenen, Benneworth, & Truffer, 2012; Gailing & Moss, 2016; Lawhon & Murphy, 2012). Thus, this research provides, on the one hand, conceptualisations of several concepts used in the context of energy transition research and, on the other, a method for mapping and analysing empirical cases in order to interpret interactions between actors and artefacts in energy transition.

1.3 Research objective
The previous section presented challenges in the fields of sustainability, spatial energy planning and complex concepts, which this research addresses, with the aim of studying energy transition and interpreting the contribution of local energy initiatives to energy transition.

The research objective is therefore:

To develop an area-based research approach as the starting point for a study of energy transition and use this approach to interpret the contribution of local energy initiatives to energy transition.

The area-based approach is already being used in spatial planning worldwide (Barca, McCann, & Rodríguez-Pose, 2012). In the context of energy transition, this approach enables the generation of novel insights that are relevant both for energy transition policy and for spatial energy planning. Energy transition research, in general, tends to focus on innovation processes in a socio-technical and governance context within a time frame of years or decades (Smith, Voß, & Grin, 2010). Often, research on societal transitions is based on rather recent theoretical perspectives, making use of complex systems, multilevel perspective on innovation, technical innovation systems, niche mainstreaming, and others. However, various concepts being used in the literature on societal transitions have limited empirical support. Geographers have indicated that a geographic perspective may provide explanations for certain transition phenomena, such as the spreading and upscaling of sustainable innovations, which are not yet well understood (Coenen et al., 2012; Sengers & Raven, 2015). To fill this research gap, this study adds an area-based approach to transitions research, which allows a context-specific focus on transition phenomena such as niches and co-evolution. Thereby, this study contributes to literature on societal transitions, both with empirically supported arguments and theory development.

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2 See for instance the ‘Journal of environmental innovation and societal transitions’, launched in 2011.
While transition research focuses on dynamic and temporal processes, the area-based approach is not dynamic as such, but rather considers the energy issue from an integrated and contextualised perspective. The area-specific research approach allows the interpretation of context-specific aspects of transition phenomena. This thesis focuses on analysing the contribution of local energy initiatives to energy transition by interpreting the area-specific links of specific local initiatives to the energy landscape. It should be noted that the contribution of initiatives is not assessed using evaluation criteria but interpreted with the help of concepts from transitions research. By combining transitions research with the area-based research approach, this research could identify context-sensitive explanations for transition phenomena.

This research contributes, on the one hand, to energy transition research and spatial energy planning theory and, on the other, to energy transition policy and spatial energy planning practice. In relation to energy transition research and spatial planning theory, this research provides scholars with knowledge about the relevance of spatial interactions and spatial developments emerging from the uptake of low carbon energy for energy transition. In relation to energy transition policy and spatial energy planning practice, this research provides practitioners with knowledge on how area-based conditions and developments, including spatial plans and policies, may constrain and/or enable the uptake of low carbon energy that supports energy transition. In addition, scholars and practitioners can use this research as inspiration to improve transitions research and to base interventions and regulations for spatial energy planning on lessons drawn from the spatial development of local energy initiatives.

The following section describes the area-based research approach that is developed in more detail. The research questions are presented in Section 1.4.

1.4 Research framework

The research framework consists of a conceptual model within a more general theoretical framework. For the development of the research framework, the project first studies more general frameworks for analysing coupled complex systems, such as the ones developed by Ostrom (2007) and the Resilience Alliance (2010). Inspired by these interdisciplinary research frameworks and in order to ground the proposed area-based research approach to energy transition, three research domains (1, 2a and 2b) are integrated into a theoretical framework. They are: spatial planning research with a focus on (1) area-based planning; and transitions research with a focus on (2a) complex systems and (2b) the multilevel perspective on innovation. It should be noted that the multilevel perspective and complex systems are not developed but applied by transitions research, and are sometimes also applied in spatial planning research. While each of the research domains is already
familiar to spatial planning, the domains have not been used explicitly in relation to each other before. Together with the conceptual model presented in Section 1.3.4., these research domains help to achieve the research objective. The following sections explain the reasons these research domains are relevant.

1.4.1 Spatial Planning Research
This research not only makes use of spatial planning theory, but also looks at disciplinary knowledge from outside spatial planning to gain more insight into energy transition as a complex spatial problem. This position can be clarified with the help of the following categorisation. Planning theory ideas can be distinguished into three arenas formed between three spatial planning domains (Hoch, 2011, see Figure 2). The planning domains are the planning discipline, the planning field and the planning movement. The planning discipline develops and promotes disciplinary knowledge consisting of ideas and tools that people use to do spatial planning. The planning field refers to the practical advice of professional planners and other actors to make and maintain spatial settlements. The planning movement refers to collective efforts to develop and promote the practice of spatial planning. Examples are the town-planning movement and the rational planning movement. Figure 1 shows how planning theory arenas are formed between the planning domains. The question mark refers to the contest that occurs between planning ideas, which stimulates learning and debate among the arenas.

Figure 2: Spatial planning domains and planning theory arenas connecting domains (modified from Hoch 2011). This research is positioned in the arena of planning theory, between planning field and planning discipline.

This research can be positioned in the planning theory arena between field and discipline (see star in Figure 1), as the research approach makes use of specialised knowledge from transitions research outside spatial planning. Transitions research is combined with area-
based planning in order to develop knowledge about the complex spatial problem of energy transition, which is a problem that practitioners are confronted with in the planning field. Thus, the complex spatial problem of energy transition demands a research approach that goes beyond spatial planning.

**Area-based Planning**

This project makes use of the area-based planning approach from spatial planning research. Area-based planning, which is sometimes also called ‘place-based’, ‘site-specific’ or ‘area-oriented’ planning, is concerned with reaching integrative solutions for the planning issues in a geographic area (Cameron, Odendaal, & Todes, 2004; De Roo, 2003; Turok, 2004; Zuidema, 2017). The ambition is to translate interrelated issues in situ into an area-based solution. The area-based approach assumes that the geographical context is significant, in a physical, socioeconomic and institutional sense, and the focus is on the issue of ‘Who knows what to do where and when?’ in policy intervention (Barca et al., 2012). The manageable area focus allows for the involvement of citizens and other stakeholders in the planning process, who have an interest in the area, providing opportunities for reaching communicative planning solutions. In turn, the local interactions and institutions allow for the establishment of synergies between actors and artefacts in a certain area. The value of area-based approaches is the main argument behind decentralisation (Zuidema, 2017).

Note that area-based planning and area-based policies are not quick-fix solutions (Turok, 2004). Rather, the area-based approach can be considered complementary to space-neutral sectoral approaches and national planning strategies. Deep-rooted structural problems, such as poverty and unemployment, are often caused by wider economic and social processes that have relatively little to do with the characteristics of the areas themselves. Such problems are manifested at the local level as well, but cannot be solved at the local level alone.

For this research, the area-based planning approach is translated into an area-based research approach. The area-based approach provides a promising starting point for the study of energy transition in its context. The area-based approach relates the issue of energy transition to other planning issues and to the potential, needs and interests of a specific area. In addition, studying transition dynamics at the scale of the province or municipality, which is internationally comparable to the sub-regional or city scale, facilitates an analysis of how energy transition is affecting areas in a physical, socioeconomic and institutional sense.
1.4.2 Transitions Research

Research on sustainability transitions and energy transition, in particular, is a growing interdisciplinary research field with many recent publications (e.g. Avelino, Grin, Pel, & Jhagroe, 2016; Gailing & Moss, 2016; Gibbs & O’Neill, 2015; Sengers & Raven, 2015). The research is receiving some attention from governance practice, for example, from the Dutch national government (Kemp, 2010). The aim of transitions research is to obtain insight into transition phenomena, which can be used for developing governance guidelines to manage a transition towards sustainability (Rotmans, Kemp, & van Asselt, 2001). Societal dynamics are studied through a complex systems lens, focusing on multilevel and multiphase system innovation trajectories (Loorbach, 2010). Transitions research is also inspired by literature on social-ecological systems, Panarchy theory (ibid.) and evolutionary economics (Hansen & Coenen, 2015), which base institutional recommendations on complex systems dynamics. In addition, recent planning literature considers complex systems approaches important for advancing planning theory (Batty, 2010; Boelens & De Roo, 2016; Portugali & Stolk, 2016). Thus, transitions research fits with developments in spatial planning research and with the research topic of this research.

Complex Systems

Thinking about the complex behaviour of systems originates from the early days of physics research (Mitchell, 2009). A system is composed of connected parts that work together, which can be understood as the function and structure of the system as a whole (De Roo, 2012). An important step occurred in the 1960s when Lorenz proved that weather systems can be very sensitive to initial conditions, that is, that complex systems behave in a non-linear way (M. Mitchell, 2009, p. 22). In addition to physics, various disciplines developed complex systems theories, as occurred in biology, the neurosciences and the social sciences.

Complex systems are open systems which behave in a non-linear manner over time and have emergent properties (De Roo, 2012). Complex systems are open systems in the sense that their boundaries are not fixed: the systems interact with their contexts and adapt to changing circumstances. To emphasise the fact that adaptation plays a major role in many complex systems, they are often called complex adaptive systems (Gell-Mann, 1994).3 Their behaviour is non-linear in the sense that the reaction to a small change can be extremely big or small depending on the situation. Non-linear behaviour and other aspects, such as tipping points, fractals, self-organisation and co-evolution, make their development fundamentally unpredictable, which means that the behaviour of the system cannot be known. Nevertheless, the system can exhibit path-dependent behaviour; that is, once a certain development has started, positive feedback induces the system to reinforce its

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3 Very few complex systems are non-adaptive, for example a hurricane (Mitchell, 2009, p. 13).
TOWARDS AN INTEGRATED ENERGY LANDSCAPE

development on that pathway (Norgaard 1984). This is an important consideration for this research, since it implies that it may be difficult to change the direction in which a system, such as the energy system, is developing.

The interacting parts of a system can be complete subsystems, nested networks, actors or artefacts. Between the parts, information is exchanged in the form of knowledge, facts or resources (Mitchell, 2009). It should be noted that, while the system as a whole is complex, parts of the system can be simple or complicated with perfectly predictable behaviour. In a simple system, the cause-effect relationships are easily understood, since there are only a few parts working together, for example an artefact such as a tower. In a complicated system, many parts are interacting, but the mechanisms and the effects can still be understood, for example a car. Nevertheless, a car that is being driven is a hybrid complex system composed of the car, which is a complicated system, and the driver, who is a complex system.

The interaction within complex systems and with their contexts gives rise to emergent behaviour such as self-organisation, (co-)adaptation and (co-)evolution. In doing so, complex systems develop over time. Self-organisation is the creation of order out of disorder: the parts organise without central control, leading to emergent behaviour of the system as a whole (M. Mitchell, 2009). Adaptation entails a change in a system in response to changed circumstances in its context. This context consists of one other or multiple systems with whom the system interact. Over time, multiple adaptations can lead to the evolution of the system, in which the function and structure of the system transform.

Thus, transformation implies a fundamental system change (Olsson et al. 2004), involving the function and structure of that system (De Roo, 2012), leading to a change in the identity of the system. The transformation of several systems in interaction with each other is called co-evolution (Norgaard, 1984). While co-adaptation is the adaptation of two or more systems in response to each other and changed circumstances in their contexts, co-evolution builds on co-adaptations, leading to the evolution of two or more systems in interaction with each other and/or in interaction with their mutual contexts. Thus, co-evolution may also be the result of indirect interaction between the co-evolving systems (Pazos & Valencia, 2008). In transitions research, particular emphasis is on the co-evolution of systems with the aim of understanding how societal systems might transform from unsustainable into sustainable systems (Loorbach, 2010).

All complex systems can be considered multilevel systems composed of at least two levels: the parts and the whole. System boundaries and the levels or scales of complex systems can be defined in various ways, leading to different classifications. Societal systems can, for example, be divided into social and physical systems, or into sectors. Moreover, the
number of levels and scales that are distinguished and how they are defined can differ significantly: a micro-meso-macro differentiation has a completely different scale in neuroscience as compared to economics. These classifications are relative: their choice depends on the system on which the research is focused. Thus, in this research, a classification of systems and scales is chosen that makes sense for researching the energy system in its context. To this end, the energy landscape (a landscape with a focus on the energy system) is defined in Section 1.3.4 as a complex system composed of several interacting systems at several scales.

The research domain of complex systems represents an important part of this research framework, with useful concepts for recognising dynamics and phenomena of complex systems in the empirical research on energy transition.

**Multilevel Perspective on Innovation**

Transition research often makes use of a multilevel perspective on system innovation trajectories (e.g. Geels 2010, Kemp 2010); that is, they distinguish between three levels of increasingly aggregated societal dynamics. The idea is that the interaction dynamics within and between these levels enable and constrain a system transition.

The macro level is the landscape level, which can be regarded as the backdrop for action at the other two levels (Geels, 2005). The landscape level consists of the physical infrastructures, political culture, social values, worldviews, the macro economy, demography and the natural environment (Kemp, 2010). The landscape level is characterised by rather autonomous processes with low dynamics – although certain events, such as a financial crisis or a highly contagious virus may also temporarily cause some high dynamics. One example of a rather autonomous process is climate change, which is one of the conditions at the landscape level that has triggered energy transition policy at various governance levels (e.g. European Commission, 2014; Scheer, 2007; SER, 2013).

The meso level is the regime level, which refers to a coherent configuration of dominant technologies, infrastructure, actor networks and institutions that guide decision-making processes (Holtz, Brugnach, & Pahl-Wostl, 2008; Kemp & Loorbach, 2006). A regime has a relatively stable composite of institutional structures that facilitates the continuity of a societal domain or sector. This composite glues the dominant regime actors, elements and resources of the system together.

The micro level is the niche level, which is characterised by high dynamics and unstable structures. A niche is inhabited by individual actors, technologies and local practices, which develop new ideas and new initiatives (Kemp, Schot, & Hoogma, 1998). Transitions
research emphasises the role of niche initiatives for stimulating an energy transition. Therefore, this research focuses on local energy initiatives (see section 1.3.4).

Transitions research, which applies a multilevel perspective, has been criticised for treating the landscape level as a residual category in the analysis of transition dynamics, and for its ‘geographic naiveté’ (Bridge, Bouzarovski, Bradshaw, & Eyre, 2013; Coenen et al., 2012; Gailing & Moss, 2016; Lawhon & Murphy, 2012). Originally, the landscape level seems to have not been intended as an area with a cultural identity, but rather as a large-scale, global, more abstract kind of landscape than appears common in landscape research. Therefore, this research connects the landscape level to the energy landscape, which is conceptualised as a holistic combination of the energy system with other social and physical systems in a spatial manifestation surrounding the niche and embedding the regime (see further section 1.3.7 below).

More generally speaking, this research project suggests, in line with other researchers (Coenen et al., 2012; Gailing & Moss, 2016; Lawhon & Murphy, 2012), that the empirical evidence for transitions is rather weak due to the conceptual abstraction of transitions research. For example, scholars in transitions research developed ‘transition management’ as an approach for steering societal transitions towards sustainability (Kemp, Loorbach, & Rotmans, 2007; Loorbach, 2010; Rotmans et al., 2001). However, the guidelines are mainly based on theoretical arguments, and the empirical evidence supporting them is limited. Therefore, this study proposes an area-based research approach to find empirical evidence for transition dynamics.

1.4.3 Interdisciplinary approach

This project uses an interdisciplinary approach, which implies that academic fields are linked or integrated in a theoretical framework; that the study design and methodology are not limited to any one field; and that multiple perspectives are used throughout multiple phases of the research process (Aboelela et al., 2007; Rosenfield, 1992). Common interdisciplinary approaches include linking technological, sociological and economic approaches. This goes a step further than multidisciplinary research, in which researchers use their own theories, concepts and methods to study a shared research topic in parallel or sequence. The difference with transdisciplinary research is that interdisciplinary research does not commonly use participatory research methods, such as action research, nor does it aim to fully synthesise one or more academic or other fields, which are two common characteristics of transdisciplinary research (Aboelela et al., 2007; Rosenfield, 1992; Stokols, 2006). It should be noted that academic disciplines and coherent bodies of specialist knowledge can be intertwined in interdisciplinary and transdisciplinary approaches, transcending individual disciplinary knowledge (ibid.). An interdisciplinary research framework makes sense for studying a complex spatial and societal problem such
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as energy transition. ‘Interdisciplinary is a means of solving problems and answering questions that cannot be satisfactorily addressed using single methods or approaches’ (Klein, 1990, p. 196). Governing society towards a more sustainable path is an inherently transdisciplinary problem, since it poses interconnected challenges, requiring the integration of insights from different scientific domains and society at large (Brandt et al., 2013).

Area-based planning, complex systems and a multilevel perspective on innovation together form this interdisciplinary research framework (see Figure 2). Firstly, area-based planning stems from multidisciplinary spatial planning: a discipline on the cross-roads of several academic disciplines, particularly demography, sociology, economics, geography, urban design, landscape architecture and governance. Secondly, the multilevel perspective on innovation stems from multidisciplinary innovation studies based in evolutionary economics, which combines insights from biology with economics. Thirdly, complex systems stems from interdisciplinary complexity science, the concepts of which have been developed and used in many disciplines, for example in urban design (Portugali & Stolk, 2016) and in ecology (Scheffer, 2009). The widespread use of complexity science in research facilitates the exchange of knowledge between disciplines. Since each of the three research domains in this framework is already multidisciplinary and interdisciplinary, there are also overlaps between the three. This allows the research to more readily detect links between the theories and concepts, and build on these overlaps to develop new insights.

The interdisciplinary approach is used for developing a novel conceptual model in order to facilitate learning about energy transition phenomena across and beyond disciplines. The conceptual model (see section 1.3.4) combines perspectives from these three research domains to interpret energy transition phenomena in a novel way beyond the disciplines; that is, this research frames transition in relation to the energy landscape. This framing also brings into perspective certain differences in the conceptions of various disciplines. For example, conceptions of scale and level partly overlap, but are also used differently in governance and landscape studies. The further aim of this interdisciplinary approach is, therefore, to enhance scientific communication and knowledge exchange between scientific disciplines that do not share methodological or conceptual definitions (Tress, Tress, & Fry, 2005).
1.4.4 Conceptual Model

This section describes the conceptual model for studying energy transition, shown in the centre of figure 3. The following sections 1.4.5, 1.4.6 and 1.4.7 describe the concepts of this model in detail. Energy transition is a process involving multilevel interaction between landscape, regime and niches. The focus of this research is on the niche level. The concepts of local energy initiative, area-based niche and energy landscape, and the relationships between them guide this research. In Chapter 2, the conceptual framework is developed, and the three terms are conceptualised in order to suit an area-based inquiry into the interaction between the energy system and other systems in society.

The concepts are selected and conceptualised by adding an area-based approach to transition research (in Figure 3, area-based planning, at the bottom, is added to two the research domains of transition research at the top). While the three concepts are not the only ones that contribute to energy transition, these concepts are key here. They are used to interpret the contribution of local energy initiatives to energy transition from an area-based and complex systems perspective. In the following sections, the three concepts are described in more detail.
CHAPTER 2

The conceptual model can be understood as follows. Firstly, the double pointed arrow at the left indicates that area-based niches and local energy initiatives influence each other. Local energy initiatives can inhabit an area-based niche, which consists of a selection of actors and artefacts from the local energy landscape. This enables and constrains the development of local energy initiatives, which are have an interdependent relationship with the characteristics of the area-based niches. At the same time, the characteristics of the actors and artefacts in the local initiative define the character of the area-based niche. This relationship is addressed explicitly in Chapters 2 and 3 by analysing the importance of the area-based niche for local energy initiatives.

Secondly, the double arrow on the right indicates that the local energy initiative and the energy landscape interact and influence each other. The local energy initiative characterised by the actors and artefacts lies in one of the nested parts that define the energy landscape as a whole. At the same time, the energy landscape as a whole provides the wider context for the initiative. In addition to the area-based niche, the energy landscape as a whole enables and constrains the development, spreading and upscaling of the local energy initiative. This relationship is addressed explicitly in Chapter 4 by analysing the links between local initiatives and the systems and scales of the energy landscape.

Thirdly, the double arrow at the bottom indicates that the area-based niche and the energy landscape interact and influence each other. The area-based niche consists of a selection of actors and artefacts from the local energy landscape, and can be regarded a nested part of the energy landscape. The interaction within the area-based niche co-defines the development of the energy landscape and vice versa. In this research, the area-based niche is always studied from the perspective of a local energy initiative inhabiting the niche. The relationship between the niche level and landscape level is addressed explicitly in Chapter 5, where the study focuses on the institutional context by analysing to what extent energy transition policy facilitates the adaptation of low carbon niches to local landscape conditions.

Finally, the development of the energy landscape, the area-based niche and the local energy initiative as well as the interaction between the three, contributes to energy transition. This relationship is addressed in Chapters 2-6.

1.4.5 Local Energy Initiatives and their Low Carbon Practices
This research is centred on local energy initiatives in their surroundings in order to operationalise the area-based research approach. These initiatives provide an area-based starting point for studying energy transition. The inquiry into local energy initiatives will provide a more detailed understanding of the complex process of energy transition. By
studying multiple initiatives through case study research, this project could compare and integrate the findings.

This study considered local energy initiatives that generate and/or facilitate low carbon energy to be niche initiatives, which according to transition research, are important for triggering energy transition (Kemp et al., 1998). A study of the literature, desk research and interviews indicated that local energy initiatives have promising qualities for studying phenomena related to energy transition. Local energy initiatives are relatively simple units to analyse, although some become more complex through upscaling over time. While wind initiatives may have over 1000 participants, local solar initiatives may have only 10–20 participants (Hier Opgewekt, 2016, p.17). The initiatives develop their low carbon practices in local landscapes. Such initiatives include collective generation of solar energy in a local community, facilitation of advice for households on energy conservation or the generation of bio-energy by a farmer (De Boer & Zuidema, 2015b; Middlemiss & Parrish, 2010). Low carbon practices are directly related to energy transition and therefore suit the research purpose.

1.4.6 Area-based Niches
Innovations are often developed in niches in society. Example of niche innovations are the electric car, the smart grid or a low carbon practice such as local solar energy generation and consumption. Transition research emphasises the importance of niche innovations for triggering new dynamics in society that support energy transition. This research (Chapter 2) indicates that local energy initiatives develop low carbon practices in close connection to the conditions in local landscapes. For this reason, such niches are called ‘area-based niches’ – a location where local and policy innovation occurs, defined by the unique environmental surroundings that constrain and enable a context-specific innovation (see Figure 4). Non-area-based niches differ in the sense that the niche is independent of the location, but does depend on the specific technological, social or economic innovation that is being developed in the niche. In contrast, a low carbon practice developed in an area-based niche has unique links with a selection of actors and artefacts in the surroundings. Such low carbon practices have an interdependent relationship with the local conditions.
Figure 4: Image of the area-based niche defined by its unique position in the landscape in terms of physical and social systems. C=community system, P=physical infrastructure system, B=bio-physical system, Ec=economic system, En=energy system, G=governance system (Source: author).

The area-based niche facilitates the contextualised study of the interaction between systems in energy transition from a specific location in the energy landscape. This conceptualisation of the area-based niche helps to analyse the multiple relationships between the initiative and its context. Keeping an eye on the unique conditions in which initiatives develop prevents hasty conclusions being drawn about the role of local energy initiatives in energy transition. The contribution of niche initiatives to energy transition may be overlooked, as they are difficult to identify when only analysed on an aggregate level as a group. This research suggests, therefore, that contextualisation is needed to interpret the contribution of initiatives to energy transition.

1.4.7 Energy Landscapes

Another concept this research identified in the literature to support this area-based research approach to energy transition is the concept of an ‘energy landscape’, which draws attention to the relationship of the energy system to the landscape. This concept offers a more macroscopic angle to study energy transition than the notions of area-based niche and local energy initiative. While the literature emphasises the physical relationship of the energy system to the landscape (Pasqualetti, 2012; Stoeglehner et al., 2016; Sven. Stremke & Dobbelsteen, 2012), this research developed a more encompassing conceptualisation of the energy landscape based on complex systems research.

In line with landscape research, the landscape is an area that is the result of the (inter)action of natural and human factors. Since this research considers the landscape to have (bio)physical, socio-economic and institutional dimensions, the landscape is regarded both geographically, as an area, and metaphorically, as a complex system. Based on these considerations, the energy landscape is conceptualised as a geographic entity; a holistic combination of the energy system with other social and physical systems – composed of artefacts and actors – in a spatial manifestation (see Figure 5). The energy landscape is
regarded both as a physical area and as a complex system, giving expression to the interdependence of the energy system with multiple other physical and social systems and scales. To analyse the interaction between these systems a representation of six systems and four scales was chosen. Distinguished are six complex systems: energy, bio-physical, physical infrastructure, economic, community and governance, and four scales: local, regional, national and global. These systems and scales of the energy landscape are interwoven and overlapping, and they also interact. The energy system, in this framing, is composed of components that link or partly overlap with the other five systems. We operationalised the six systems in Table 1, indicating in greater detail what we consider them to refer to.

![Diagram of the energy landscape]

**Figure 5: Image of the energy landscape composed of 6 systems and 4 scales, and the area-based niche in its centre (Source: author)**

<table>
<thead>
<tr>
<th>Systems</th>
<th>Operationalisation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy System</td>
<td>Confined to activities and aspects directly related to extracting, transporting, storing, generating, transmitting, distributing and using energy from different resources.*</td>
</tr>
<tr>
<td>Physical Infrastructure</td>
<td>Built environment, transport, infrastructure, etc.</td>
</tr>
<tr>
<td>Bio-physical System</td>
<td>Land use, ecology, morphology, water, natural resources, etc.</td>
</tr>
<tr>
<td>Community System</td>
<td>Identity, culture, acceptance, etc.</td>
</tr>
<tr>
<td>Economic System</td>
<td>Trade, finance, etc.</td>
</tr>
<tr>
<td>Governance System</td>
<td>Public institutions, laws, rules, norms, etc.</td>
</tr>
</tbody>
</table>

*Table 1: Identifying the systems of the energy landscape. *(cf. Alanne & Saari, 2006; Bridge et al., 2013).
This conceptualisation of the energy landscape helps the development of a more detailed picture of the multiple relationships between the energy system and the landscape. An analysis of local energy initiatives and their low carbon practices helps to identify connections between the systems of the energy landscape that contribute to the emergence of a more sustainable low carbon energy system. At the same time, such an analysis provides insight into how to adapt and mitigate unsustainable energy practices and foster more sustainable ones.

1.5 Research questions

Central Research Question

How do we interpret the contribution of local energy initiatives to energy transition with an area-based research approach?

The central research question follows from the research objective and the interdisciplinary area-based research approach (see Sections 1.2 and 1.3 above). The research question is addressed on a theoretical and an empirical level. On a theoretical level, the aim is to contribute to recent efforts to improve transition research by incorporating insights from area-based spatial planning into the research approach. On an empirical level, the aim is to disclose the contribution of local energy initiatives to energy transition by studying these initiatives in practice and interpreting their spatial development. As part of the research, the aim is to establish whether local energy initiatives can be regarded as focal points in energy transition. This research considers a focal point to be a concise part of a complex system, which is relevant for the functioning of that system, and contains specific information about the functioning of the system as a whole. Because it is a concise part, the information can be investigated. For this research, a focal point would be a concise and relevant part of the energy landscape which explains specific phenomena in an energy transition.

The response to the central research question is supported by answers to the following research questions. Since a paper-based PhD develops sequentially, the answers to the following research questions reflect advancing insights into the research subject. The conclusions in Chapter 6 will, consequently, focus on the research objective and on answering the central research question.

Research Question 1

What is a suitable area-based research approach to study energy transition?
Chapter 2 develops the first outlines of the area-based research approach, and local energy initiatives are introduced as research objects with the potential to study energy transition. The relevance of connecting and integrating local energy initiatives with the landscape is investigated, firstly, based on a literature study of energy transition research and certain criticisms of it. Secondly, an empirical study is also reported on, composed of desk research, interviews with stakeholders and exploratory case study research of four wind farm projects in the northeast Netherlands and two local bio-energy initiatives.

This chapter also identifies two relevant concepts from the literature: ‘niche’ and ‘energy landscape’. The concepts are developed further into the notions of ‘area-based niche’ and ‘integrated energy landscape’ on the basis of the chapter’s empirical study (see Figure 2 for the relationship between these concepts and local energy initiatives). In Chapter 4 and Chapter 5 the concepts are operationalised further for empirical research. In these chapters, the term ‘integrated’ was removed from the concept of energy landscape, as it already assumes an integrated result. However, the present conceptualisation does enable the identification of the integration of multiple systems in the energy landscape.

Research Question 2
How does the interdependence of the energy system with the landscape change, in terms of land use, socioeconomic relationships and governance, in historical and emerging energy transitions?

In order to obtain a better understanding of the interdependence of the energy system with the landscape, Chapter 3 reports on a study of historical and emerging energy transitions. The characteristics of the pre-industrial, existing and emerging energy landscapes were investigated based on desk research. The interdependences between the energy system and the landscape are interpreted based on an interdisciplinary area-based research approach. The research studied differences in land use, socioeconomic relationships and governance styles. In line with transitions research, changes in these interdependences are interpreted as co-evolutionary processes of complex systems. The area-based approach directed the research to the interaction between the systems of the energy landscape. This indicated shifts in the relative importance of the local scale for system interaction within the pre-industrial, existing and emerging energy landscapes.

Research Question 3
Which starting points of co-evolution between the energy system and other systems of the energy landscape can be identified based on the development of local energy initiatives?

This question is also addressed in Chapter 3, by studying the development of local energy initiatives in their local contexts and how they may spread and upscale. A quick scan and
two case studies are conducted to collect empirical data. The quick scan is composed of analysing research reports on local energy initiatives, workshops the researchers participated in, and interviews conducted with experts. The case studies of the regional energy initiative, Green Hub, and the local energy initiative, Grunneger Power, are based on a desk study of documents and reports on the initiatives and interviews with relevant stakeholders. The analysis indicated several starting points for new co-evolutionary pathways in the energy landscape.

Research Question 4
How do local energy initiatives facilitate new interactions between the energy system and the landscape?

In Chapter 4 the interaction of seven local energy initiatives with the energy landscape is analysed. Each initiative is analysed through a case study composed of desk research, interviews, artefact-actor network mapping and Atlas TI analysis (see Section 1.4 for a description of the cases and the research methods). The links between local energy initiatives and the systems and scales of the energy landscape are mapped. The aim is to establish whether local energy initiatives create new interactions between the systems and scales of the energy landscape, which would make the initiatives interesting focal points in energy transition.

Research Question 5
To what extent does energy transition policy facilitate the accommodation of renewable energy projects by community energy initiatives and how are new practices feeding back into the energy policy system?

Chapter 5 analyses, firstly, to what extent an energy transition policy facilitates the accommodation of renewable energy projects by community energy initiatives. Secondly, it analyses how new practices feed back into the energy policy system. The case study concerns a new energy transition policy regulation in the Netherlands: the postcode rose regulation (PCR: Postcaderoosregeling). While working with the regulation, new practices are tried and tested that might influence existing practices and, notably, the policies and regulations surrounding them. The analysis is based on evidence from desk research, four niche initiatives and four governance actors involved in the PCR. The aim is to establish whether area-based energy practices are inducing the adaptation of energy transition policy.
1.6 Research design

1.6.1 Interpretive Qualitative Inquiry
This research involves an interpretive qualitative inquiry into energy transition. Such an inquiry attempts to make sense of a situation or process based on a study of details in specific cases (Mills, Durepos, & Wiebe, 2010, p. 486). Specific rules or patterns, which are distilled from case studies, remain connected with the actual situation. The interpretive approach, therefore, fits with a context-sensitive analysis, which is needed for this area-based research approach to energy transition. From this perspective, reality is considered organically and holistically (‘t Hart et al. 1998, p.103). This research is qualitative since it synthesises and interprets the raw data to identify patterns that describe and explain social phenomena (Mills et al., 2010, p. 756). As is often the case with this kind of research, this entails the application of various analytic techniques (triangulation), such as coding of data, analysing coded data and graphic representation of networks to interpret the raw data.

1.6.2 Multiple Case Study Design
To interpret the contribution of local energy initiatives to energy transition, this research followed a multiple case study design. ‘A case study is an in-depth exploration from multiple perspectives of the complexity and uniqueness of a particular project, policy, institution, program or system in a “real life” context’ (Simons 2009, p. 21, in: Thomas, 2011). The case study should not be seen as a method in and of itself. Rather, it is a design frame that may incorporate a number of methods (Thomas, 2011). Section 1.5.4 describes the methods and analytical techniques that are applied in the analyses. The case studies are based on snapshots of the initiatives at a certain time.

The case study design is partly exploratory and partly instrumental. The exploratory case studies were conducted to explore the research field and develop the area-based research approach (see Figure 6a). Together with a literature review, multiple exploratory cases contributed to theory building in the first research phase. The exploratory cases helped to conceptualise and operationalise aspects of energy transition. For the operationalisation, categories were created (systems, spatial scales and governance levels) to interpret empirical data in the subsequent research phase. The instrumental case studies were used to apply the area-based research approach (see Figure 6b). Multiple instrumental cases contributed to theory testing in the second research phase. The data was interpreted on the basis of the conceptualisations and categories, which were developed in research phase one. By combining exploratory and instrumental case studies, this research contributes to both theory building and theory testing.
Case Selection

The selection of local energy initiatives was based on an inventory of initiatives primarily located in the northern Netherlands, but also elsewhere in the Netherlands and other countries (Song & De Boer, 2014). In addition, a GIS analysis was conducted to gain insight into the coupling of natural and cultural systems. To this end, the research analysed how bio-energy installations can be allocated in a logical way within a region by coupling local bio-energy potentials to local socioeconomic activity (De Boer & Zuidema, 2014). This helped to obtain an idea of the key characteristics of local energy initiatives and their potential physical and socioeconomic synergies with the local contexts. For the exploratory cases, initiatives in the northern Netherlands were selected, with the three bio-energy cases aiming for area-based synergies and the other four wind cases not focusing on establishing area-based synergies (see Table 2). For the instrumental cases in the second research phase, seven cases were selected (see Table 3). These cases were selected on the basis of being local energy initiatives based in the Netherlands and showing a variety in the kind of renewables that they generated and/or facilitated. The initiatives were selected on the basis of having a capacity to contribute to energy transition, not in the sense that they were typical (Thomas, 2011).
### Exploratory Case Characteristics of Phase 1

<table>
<thead>
<tr>
<th>Initiative</th>
<th>Hoogeveen</th>
<th>Haarlose Veld HOE Duurzaam</th>
<th>Green Hub</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initiator</td>
<td>Municipality</td>
<td>Agri-Nature Org.</td>
<td>Municipalities</td>
</tr>
<tr>
<td>Organisation</td>
<td>PPP</td>
<td>Foundation</td>
<td>PPP</td>
</tr>
<tr>
<td>Renewables</td>
<td>Bio-energy</td>
<td>Bio-energy</td>
<td>Bio-energy</td>
</tr>
<tr>
<td>Additional activities</td>
<td>Residual heat from bio-energy to be used for sports park</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Presented in chapters</td>
<td>1 and 2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Initiative</th>
<th>De Drentse Monden</th>
<th>Oostermoer</th>
<th>Meeden-Menterwolde</th>
<th>Emmen-Compascuum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initiator</td>
<td>Project developer</td>
<td>Project developer</td>
<td>Project developer</td>
<td>Project developer</td>
</tr>
<tr>
<td>Organisation</td>
<td>Company</td>
<td>Company</td>
<td>Company</td>
<td>Company</td>
</tr>
<tr>
<td>Renewables</td>
<td>Wind energy</td>
<td>Wind energy</td>
<td>Wind energy</td>
<td>Wind energy</td>
</tr>
<tr>
<td>Additional activities</td>
<td>Windvogel participates with 1 windmill</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Presented in chapter</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2: Overview of exploratory case characteristics of research phase 1. The analysis of these initiatives is based on desk study and additional empirical data from workshops and conferences.
## INSTRUMENTAL CASE CHARACTERISTICS OF PHASE 2

<table>
<thead>
<tr>
<th>Initiative</th>
<th>EnergiePon</th>
<th>‘tHaantje</th>
<th>Windvogel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initiator</td>
<td>Farmer</td>
<td>Farmer</td>
<td>Citizen collective</td>
</tr>
<tr>
<td>Organisation</td>
<td>Company</td>
<td>Company</td>
<td>Cooperative</td>
</tr>
<tr>
<td>Renewables</td>
<td>Bio-energy</td>
<td>Bio-energy</td>
<td>Wind energy</td>
</tr>
<tr>
<td>Additional activities</td>
<td></td>
<td>Facilitation of participation in German solar fields</td>
<td></td>
</tr>
<tr>
<td>Interviewee</td>
<td>Responsible Employee</td>
<td>Farmer and brother</td>
<td>Project + windmill operating member</td>
</tr>
<tr>
<td>Presented in chapter</td>
<td></td>
<td></td>
<td>3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Initiative</th>
<th>BergenEnergie</th>
<th>Grunneger Power</th>
<th>MorgenGroene Energie</th>
<th>DeRamplaan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Established</td>
<td>2012</td>
<td>2011</td>
<td>2010</td>
<td>2011</td>
</tr>
<tr>
<td>Initiator</td>
<td>Citizen collective</td>
<td>Citizen collective</td>
<td>Citizen collective</td>
<td>Citizen collective</td>
</tr>
<tr>
<td>Organisation</td>
<td>Cooperative</td>
<td>Cooperative</td>
<td>Cooperative</td>
<td>Cooperative</td>
</tr>
<tr>
<td>Renewables</td>
<td>Solar energy</td>
<td>Solar energy</td>
<td>Solar energy</td>
<td>Solar energy</td>
</tr>
<tr>
<td>Additional activities</td>
<td>Facilitation of individual uptake</td>
<td>Facilitation of individual uptake</td>
<td>Facilitation of individual uptake and energy conservation</td>
<td></td>
</tr>
<tr>
<td>Date of interview</td>
<td>10 Jan 2015</td>
<td>09 Mar 2015</td>
<td>23 Feb 2015</td>
<td>12 Mar 2015</td>
</tr>
<tr>
<td>Interviewee</td>
<td>Board member</td>
<td>PCR project member</td>
<td>Board member</td>
<td>Board member</td>
</tr>
<tr>
<td>Presented in chapters</td>
<td></td>
<td></td>
<td>3 and 4</td>
<td></td>
</tr>
</tbody>
</table>

Table 3: Overview of instrumental case characteristics of research phase 2. The analysis of these initiatives is based on desk study and interviews, which are coded in Atlas TI.
1.6.4 Methodology
The empirical data was gathered from the case studies using an analytic triangulation of several methods and analytical techniques: literature review, desk research, workshops, interviews, interview transcript analysis with Atlas TI, artefact-actor network analysis, and network mapping. The synthesis of data gathered using several techniques helped to develop a more in-depth picture of the case studies, as well as to observe the cases in a broader context through a literature review and desk research.

Literature review
In the exploratory research phase entailed a literature review and was conducted to establish any theoretical or empirical research gaps, develop a research framework and also to frame the research in the light of existing scientific literature on sustainability transitions. A wide range of literature was studied, including literature on energy systems, energy landscapes, spatial planning theory, complex systems, resilience thinking, social-ecological systems, geographic landscapes, transitions research, historical energy transitions, critical transitions, co-evolution, multilevel governance, adaptive governance, social innovation and social networks theory. This literature was used to deduce the area-based research approach and for writing the theory sections in Chapters 2-5.

Desk Research
The desk research consisted of an analysis of research reports, policy documents, statistical data, newspaper articles and websites. The main research topics investigated on the local, regional, national, European and global scale were: performance of energy systems (fossil fuel-based, renewable energy, low carbon, decentralised and distributed energy and residual heat), historical and emerging energy transitions, energy transition policy, and various low carbon energy initiatives. The desk research provided background information to situate the research and its case studies within a specific context. The empirical data was used for the empirical parts of Chapters 2-5.

Workshops
In the exploratory research phase, the researchers participated in several workshops that discussed and/or developed plans for future energy systems and sustainable landscapes. These included workshops in the context of the broader research projects, of which this PhD project was a part: MACREDES (EDGAR, 2011) and DELaND (Groen Gas-Grünes Gas, 2012). The workshops were used to discuss the research object and research approach, generating new ideas and receiving feedback.
Interviews
In the exploratory research phase, semi-structured exploratory interviews were conducted with relevant stakeholders to gain more insight into the research field. To ensure an openness to learning, these interviews did not follow a rigid interview format – the questions that were prepared were posed according to the line of discussion. In the theory-explanation phase, semi-structured in-depth interviews were conducted with key members of local energy initiatives, such as board members (see Table 2). To gain detailed insight into the development of local energy initiatives and be able to compare results, these interviews included a set of questions that were always posed in the same order. This technique was used as it can offer detailed insight into perceptions of why and how certain processes emerge and decisions are taken (Emans, 2004). The balance between questions and fluid conversation allowed interviewees to bring up other relevant issues and insights (Liamputtong & Ezzy, 2005). The interviews were digitally recorded, transcribed and stored by the researcher.

Interview Transcript Analysis
The transcriptions of the in-depth interviews were coded and processed with the qualitative analysis software ATLAS.ti. This software allows for a transparent analysis of qualitative data by coding text parts. A list of codes was developed, which were used to code text parts of the interview transcripts using ATLAS.ti. Actors and artefacts that were mentioned in the transcripts were tagged and coded, and also classified into a system and a scale. Additional codes were added to text parts with useful descriptions (such as co-dependence link or frequent contact). The evaluation of the link strengths is based on the typology of Nooteboom and Gilsing (Gilsing & Nooteboom, 2006; 2004). Other codes were applied to analyse the policy experiences of the initiatives for Chapter 5. By further clustering the codes into super-codes in Atlas TI, the linked actors and artefacts in each initiative could then be classified into systems and scales. This analysis was done to identify the quality of the links and to identify linking patterns in Chapter 4.

Artefact-Actor Network Analysis
The local energy initiatives of the second research phase were analysed to determine their links with actors and artefacts in their contexts. The actors were people and groups, such as a community initiative, firm or Ministry; the artefacts were material constructs, such as a PV panel or journal article (cf. Reinhardt, Moi, & Varlemann, 2009). The advantage of artefact-actor networks, as Reinhardt et al. (ibid.) explain, is that not only are social networks mapped, but also the artefacts in the network. This gives a more complete image of who and what is enabling the low carbon practices of the initiatives. The links were mapped graphically as ego networks, with the initiative in the centre of the network (Prell, 2012). The analysis of the networks is based on the coded interviews in Atlas TI and on additional desk research.
Synthesis: Network Mapping

In a final research step, the analyses of the interview transcripts and the artefact-actor networks were synthesised and used to construct graphic images of the network links of the initiatives. To this end, the relationship between niche and energy landscape was operationalised graphically. The researchers created an innovative graphic image of the energy landscape with the area-based niche in the centre (see Figure and Chapter 4). This image is based on the area-based operationalisation of the concepts of ‘niche’ and ‘energy landscape’ in terms of complex systems.

The artefact-actor networks were then mapped onto the systems and scales of the energy landscape. This was done as follows. By coding and analysing the interviews in ATLAS.ti, the linked artefacts and actors were classified into systems and scales. The artefacts and actors belonging to a system-scale were aggregated as were the link strengths. Each system-scale of the energy landscape (see Figure 5) was then assigned an aggregated link strength of absent, weak or strong. By doing so, innovative graphic images were created of the local energy initiatives and their network links. This unconventional approach allowed the research question to be innovatively addressed.

1.7 Thesis outline

The research is presented in this thesis as follows (see Figures 7a and 7b for a graphical representation of the thesis outline). In the introduction in Chapter 1, the area-based research approach to the research object of energy transition is presented. Chapters 2-5 address the various research questions. Chapter 2 identifies the potential and the building blocks of this area-based research approach to study energy transition. The concepts of ‘area-based niche’, ‘energy landscape’, ‘local energy initiatives’ and ‘energy transition’ are introduced and conceptualised. The first part of Chapter 3, desk research demonstrates how the role of the local landscape changes through historical and emerging transitions of energy landscapes through. In the second part, the starting points of several co-evolutionary pathways are identified by studying synergies in the development of several local energy initiatives. Chapter 4 analyses the network maps of several local energy initiatives. The initiatives appear to link the systems and scales of the energy landscape in their area-based niche. By doing so, the initiatives create new interaction paths in the energy landscape. Chapter 5 discusses to what extent energy transition policy facilitates the adaptation of low carbon niches to landscape conditions. Finally, Chapter 6 brings together the most important findings and conclusions of this research on local energy initiatives and the spatial aspects of energy transition. The thesis closes in Chapter 7 with a reflection on the research findings. The chapter highlights implications for spatial planning.
and public policy, discusses the methods and overall research findings from a wider angle, and completes the thesis with suggestions for follow-up research.
**Introduction**

An Area-based Research Approach to Energy Transition

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**Chapter 1**

**Conceptualisations**

Local Energy Initiative

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**Chapter 2**

Area-based Niche

Energy Landscape

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Figure 7a: Graphic representation of the thesis outline (Source: author): Chapters 1-2. Key central diagram: L=landscape, FF R= fossil fuel regime, LC R= low carbon regime, N=niche initiative. Key for the diagrams at the bottom: C=community system, P=physical infrastructure system, B=bio-physical system, Ec=economic system, En=energy system, G=governance system.
Figure 7b: Graphic representation of the thesis outline (Source: author): Chapters 3-7. Key for diagrams at the bottom: C=community system, P=physical infrastructure system, B=bio-physical system, Ec=economic system, En=energy system, G=governance system.
References


